MA4891 Syllabus

The Theory of Error-Correcting Codes

Instructor: William J. Martin
Office: SH 305A (let's hope!)
Phone: none
e-mail: `martin@wpi.edu`
Office hours: 11:00-11:30 MTRF
. . . or just video chat at any time.

MA 4891 – D01, D Term 2020
Error-Correcting Codes
Text: "Notes on Coding Theory"
by J. I. Hall
Zoom Meeting ID 436-833-170
Meetings: 10-10:50 MTRF

In this course, we see one of the most powerful modern applications of abstract algebra. The twentieth century brought us widespread communications over many forms of "channel": from telephone lines to internet packets to spacecraft communications, our messages have been cleverly protected through the use of algebra against various forms of corrupting noise. The goal of this course is to introduce the algebraic theory of error-correcting block codes and to survey some of the recent developments and recent applications of the theory.

Related topics of data compression and cryptology will only be touched upon briefly. Our focus is on adding redundancy (so we expand rather than compress) so that a message or file can be reconstructed even after it has been slightly corrupted. Once we understand our communication channel, as well as the basic options we have for signal components, we encounter questions in pure mathematics, from Fourier series to metric spaces, to algebra over finite fields. It is this last aspect of communications that we focus on in this course.

The topics we develop include the general theory of linear codes, Hamming and Reed-Muller codes, generalized Reed-Solomon codes, cyclic codes, and bounds for codes. As time permits, we will discuss modern applications in cryptography, biometrics, numerical integration and quantum computing.

We assume the student is highly motivated and able to read the text independently. In addition to general mathematical maturity, we assume material from the recommended background: MA1971, MA2071, MA3825.

Literature, including cryptography:

- J.I. Hall, Notes on Coding Theory (2017)
- R. Hill, A First Course in Coding Theory
- R.A. Mollin, An Introduction to Cryptography, Richard A. Mollin
- G.A. Jones and J.M. Jones, Information and Coding Theory
- D.C. Hankerson, et al., Coding Theory and Cryptography: The Essentials

TERM SCHEDULE

Here is a rough outline of what I expect us to cover in D Term:

Mar. 25 to Mar. 27	*Basic Example, Channels*	Chapters 1, 2
Mar. 30 to Apr. 3	*Hamming space, Basic Bounds, Shannon's Thm*	Chaps. 2, 3
Apr. 6 to Apr. 10	*Linear Codes*	Chap. 4
Apr. 13 to Apr. 17	*Hamming Codes*	Chap. 5
Apr. 21 to Apr. 24	*Generalized Reed-Solomon Codes*	Chap. 6
Apr. 27 to May 1	*Cyclic Codes*	Chap. 8
May 4 to May 8	*Special Topics*	
May 11 and May 12	*Additional Topics (as time allows)*	

GRADES

A: 100 % – 88 %; **B**: 87.99 % – 74 %; **C**: 73.99 % – 60 %

GRADING SCHEME

Homework (best 5 out of 6):	50 %		
Zoom Participation:	10 %	Final Exam (Oral, individual):	40 %

Assignments

Assignments will be scanned and sent via email; due dates will be given when problem sets are distributed. (As a rough guide, let us expect homework due on Thursdays, April 2, 9, 16, 23, 30 and May 7.) Now is the time to ensure you have a reliable way to scan and send easily readable homework solutions. Options include Adobe Scan and Notes on the iPhone.

Tests

There will be one oral final exam, worth 40% of your grade. We will schedule these Zoom meetings in May.

Participation

Attendance at all class meetings is mandatory. If you must miss a class meeting, please contact me to explain why this should not affect your grade. Each student is expected to actively engage in group discussion and problem solving, to present solutions to problems during class meetings when called upon.

Moreover, all students are expected to participate daily by asking and answering questions. At the end of the course, each student will be assigned a grade for this component based on the instructor's judgment.

ACADEMIC INTEGRITY

As a student in this course, you are expected to familiarize yourself with WPI's Academic Integrity policies which can be found at

`https://www.wpi.edu/about/policies/academic-integrity`

All acts of fabrication, plagiarism, cheating, and facilitation will be prosecuted according to the university's policy. If you are ever unsure as to whether your intended actions are considered academically honest or not, please see Professor Martin (or check here).

STUDENTS WITH DISABILITIES

If you need course adaptations or accommodations because of a disability, or if you have medical information to share with me that may impact your performance or participation in this course, please make an appointment with me as soon as possible. If you have approved accommodations, please request your accommodation letters online through the Office of Disability Services Student Portal.

If you have not already done so, students with disabilities who need to utilize accommodations in this class are encouraged to contact the Office of Disability Services (ODS) as soon as possible to ensure that such accommodations are implemented in a timely fashion. This office can be contacted via email: DisabilityServices@wpi.edu, or via phone: (508) 831-4908.

INFORMATION ON THE WEB

There will be no official course web page. Documents will be uploaded to CANVAS. When appropriate, additional materials may be posted on my teaching webpage.

`https://users.wpi.edu/~martin/TEACHING/4891/`