Outline: CS 4803/8803 Computing and Coding with Probability

(Classroom: CCB (College of Computing) 102)

Instructor: Prasad Tetali, office: Skiles 234, email: tetali@math.gatech.edu

Course Objective: To cover the essentials of error-correcting codes, from a combinatorial, probabilistic and computational perspective.

Summary:

The classical topic of error-correcting codes has received tremendous attention in recent years, thanks largely to important contributions by theoretical computer scientists. This course attempts to cover basics of error-correcting codes (such as Hamming, Hadamard, Reed-Solomon codes), bounds on codes, and move on to current topics such as expander codes, turbo codes, and list decoding. The algorithmic and probabilistic point of view will be emphasized.

The course is particularly aimed at the junior/senior undergraduates, comfortable with mathematics. Requisite background in linear algebra, finite fields, elementary probability, and randomized algorithms will be reviewed along the way.

Topics:

1. Introduction: The q-ary symmetric channel, Classical Shannon's theorems, Probabilistic methods

2. Linear codes: Representation through generator and parity-check matrices, Syndrome decoding, Hamming codes

3. Introduction to finite fields and double-error-correcting codes

4. Bounds on the parameters of codes : The Singleton bound; MDS codes, The Hamming sphere-packing bound; perfect codes, The Gilbert-Varshamov bound

5. Reed-Solomon and related codes : Generalized Reed-Solomon and Concatenated codes.

6. Modern stuff : Basics of List-decoding, Expanders, Expander Codes.

Time permitting :

7. Structure of finite fields and cyclic codes : Minimal polynomials, BCH codes

Course material based on the following sources:

(1) "Introduction to Coding Theory," Ron Roth, Cambridge University Press (2006).

(2) Lecture notes by Madhu Sudan (MIT).

(3) "Introduction to Coding Theory," van Lint

Workload: Five or six homeworks, plus a 25 minute presentation.