

# UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

# **COURSE SYLLABUS**

# **Mathematical Physics**

2324-3-E3501Q059

#### **Aims**

The course aims at showing fundamental examples of partial differential equations, at teaching the methods for finding solutions and the study of the properties of such solutions.

#### **Contents**

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

## **Detailed program**

- Introduction to partial differential equations: Maxwell equations, continuity equation and Euler equation.
- Continuity equation: initial value problem solution and method of charachteristics.
- Wave equation: deduction from the model of vibrating string and of chain of harmonic oscillators,
  1-dimensional solutions, characteristics and causal cone, dependence on the dimension of the space,
  Huygens principle and Kirchhoff solution, Lorentz invariance, effects of sources and boundary conditions,
  well posedness.
- Heat equation: physical meaning, self-similar solutions, fundamental solutions and initial value problem solution, weak maximum principles, effects of sources and boundary conditions, well posedness.
- Comparison between heat and wave equations, dispersion relations.
- Laplace equation: radial solutions, Green identities, properties of harmonic functions, Dirichlet principle, boundary conditions and compatibility conditions.
- Poisson equation: representation formula and general solution, Green functions, method of images.
- Distributions: definition and fundamental properties, Dirac delta and Green functions, computation of

propagators, weak solutions.

# **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

Second

#### **Assessment method**

The exam is individual and is divided in a written and an oral part. In the written exam the proficiency in solving exercises and problems similar to those discussed in the lectures is evaluated. IThe oral exam is focused on assessing the understanding of the mathematical concepts and their derivation, by asking the statements and the proofs of theorems, relevant examples and deductions of equations from physical examples.

### Office hours

By email appointment.

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# **Sustainable Development Goals**

QUALITY EDUCATION