



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Mathematical Physics

2021-3-E3501Q059

Aims

Learning the methods for the solution of partial differential equations of Mathematical Physics.

Contents

Introduction to classical partial differential equations of mathematical physics and to the related models: Laplace equation, heat equation and wave equation. Solution methods.

Detailed program

- Introduction to partial differential equations:
 - Maxwell equations, transport equation and Euler equations
- Transport equation
 - characteristics and solution of the initial value problem
- Wave equation
 - Physical models (D'Alembert e Lagrange)
 - Characteristics and casual cone
 - Dependence on the space dimensions: Huygens principle and Kirchhoff solution
 - Lorentz invariance
 - Effects of sources and boundaries (Neumann e Dirichlet)
 - Well-posedness
- Heat equation (Diffusion equation)

- Physical models (Fick law and probabilistic derivation à la Einstein)
- Self-similar solutions
- Fundamental solution and solution of the initial value problem
- Weak maximum principle
- Effects of sources and boundaries (Neumann e Dirichlet)
- Well-posedness
- Comparison between wave and heat equation. Dispersion relation.
 - Hints about the Schroedinger equation
- Laplace equation
 - Radial solutions
 - First and second Green identities
 - Mean property for harmonic functions
 - Strong maximum principle for harmonic functions
 - Dirichlet principle
 - Neumann boundary condition (compatibility conditions) and Dirichlet boundary conditions
 - Poisson equation: representation formula and general solution
 - Green functions
 - Method of images
- Distributions
 - Definition and main properties
 - Dirac delta and Green functions
 - Fourier transform method for computation of propagators
 - Weak solutions
- Burgers-Hopf equation
 - Characteristics and initial value problem.
 - Shocks and their regularization.

Prerequisites

Elements of classical Analysis (I & II). Elements of finite dimensional Euclidean geometry. Elements of Physics (I & II)

Teaching form

Lectures

Until the end of the health emergency, the lessons will be uploaded online in the elearning platform.

Textbook and teaching resource

Textbook:

W. Strauss Partial differential equations, Wiley&Sons

Suggested readings:

S.Salsa, Partial differential equations in action, Springer

L.C. Evans, Partial differential equations, AMS

G. B. Whitham, Linear and nonlinear waves, Wiley&Sons

Semester

2nd semester

Assessment method

Oral exam: solution of exercises, statements and proofs of theorems, relevant examples and physics derivation of equations, solutions of exercises proposed in class.

Five exam sessions (January-February, June, July, September).

Until the end of the current health emergency, the oral exam will be online using WebEx with access from the e-learning page.

Office hours

By appointment.
