UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Mathematical Methods for Materials Science

2425-2-ESM01Q007

Aims

The objectives of the course are the following.

Knowledge and understanding. The student will learn the principal results of the theory of complex numbers, linear algebra and ordinary differential equations and will become acquainted with their tools and techniques.

Applying knowledge and understanding. By means of several examples and exercises, the student will develop the ability of applying the theorical results presented in the lectures to problems related to complex numbers, linear algebra and ordinary differential equations.

Making judgements. The student will be able to face critically problems concerning complex numbers, linear algebra and ordinary differential equations, identifying by himself/herself the most appropriate tools among those introduced in the course.

Communication skills. The student will become familiar with the introduced language and mathematical formalism, which will make him/her able to communicate with rigor and clarity the acquired knowledge.

Learning skills. The student will be able to apply the acquired knowledge to different contexts, in particular in the study of other scientific disciplines (such as chemistry and physics) which require a good mathematical background.

Contents

Complex numbers, linear algebra and ordinary differential equations.

Detailed program

1. Numeri Complessi
Definition and elementary properties; geometrical interpretation; operations with complex numbers; trigonometrical form; nth-roots.

2. Linear Algebra.
Real and complex vector spaces, dependent and independent sets in a linear space, subspaces. Bases and dimension of a linear space, euclidean spaces, norms and (Hertmitian) inner products, Cauchy-Schwarz inequality, orthogonality. Orthonormal bases. Linear transformations: matrix representation, null space and range, nullity and rank, matrices, matrix operations, determinants, Binet formula, Laplace expansion; inverses of square matrices, change of the bases. Eigenvalues and eigenvectors of endomorphisms, diagonalizability. Adjoint endomorphism, hermitian operators, Spectral Theorem, simultaneous diagonalization.

3. Ordinary Differential Equations.
Separation of variables. Linear differential equations. Linear independence of the solutions, the Wronskian. The variation of the constants method. The case of constant coefficients. Linear second order equations with constant coeffcients.

Prerequisites

Matematica I e Matematica II

Teaching form

28 hours of in-person, lecture-based teaching (4 ECTS)
24 hours of in-person, exercises classes teaching (2 ECTS)

The course is taught in italian.

Textbook and teaching resource

For linear algebra:

- Notes (in italian) by Prof. Felli
- Strang, Gilbert. Linear algebra and its applications

For the rest of the program the teachers will make available some notes.

Semester

Second year, First semester

Assessment method

****Written examination with **optional oral colloquium.**

The goal of the evaluation (partial, complete and oral colloquium) is to ascertain a correct assimilation of concepts and techniques studied during lessons and exercises sessions.

The written exam is passed ONLY if the vote is greater or equal to 18/30.

The written exam will consist of exercises (similar to those done in the classroom and/or proposed to the students in the lectures) up to 22-24 points. There will be a maximum of 6-8 points for questions relating the theory (basic definitions and theoretical results done in the lectures).

Oral exam (optional)
Oral exam is not compulsory and will be done typically after a couple of days of the written exam. It is only possible to take the oral exam if the mark in the written part is greater or equal than 18/30.

Students who got a positive grade in the written part (i.e., at least 18/30) might choose to take an oral exam to try to get a better grade if *they think that their preparation is good enough.* Needless to say, the oral exam can change the written grade in the positive, as well as in the negative direction. In particular, the minimal grade in the written part plus a poor oral part might end up in a failed exam.

The students who have not passed the written part, **do not have the right to do an oral exam

Partial exams (not compulsory)

During the course there will be two partial exams. Students who passed both (with mark >=18/30) will have the option to skip the final written exam. Students who obtain at least 15/30 in any of the two partials tests, will have the option of being examined of the other part (only) in the first written final exam. The final mark would be the average of the marks obtained in each part.

Number of exams
During the year there are **6 exams** in the following periods: **two** in January-February, **one** in April/May, **one** in June/July, **one** in September and **one** in November. The final exam can be replaced by two-three intermediate written tests, the first of which will take place in November while the second and third will take place toward the end of the course.

Office hours

By appointment

Sustainable Development Goals

QUALITY EDUCATION