Syllabus of the course “Advanced Mathematical Methods”

Contents: Introduction to partial differential equations. The linear transport equation. The method of characteristics for quasilinear first order equations. Scalar conservation laws. The diffusion equation. The Laplace and the Poisson equations: classical approach. Basics on functional analysis and Sobolev spaces. Boundary value problems for the Poisson equation: modern approach. The wave equation.

Reference Books: S. Salsa, Partial differential equations in action. From modelling to theory, Springer-Verlag Italia, Milan, 2008. Y. Pinchover, J. Rubinstein, An introduction to partial differential equations. Cambridge University Press, Cambridge, 2005. L.C. Evans, Partial differential equations. American Mathematical Society, Providence, RI, 2010.

Objectives: The purpose of this course is to train students from different disciplines, such as applied mathematics, physics, engineering, to integrate theory and models in the study of some problems arising in applied sciences and which result in partial differential equations; the course will provide students with a mathematical background suitable to analyze them. D1. (Knowledge and understanding) At the end of the course, the student will be able to derive a mathematical model from general principles and constitutive laws, will have got knowledge of some basic partial differential equations and of their main features, as well as will have learnt some methods for their resolution. D2. (Ability to apply knowledge and understanding) The student will be able to face and solve simple exercises, questions, problems, of theoretical and computational nature, related to the topics covered in the course. D3. (Making judgments) The student will be able to describe, model and solve simple problems of applicative interest, making use of the mathematical tools developed in the course. D4. (Communication skills) The student will be able to describe mathematical topics with an adequate command, as well as to reformulate practical problems in mathematical language. D5. (Learning skills) The student will be able to read and understand books and articles using the mathematical tools learned in the course, and will be able to learn more advanced notions.

Prerequisites: Basics on differential and integral calculus in several variables, series of functions, ordinary differential equations, linear algebra.

Information will be posted on https://moodle2.units.it// and https://www.dmi.units.it/~obersnel/