Course Outline
Math 699: Coding Theory
Winter 2014

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Office: 10-2030

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Office Hours: MWF 11:30-12:30

Lecture: MWF 16:30-17:20, 5-174

Prerequisites: Math 320 (desirable: any of Math 420, Math 421, Math 450)

Textbook: An introduction to error-correcting codes with applications by S.A. Vanstone and P.C. van Oorschot.

Course content: The course deals with the mathematical aspects of error correction. Topics to be studied:
1) Fundamentals
2) Finite fields
3) Linear codes
4) Cyclic codes
5) BCH codes
6) Applications

Evaluation:

Survey paper:	5%
Assignments:	20%
Midterm:	25% (Feb. 26)
Final Exam:	50%

(This course is also offered as Math 499; the undergraduate students will be evaluated in a similar way, except that they will receive up to 25% for assignments and will not be required to write a survey paper.)

Description: The theory of error detecting and correcting codes is a branch of engineering and mathematics which deals with the reliable transmission and storage of data. Information media are not 100% reliable in practice, in the sense that noise (any form of interference) frequently causes data to be distorted. To deal with this undesirable, but inevitable situation, some form of redundancy is incorporated in the original data. With this redundancy, even if errors are introduced (up to some tolerance level), the original information can be recovered, or at least the presence of errors can be detected.

The study of error-correcting codes is a branch of coding theory, a more general field of science dealing with the representation of data, including data compression and cryptography. These three areas are related in that they involve the transformation of data from one representation to an alternate representation and back again via appropriate encoding and decoding rules.

Computers now have error-correcting capabilities built into their random access memories. Disk storage is another area of computing where error-coding is employed. Storage capacity has been greatly increased through the use of disks of higher and higher capacity. With this increase in density, error probability also increases, and therefore information is now stored on disks using error- correcting codes. Hamming codes, or more generally, linear codes are in use in this application.

The space probes transmitted pictures back to earth. The channel for such transmissions is space and the earth's atmosphere. Solar activity and atmospheric conditions can introduce errors into weak signals coming from the spacecraft. The codes used in these transmissions are known as Reed-Muller codes and Golay code, respectively.

The compact disk system pioneered by Phillips and Sony Corporations is another example of the application of error-correcting codes to digital communications. Given an error-coded digital recording, a digital audio system can (on playback) correct errors introduced by fingerprints and scratches and virtually makes the disc everlasting. Cross-interleaved Reed-Solomon codes are used for error correction in this system.

Further applications include Digital Video Broadcasting (DVB), Transmission Control Protocol/ Internet Protocol (TCP/IP), Digital Subscriber Line (DSL) technology, streaming video, mobile phones, and many more. Some of these applications involve more complex and more efficient codes such as Convolutional Codes, Turbo Codes and Low-Density Parity-Check (LDPC) codes.