

# UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

# **COURSE SYLLABUS**

# **Mathematical Physics**

2223-3-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

## 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

2?? semester

#### **Assessment method**

Written 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).

# Office hours

By appointment.

# **Sustainable Development Goals**

QUALITY EDUCATION