Syllabus
MA535/CS525D Topics in Coding Theory

Instructor: William J. Martin
Office: SH 305A
Phone: 831-6764
e-mail: martin@wpi.edu
Office hours: Mon 3:00-5:30
or by appointment

MA 533 – Spring 2015
Discrete Mathematics II
Text: "Introduction to Coding Theory" (3rd ed.)
by J. H. van Lint
Meetings: Mon 5:30–8:20pm, SH308

The theory of error-correcting codes is a wonderful subject in modern applied mathematics. Motivated by the real-world challenge of reliably transmitting digital information over noisy channels, a beautiful theory emerged in the 1950s through 1970s, importing powerful tools from algebra and combinatorics, crafting elegant solutions to numerous immediate problems, and framing a number of monumental challenges for the research community, some of which remain unresolved to this day. At the same time, surprising connections to group theory, lattices and modular forms, and finite geometry drew in researchers with wide-ranging expertise and interests.

But the subject has changed in the past decade or two. While the more applied community has lost interest in some of the more esoteric questions that emerged in the 1960s and '70s, new applications and challenges have begun to reshape the subject and mathematicians are now scrambling to determine which tools from the old toolkit still apply and what new machinery is needed to tackle the latest puzzles.

The goal of this course is to move directly to the newest challenges in coding theory, to attempt to lay out a modern view of the subject by surveying some of the most recent developments, applications and open questions. Naturally, the tricky part is to efficiently summarize the tools from the (traditional) theory that are needed for our investigation. While no previous knowledge of coding theory will be assumed, the course will move at a fast pace and will assume quite a bit of mathematical maturity on the part of the student. Knowledge of abstract algebra will be required and we will try to assign remedial work, as necessary, at the beginning of the course. Knowledge of discrete mathematics and/or information theory and communications systems will also be quite useful.

TERM SCHEDULE

Here is a rough outline of what we will cover in the 14 Wednesday evening meetings:

Part I:	Algebraic Background and Basic Coding Theory	(2 weeks)
Part II:	Quantum Error Correction and Quantum Information Theory	(3 weeks)
Part III:	Low Density Parity Check Codes, Polar Codes	(3 weeks)
Part IV:	Network Coding	(2 weeks)
Part V:	Applications to Cryptology	(1 week)
Part VI:	RAID Architectures and Large Data Facilities	(2 weeks)

WORKLOAD

Each student is expected to attend and participate in every scheduled class meeting.

Each week, a number of exercises will be assigned for students to complete on their own or in groups. Most weeks, three exercises will be assigned for credit. These are to be completed individually and submitted the following Monday for course credit.

Students will form teams early in the semester and these teams will carry out detailed research projects as assigned by the instructor. These projects will be surveys of specific new developments in coding theory. Before Monday, April 6, each team will submit a project report on their assigned topic. In our last few class meetings, teams will give oral presentations summarizing their projects.

We will have one-hour exams on Monday February 23 and Monday March 30. If needed, there will be a comprehensive final take-home exam due on Monday, May 4.

Your grade will be based on the activities listed above.

INFORMATION ON THE WEB

The course web page is

`http://www.wpi.edu/~martin/TEACHING/current.html`

ACADEMIC HONESTY

Each student is expected to familiarize him/herself with WPI's Academic Honesty policies which can be found at
`http://www.wpi.edu/offices/policies/honesty`
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 me.

STUDENTS WITH DISABILITIES

Students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Disability Services Office (DSO) as soon as possible to ensure that such accommodations are implemented in a timely fashion. The DSO is located at 157 West Street, (508) 831-4908.

If you are eligible for course adaptations or accommodations because of a disability (whether or not you choose to use these accomodations), or if you have medical information that I should know about please make an appointment with me immediately.

SOME RESOURCES:

- *"The Theory of Error-Correcting Codes"* by F.J. MacWilliams and N.J.A. Sloane (Elsevier North-Holland, 1977)
- *"Algorithmic Results in List Decoding"* (Foundations and Trends in Theoretical Computer Science, #6) by Venkatesan Guruswami (Now Publishers Inc 2007)

- *"A Course in Combinatorics" (2nd ed.)* by J.H. van Lint and R.M. Wilson (Cambridge, 2001)
- *"Designs, Graphs, Codes and their Links"* by P. J. Cameron and J. H. van Lint (Cambridge, 1991)
- *"Quantum Computing: A Gentle Introduction"* by E.G. Rieffel and W.H. Polak (MIT Press, 2014)