



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Combinatorica Algebrica

2021-1-F4001Q090

Aims

In line with the aims of the CdS, the course will provide students the knowhow necessary to deal with transmission of information via noisy channels, in order to analyze optimal error-correcting and -detecting procedures. Time permitting some rudiments of programming languages as Magma and Gap will be imparted. These tools serve to emphasize experimental aspects of mathematical discovery. We will also impart the necessary skills to comprehend and analyze the main technical and proof methods.

Those will be tested via problem solving and resolution exercises related to the contents of the course.

Contents

Information Theory, messages transmission, error probability, entropy, Shannon's Theorem, symmetric channel, Error-correcting codes, alphabet, finite fields, linear codes, Hamming codes, cyclic codes, Reed-Solomon and Reed-Muller codes, Weight preserving maps, MacWilliams' Theorems, Invariant Theory of Finite Groups.

Detailed program

1. Information Theory, messages transmission, noisy channels, error probability, entropy, Shannon's Theorem, symmetric channel.
2. Error-correcting codes, alphabet, finite fields, linear codes, Hamming codes, cyclic codes, Reed-Solomon and Reed-Muller codes.
3. Upper and lower Bounds, Sphere Packing, Gilbert-Varshamov, Perfect codes and their classification.

4. Weight preserving maps, MacWilliams' Theorem, Monomial maps, Wilson Theorem.
5. Weight enumerator polynomials, MacWilliams' Theorem, self-dual codes, isotropic vectors, Witt Theorem,.
6. Invariant Theory of Finite Groups, primary and secondary invariants, Cohen-Macaulay rings, groups generated by pseudo-reflection, Shephard-Todd Theorem.

Prerequisites

Algebra I and II, Linear Algebra, Group Theory, Finite Field Theory, Elementary notions of Thermodynamics and Probability.

Teaching form

The course consists of Lectures for 8 credits. They will give knowledge of basic definitions, relevant results and theorems. On the other side, we intend to give skills to use results and knowledge in solving exercises and analysing problems

Because the evolution of Covid-19 health emergency, at the moment (A / A 2020/21) it is not possible to say if the lectures will be in presence; in any case the lectures of this course will be videotaped and will be available to students on the e-learning platform.

Textbook and teaching resource

Textbooks:

- Hall, Notes on Coding Theory, 2005
- Tablet taken notes available on this platform.
- LaTeX Notes in pdf format available on this platform.

Further Readings:

- Huffman and Pless, Fundamentals of error-correcting codes, 2010
- MacWilliams and Sloane, The Theory of Error-Correcting Codes, 1977
- Smith, Polynomial invariants of finite groups, 1995

Semester

Second semester.

Assessment method

The exam starts with a discussion concerning the solution with the support of the programming language Magma of a previously assigned problem.

This will immediately be followed by an oral enquiry assessing both the student's acquisition of the course contents and her/his capabilities of analyzing and solving problems. Both aspects equally contribute to the final score.

In case of failure the student will be told if a new problem (or a better solution for the old one) is requested in order to face a new oral exam.

Pending the current health emergency, the oral exam will be held online through WebEx or analogous, with access made available on the e-learning website.

Mark range: 18-30/30.

Office hours

By appointment. Due to the current health emergency, student reception will be carried out online through WebEx or analogous.
