UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Mathematical Methods for Materials Science

2425-1-FSM01Q004

Aims

The aim of the course is to provide some basic tools of Mathematical Analysis, notably of Fourier analysis and complex analysis, which reveal useful in the study of the differential equations of Classical Physics and Quantum Mechanics.

The expected learning outcomes include:

- the knowledge and the understanding of the fundamental definitions and statements, as well as of the arguments in some proofs; the knowledge and the understanding of some classes of fundamental examples to which the theory applies.
- the ability to solve exercises and simple problems and to interpret the results; the ability to apply the theoretical results to specific examples and settings; the ability to communicate and explain in a clear and precise manner both the theoretical aspects of the course and their applications to specific situations.

Contents

Complex analysis. Fourier series. Fourier transform. Tempered distributions and Dirac delta.

Detailed program

Fourier series

Fourier coefficients and series in real and complex form. Dirichlet theorem. Parseval formula.

Complex Analysis

Complex functions. Holomorphic functions and harmonic functions. Cauchy's theorem. Laurent series. Residue theorem. Jordan Lemma. Calculation of integrals by means of residue theorem.

Fourier transform I

Classical Fourier tranform and antitransform. Properties of the Fourier transform. Parseval formula. Gaussian functions. Calculation of some Fourier transforms with the residue theorem.

Distributions

Schwartz space. Tempered distributions. Operations and derivatives of distributions. Dirac delta distribution.

Fourier transform II

Fourier transform of tempered distributions. Convolution. Applications to the resolution of some partial differential equations.

Prerequisites

Basic mathematical analysis: trigonometry, complex numbers, differential calculus for functions of one or several variables, ordinary differential equations, integral calculus (very important), sequences and series of functions.

If ever a student thinks he has gaps on one of the prerequisites above, he is warmly invited to point it out to the teacher as soon as possible (ideally before the beginning of the course).

Teaching form

Lectures with blackboard and exercises sessions. The course will be taught in English.

Textbook and teaching resource

Some lecture notes prepared by the teacher will be made available in the e-learning.

These notes can be supplemented by textbooks, as for instance:

- Advanced engineering mathematics / Erwin Kreyszig. Wiley 10. ed. 2011 (available on Internet Archive at)
- Methods of Applied Mathematics with a MATLAB Overview / John H. Davis. Birkhauser (available as an ebook at Bicocca Library)
- Applied Mathematics / Gerald Dennis Mahan. Kluwer 2002 (available as an ebook at Bicocca Library)
- K. F. Riley, M. P. Hobson and S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press (available only in paper form at Bicocca Library)
- Advanced engineering mathematics / K.A. Stroud. Palgrave Macmillan. 6. ed. 2020. 978-1352010251

Semester

First half of the 1st Semester 2023-2024.

Assessment method

A **written exam**, which consists in open questions about solution of exercises, problems or the theory of the course. Marks out of 30.

The **oral exam** in general is not mandatory. However it can be requested either by the student or by the teacher in order to confirm or modify the score obtained at the written exam. Oral exams consist in: discussion of the written exam; questions on definitions, statements and (selected) proofs of theorems; solution of further exercises can be required.

The exams aim at verifying the level of knowledge, the student's independence in making judgements, as well as his/her communication skills.

There are no ongoing partial test.

Office hours

By appointment, sending an e-mail to giona.veronelli@unimib.it.

Sustainable Development Goals