MATH-625: Algebraic Coding Theory,
Spring Semester 2014

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Classes Days / Time: MW/ 2:00 – 3:15 PM
Location: GMCS–308, San Diego State University
Class Website: https://blackboard.sdsu.edu

Office Hours: T: 10:00 AM – 1:00 PM and TH: 1:30 – 2:30 PM. If your schedule does not allow you to come to my office during these hours, by all means please make an appointment with me so we can find a mutually agreeable day and time. I strongly encourage you to see me if there is anything related to the course that you are unclear on or would like to know more about. I want to help you learn the material and do well in the class.

Textbook


Course Description, Relevance, and Learning Outcomes

This course is intended for graduate students in mathematics, computer science, and engineering. Claude Shannon’s 1948 paper *A Mathematical Theory of Communication* gave birth to the twin disciplines of information theory and coding theory. As Shannon wrote, “The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point.” This is what we call reliability. However, efficiency is also required: Informally, transmitting information must not require a prohibitive amount of time and effort. In this course, we will study Shannon’s theorem on the existence of “good” codes and also the main families that have been proposed in the last sixty years, along with their respective decoding algorithms. This is essentially Chapters 1, 2, 7 – 10. Time-permitting, we will also study other relevant families of codes. The theory can be seen essentially as an application of elementary probability and statistics, and linear and abstract algebra.

Relevance: The study of error-control codes (ECC) is important both from a theoretical and from a practical point of view. From the theoretical point of view, the design of the so-called good codes involves techniques from algebra (linear and abstract), combinatorics, and algebraic geometry. Hence, results in the theory of ECC can be
regarded as applications of those areas of mathematics. From the practical point of view, ECC provide the means for achieving the high degree of efficiency and reliability required in modern data transmission and storage systems. The control of errors that occur during the transmission of information is a major concern of the designer of such systems. Therefore, the communications industry can be seen as the main customer of this area.

**Learning Outcomes**: This course will give you insight into a discipline of tremendous practical significance. You will: 1) understand how ECC work, 2) know how to compute theoretical limits on error-correction, 3) know how to design a linear code based on the concepts of rate and minimum distance, and 4) learn some of the relationship between algebra and ECC. You will also be given the opportunity to study a topic of your choice pertaining to coding theory. The rationale behind this is that you will get exposed to material not covered in class, and hopefully it will inspire you to do research on it.

**Prerequisite**

The main prerequisite is mathematical maturity. No familiarity with coding theory will be assumed. On the other hand, students are expected to be comfortable with vector spaces, polynomial rings in one variable, elementary probability, and discrete mathematics.

**Examinations, Homework, and Grading**

There will be two exams worth 350 points each and a final project worth 300 points. The project will consist of a report concerning a particular topic (that you will choose from a list) and a presentation in class. You will be free to choose topics which are not on the list as well.

**Exam 1**: Wednesday, February 26.

**Exam 2**: Wednesday, April 23.

In summary:

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<td>Tests</td>
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<td>Project</td>
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The numerical points for letter grades (A, A–, B+,….) will be based only on the texts, project, and homework scores. Roughly, an A is above 86%, A– is above 80%, B is above 70%, C is above 60%, etc.
Read the textbook carefully. You are strongly advised to do all the homework problems as this is an important part of the learning process in mathematics. As with other math courses, experimentation is fundamental for you to understand the material, see patterns, and obtain results. If you get stuck on a problem, please do not hesitate to contact me. You are also encouraged to discuss homework problems with your classmates as this frequently provides new perspective and new solutions.

**Students with Disabilities**

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Disability Services. Your cooperation is appreciated.

**References for Further Reading**