Introduction to Coding Theory (MATH 532)

Sabancı University, Spring 2021

Lecturer: Prof. Dr. Michel Lavrauw (mlavrauw@sabanciuniv.edu), Office: FENS 1015

Course content

The course aims to cover the following basics: block codes, linear codes, syndrome decoding, bounds on the parameters of codes, BCH and cyclic codes, MDS codes, algebraic geometry codes, LDPC codes, Reed-Muller codes, Kerdock codes. If time allows some more recent developments (e.g. quantum stabiliser codes, and/or network coding) will also be addressed.

Background and references

Students enrolled in the course are expected to have basic knowledge of algebra (including finite fields).

There are many books on coding theory, and most of them would serve as a good resource for this course. Here are some references.

[1] Simeon Ball: *A course in algebraic error-correcting codes.* Compact Textbooks in Mathematics. Birkhäuser/Springer, Cham, 2020.
[2] J. Bierbrauer: *Introduction to coding theory.* Discrete Mathematics and its Applications (Boca Raton). Chapman & Hall/CRC, Boca Raton, FL, 2005.
[3] Jonathan Hall: *Notes on Coding Theory.* available from
`https://users.math.msu.edu/users/jhall/classes/CODENOTES/CODING-NOTES.HTML`
[4] J. H. van Lint, J. H. *Introduction to coding theory.* Third edition. Graduate Texts in Mathematics, 86. Springer-Verlag, Berlin, 1999.
[5] F. J. MacWilliams; N. J. A. Sloane: *The theory of error-correcting codes.* I & II. North-Holland Mathematical Library, Vol. 16. North-Holland Publishing Co., Amsterdam-New York-Oxford, 1977.

The lectures will pretty much reference [1], which is the most recent one in the list. Most topics treated in the course can also be found in the other references. Reference [5] is a classic.

Objectives

On successful completion of this course, students should be able to:

- develop an understanding of the basics of error correcting codes.
- demonstrate knowledge of applications of algebra and geometry to the theory of error-correcting codes;
- demonstrate the ability to understand and outline proofs of major theorems covered in this course;
- demonstrate the ability to apply basic ideas of abstract mathematics in computations and proofs;
- demonstrate the ability to reason abstractly in exploring concepts covered in this course.

Performance assessment

- Students are expected to attend all lectures. If for some reason this is not possible, then the lecturer should be informed before the start of the lecture. (This does not apply to students who have received a time conflict approval.) All students are responsible for all the communications about the course (exams, homeworks, assignments, etc...) which are made during the lectures.

- Homework exercises and assignments will be published on SUCourse on a regular basis, and should be uploaded to SUCourse before the deadline (generally on the last day before the next lecture). Solutions will contribute (30%) towards the final grade.
- There will be no midterms exams. There will be one final exam (70 %), further details of which will be announced in the lectures and on SUCourse.