SYLLABUS
Spring 2003

University Course No.: ENEE 722
Course Title: Error Correcting Codes

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Texts:

Optional Reference: Stephen B. Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice Hall, 1995.

My hand written lecture notes, selected journal articles, and problem sets are on my web site
www.ee.umd.edu/∼tretter
I will be following these notes closely.

Prerequisites: Basic Linear Algebra

Course Description:

This course will demonstrate how redundancy can be used to improve the performance of a communication system operating over a noisy channel. Specifially, convolutional, trellis, and cyclic error correcting codes will be studied.

Course Requirements:

Homework: Problems will be assigned but not collected. Solutions will be distributed. The problems are at the end of the web site index.

Computer Exercises: A couple of encoding and decoding problems requiring computer programs to be written will be assigned and collected.

Exams: A midterm and a final exam. Both exams will be closed book.

Exam 1 - about halfway through the course. Closed book. 75 minutes.

Exam 2 - (Final Exam) Last class day. Only material after 1st exam. Closed book. 75 minutes.

Grading Policy: Exam 1 - 45%, Exam 2 - 45%, Projects - 10%

Course Outline:

I. Introduction to Linear Codes (3 lectures)

A. Groups and fields

B. Linear block codes

C. Maximum likelihood decoding

D. Hamming distance and weight

E. Guaranteed error correction theorem

F. Distance structure of block codes

G. Syndrome decoding

H. Examples of linear block codes
    1. Hamming codes
    2. Maximal length codes

II. Bounds on Error Correction Capabilities of Block Codes (2 lectures)

A. Elspas bound
B. Hamming bound
C. VGS bound
D. Gilbert bound

III. Convolutional Codes (8 lectures)

A. Description and Properties
    1. Definition
    2. Huffman transform
    3. Generator and check matrices
    4. Encoding circuits
    5. Error correction capabilites
B. Deterministic Decoding (Now obsolete, will not discuss)
    1. Feedback and definite decoding
    2. Syndrome decoding
    3. Threshold decoding
    4. Self orthogonal codes
C. Sequential Decoding
D. The Viterbi Decoding Algorithm
E. Trellis Coded Modulation for bandlimited channels

IV. Algebraic Cyclic Block Codes (9 lectures)

A. Introduction to groups and fields
B. Cyclic code definition
C. Galois fields
D. Syndrome decoding
E. Particular Cyclic Codes
    1. Maximal length codes
    2. Hamming codes
    3. BCH codes
    4. Reed-Solomon Codes

V. Burst Error Correcting Codes (as time permits)

A. Gallager bound
B. Bounds on burst correction for cyclic codes
C. Maximum likelihood burst decoders
D. Interleaving

VI. Turbo Codes (as time permits)