



Prof. Daniele Chiappini
Full Professor
GSD: IIND01/F – Fluid dynamics
University of Rome Niccolò Cusano



Dates: 14, 15 and 16 April 2026

Morning Session (Theory) 9:30 – 12:30

Afternoon Session (Practical Exercises) 14:30 – 17:30

Room: W (Old Building)

University of Rome Niccolò Cusano

Advanced Engineering Analysis

Introduction to Finite Difference Analysis

The aim of this course is to provide the basis for the finite difference analysis. This powerful tool may be adopted for a large number of engineering problems. The course is structured so to give to attendants a general overview of the methods which may be used while facing up with a differential equation (both ordinary and partial). More specifically the first part of the course is addressed to the definition of the discrete forms of derivatives which are most commonly used in applications. After, the Ordinary Differential Equations (ODE's) have analysed with referring both to Boundary Values Problems as well as to Initial Values Problems. ODE's have solved in case of system of equations as well, and the way to pass from a high order equation to a system of first order ones is presented as well. Thus, the focus moves towards the numerical solution of Partial Differential Equations (PDE's) both at steady state and during transients. Particular attention has addressed to the distinction between explicit and implicit methods with defining to stability conditions when needed.

The course is organized in 6 lessons (expected duration 3h/each). The first part is purely theoretical, while within the second one some applications will be developed. It is warmly suggested to have at least one laptop every two students. The exercises will be developed in Matlab.

Students' attendance will be monitored during the course execution – 75% minimum attendance is required for the access to the final exam.

At the end of the course an exam is mandatory to achieve the positive fulfilment (discussion of self-developed exercises – PowerPoint presentation).

To join the course, please send an email to daniele.chiappini@unicusano.it

Total expected duration 18 h – 6CFU

Table of contents:

- Introduction to numerical methods;
- Solution of Ordinary Differential Equations;
- Solution of System of Ordinary Differential Equations

- Solution of Elliptic Equations
- Iterative Solution of Linear Systems
- Solution of Parabolic Equations - 1D case
- Solution of Parabolic Equations - 2D case
- Solution of Hyperbolic Equations - 1D case
- Solution of Hyperbolic Equations - 2D case

Short Curriculum Vitae

Daniele Chiappini received the B.S and M.S. degrees (summa cum laude) in mechanical engineering at University of L'Aquila, and then the PhD in Engineering of Energy-Environment at University of Rome Tor Vergata, in 2004, 2006 and 2010, respectively. He is currently Associate Professor at University of Rome Niccolò Cusano where he holds two courses in Fluid-Dynamics and Internal Combustion Engines.

His current research interests include the Computational Fluid-Dynamics of complex systems both through traditional Navier-Stokes solvers and alternative ones such as Lattice Boltzmann Methods. He deals with conjugate heat transfer, multi-phase flows and flow through porous media. He is recently focusing on Phase Change Materials modeling. He is involved in different EU project aimed at the development of electric powertrains, focusing on the thermal-management aspects and control logic definition for integrated systems.