EE 490/599: Error Correcting Codes
Course Syllabus: Fall 2007

COURSE INFORMATION:
Class Schedule: TTh 12:45 - 2 PM; Room 235, Engineering Bldg 69
Course URL: http://www2.nau.edu/~sh295/ECC

INSTRUCTOR INFORMATION:
Instructor: Dr. Sheryl Howard
Office Hours: To be announced
Office: Room 261, Engineering Bldg 69
Phone: 523-3504
Email: sheryl.howard@nau.edu
URL: http://www2.nau.edu/~sh295

COURSE TEXTBOOK:
There is no required course textbook. Material for the lectures will be gathered from several different sources. However, a good reference book is the following:


You may wish to check this book out from the library or order a copy for your own reference library, but the material will be covered sufficiently in lecture so as to not require the textbook.

Under Course Outline, the Lin & Costello chapter corresponding to the material covered is given. Some topics will be covered in greater detail during the lectures than in the book.

Other references on error-correcting codes include:


CO-CONVENEED COURSE:
This course is a co-convened course; undergraduates take this course as EE490, and graduate students take this course as EE599. The course lectures apply to both undergraduate and graduate students. Both undergraduate and graduate students are expected to do homework and project components of this course. However, each homework assignment will have an extra problem included specifically for the graduate students; undergraduates are not required to do this extra problem. Similarly, each mini-project will have a section designated for graduate students only. Undergraduates are not required to do this extra section of each mini-project. If desired, however, undergraduates may work any of the extra graduate homework problems or extra mini-project sections for extra credit.

OFFICE HOURS:
Office hours will be announced in class and posted on the course website. If your schedule conflicts with my
office hours, email me at sheryl.howard@nau.edu to make an appointment. If you have questions on the course material, please contact me as soon as you can for assistance.

**COURSE GRADING:**
This course is project-based, rather than exam-based. There will be two mini-projects and one final project assigned during the semester. Further details on the projects are listed in the Projects section below. The course grade is based on the projects, presentation of the final project, homework and attendance at the graduate seminar.

<table>
<thead>
<tr>
<th>Mini-Project 1</th>
<th>100 points</th>
<th>Due approximately 5th week</th>
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</thead>
<tbody>
<tr>
<td>Mini-Project 2</td>
<td>100 points</td>
<td>Due approximately 9th week</td>
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<tr>
<td>Final Project Report</td>
<td>150 points</td>
<td>Due finals week</td>
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<tr>
<td>Final Project Presentation</td>
<td>50 points</td>
<td>Last week of classes</td>
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<tr>
<td>Homework</td>
<td>100 points</td>
<td>Approximately every week</td>
</tr>
<tr>
<td>Seminar Attendance</td>
<td>50 points</td>
<td>Reports due week 15</td>
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<tr>
<td>Total</td>
<td></td>
<td>550 points</td>
</tr>
</tbody>
</table>

Final grades will be determined by the following percentages:

A = 90+%, B = 80-89%, C = 70-79%, D = 60-69%, F = below 60%.

However, at the professor’s discretion, grading cutoffs may be lowered slightly.

**LATE WORK:**
Assignments are due when specified. Late homework will only be accepted until solutions are posted (typically two days past the due date), and will be penalized by 10% off. Late project reports will only be accepted for one week past the due date, and will be penalized by 20% off. The final project presentation is due when scheduled, as is the final project report. No late final project reports will be accepted. Seminar reports are due two weeks before finals.

**PROJECTS:**
This course is project-based instead of exam-based. Two mini-projects will be assigned, both of which involve programming in C or Matlab. One month is allowed for completion of each mini-project.

Graduate students taking EE 599 will be assigned an extra section on each mini-project to complete. Undergraduates taking EE 490 are not required to do the graduate portion of each mini-project. However, if they wish, undergraduates may do the EE 599 portion for extra credit.

The final project is chosen by each individual student. The instructor will provide a list of possible final project topics. The student may also choose their own topic after consultation with the instructor.

Undergraduates taking EE 490 may do either a literature search on a topic of interest, or a programming project, pending project approval from the course instructor.

Graduates taking EE 599 are required to include both a programming component and a literature review in their final project. The final project topic must be approved by the course instructor.

**HOMEWORK:**
Homework will be assigned approximately every week. Solutions to all homework problems will be posted on the course website approximately two days after the homework assignment is due. After solutions are posted, no late homework for that assignment will be accepted.

Graduate students taking EE 599 will be assigned additional homework on each assignment, which the undergraduates taking EE 490 will not be required to complete. The undergraduates may do the EE 599 problem(s) for extra credit if they wish.
SEMINAR ATTENDANCE:
Both graduate and undergraduate students are required to attend 8 seminar presentations of EE698. Students are required to turn in a written report about two of these seminars for credit. If students are unable to attend the EE698 graduate seminar due to scheduling conflicts, they may either attend seminars held by another department in the College of Engineering and Natural Sciences and write reports on two seminars, or read two articles from either the IEEE Spectrum, the IEEE Communications Magazine, the IEEE Transactions on Communications, the IEEE Transactions on Information Theory or the IEEE Transactions on Wireless Communications (pending article approval by course instructor), and write a report on each article.

COURSE OUTLINE:
The proposed schedule below is a guideline only and is subject to change. Supplementary topics may be included at the instructor's discretion.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics Covered</th>
<th>Text Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motivation for Coding, Noise in Communication Systems</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>2</td>
<td>Probabilistic Channels, Modulation</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>3</td>
<td>Probability of Error, Channel Capacity</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>4</td>
<td>Block Codes: Encoding, Minimum Distance, Decoding</td>
<td>Ch. 3</td>
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<tr>
<td>5</td>
<td>Performance Analysis; Repetition and Hamming Codes</td>
<td>Ch. 3 and 4</td>
</tr>
<tr>
<td>6</td>
<td>Convolutional Codes: Encoding, Catastrophic Codes</td>
<td>Ch. 11</td>
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<tr>
<td>7</td>
<td>Convolutional Codes: State Diagrams, Trellises</td>
<td>Ch. 11</td>
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<tr>
<td>8</td>
<td>Maximum-Likelihood Decoding, the Viterbi Algorithm</td>
<td>Ch. 12</td>
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<tr>
<td>9</td>
<td>Performance Bounds</td>
<td>Ch. 12</td>
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<tr>
<td>10</td>
<td>Soft-Decision Decoding: Maximum A Posteriori (MAP) Decoding</td>
<td>Ch. 14</td>
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<tr>
<td>11</td>
<td>Iterative Decoding, Use of MAP Decoders in Iterative Decoding</td>
<td>Ch. 14</td>
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<tr>
<td>12</td>
<td>Turbo Codes: Encoding and Decoding</td>
<td>Ch. 15</td>
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<tr>
<td>13</td>
<td>Low-Density Parity Check (LDPC) codes: Sum-Product Decoding</td>
<td>Ch. 17</td>
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<tr>
<td>14</td>
<td>LDPC Encoding and Code Design, Min-Sum Decoding</td>
<td>Ch. 17</td>
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<tr>
<td>15</td>
<td>Final Project Presentations</td>
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<tr>
<td>16</td>
<td>Finals Week: Final Project Report Due</td>
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COURSE PREREQUISITES:
EE 110 and EE 348 with a grade of C or better. Good Matlab and C programming skills are expected. Familiarity with the following mathematical skills: complex arithmetic, linear algebra and integration.

COURSE DESCRIPTION:
A first course in coding theory. Linear block codes, decoding and encoding. Hamming distance and error-correcting capabilities. Convolutional codes, maximum-likelihood decoding and the Viterbi algorithm. Iterative decoding and design of state-of-the-art iteratively-decodable codes such as turbo codes and low-density parity-check codes (LDPCs).

COURSE OBJECTIVES:
Understand the principles of error-correcting codes, and their application to communication systems with noise.
CELL PHONE POLICY:

- **Cell Phone Use in Class:**
  If you have a cell phone or beeper, please turn it to silent mode. You should not make calls during class. You should not speak or text message in the classroom. If you do receive an emergency call, ask to be excused so that you can take it outside the classroom.

UNIVERSITY POLICIES:
Links to the following policies are posted on the course website.

- Academic Integrity
- Accommodation of Religious Observance and Practice
- Classroom Management
- Safe Environment
- Students with Disabilities

ACADEMIC DISHONESTY:
Incidents of cheating or plagiarism are treated seriously. The NAU policy on academic dishonesty in Appendix G of the current Student Handbook (linked on the course website) applies in these situations.