

# Introduction to Coding Theory

MATH406/806/MTHE406

Winter 2012

**Time and Location:** Mon 8:30, Tues 10:30, Thurs 9:30 at Jeffery Hall 115  
**Course Website:** <http://www.mast.queensu.ca/~math406/>  
**Instructor:** Jan Foniok  
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**Office hours:** Weds 9:30–11:30 at Jeffery 207 or by e-mail appointment

## Course Outline

- *Introductory Concepts:* Block codes, encoding and decoding, maximum-likelihood decoding, minimum-distance decoding, error detection and correction. Shannon's noisy-channel coding theorem.
- *Linear codes:* Minimum distance, generator and parity-check matrices, dual codes, standard array decoding, syndrome decoding. Repetition codes, Hamming codes.
- *Bounds on Code Parameters:* Hamming bound, Singleton bound, Gilbert-Varshamov bound, Plotkin bound. Using bounds to design good codes for a given set of parameters.
- *Basic Finite Field Theory:* Definitions, prime fields, construction of prime power fields via irreducible polynomials, existence of primitive elements, minimal polynomials.
- *Algebraic Codes:* Bose-Choudhury-Hocquenghem (BCH) and Reed-Solomon Codes. Decoding of generalized Reed-Solomon codes. Applications of Reed-Solomon codes in digital communications and storage. Cyclic codes as ideals of polynomial rings.
- *Other topics to be selected from, as time permits:* List decoding of Reed-Solomon codes, Golay codes, Reed-Muller codes, Goppa codes and algebraic geometry codes, convolutional codes, turbo codes, expander codes, low-density parity-check (LDPC) codes.

## Textbooks

There is *no required textbook*. The *recommended textbook* is: R.M. Roth. *Introduction to coding theory*. Cambridge University Press, 2006. See the course web page for more information.

## Marking Scheme

Undergraduate Students: Written Assignments 40%, Active Participation 10%, Final Written Exam 50%

Graduate Students: Written Assignments 32%, Active Participation 8%, Project 20%, Final Written Exam 40%

The use of calculators, mobile phones and tablets, other communication devices, computers, written notes or other aids will *not* be allowed during the final written exam.

All components of this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to Queen's Official Grade Conversion Scale (see course website).

### **Academic Integrity**

Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility (see [www.academicintegrity.org](http://www.academicintegrity.org)). These values are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University (see the Senate Report on Principles and Priorities at <http://www.Queensu.ca/secretariat/policies/senateandtrustees/principlespriorities.html>).

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments conform to the principles of academic integrity. Information on academic integrity is available in the Arts and Science Calendar (see Academic Regulation 1 at <http://www.Queensu.ca/artsci/academic-calendars/2011-2012-calendar/academic-regulations/regulation-1>), on the Arts and Science website (see <http://www.Queensu.ca/artsci/academics/undergraduate/academic-integrity>), and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery and falsification, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.