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