TELE4653

DIGITAL MODULATION AND CODING

S1, 2008

Lecturer:
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Course information
This course is a comprehensive analysis of modern digital communication systems. It encompasses all aspects of communication systems, ranging from coding and decoding, modulation and demodulation rationales, and presents analysis of their noise and bandwidth performance. It aims to provide the student with the necessary background knowledge, skills and fundamentals to work successfully in the telecommunications industry. The course requires a firm knowledge of the concepts covered in ELEC3104: Digital Signal Processing, and TELE3113: Analogue and Digital Communications. In addition, the material will require a moderate degree of mathematical ability.

Course Objectives
At the end of the course the student should:
(a) Understand the effects of noise on digital communication systems, and methods for efficient, robust communication in the presence of noise.
(b) Appreciate the relative merits and disadvantages of a wide variety of different modulation methods.
(c) Be able to construct appropriate digital codes and their corresponding decoding algorithms to improve communications reliability.

Course Handbook Entry

Lecture Times
Monday 9-11am, EE224

Tutorials
The tutorials start in Week 1. The first tutorial will be revision, and all students are welcome to attend. Students should attend a tutorial every second week. However, the tutorials will cover different questions each week, so students may wish to attend tutorials every week.

Monday 12pm, EE220 (Even and Odd weeks), Tuesday 12pm, EE220 (Odd)

Laboratory
The laboratories are all in EE302, performed on the TIMS and MATLAB.

Tue 3-6 (Odd), Fri 9-12 (Even and Odd), Fri 1-4 (Even and Odd)

The assessable labs start in week 1. If a student must miss a laboratory for any reason please contact the lecturer as soon as possible, in order that alternative arrangements can be made.

There are 5 labs to complete in total, and students must get marked by a demonstrator before the end of each lab session. A satisfactory performance in the lab component is a requirement of passing this course. Due to public holidays some lab times may have to rescheduled. Announcements will be made in lectures and on the subject website regarding alternative arrangements.

Assessment
Final Examination: 55%
Labs: 20%
Two Assignments: 20% (Due around weeks 6 and 10)
Lab Quizzes: 5% (online quizzes at the beginning of lab classes)

Academic honesty and plagiarism
Plagiarism is a serious issue at UNSW. Students should all be familiar with the university wide policy for plagiarism and academic honesty. This can be found at www.lc.unsw.edu.au/plagiarism.
Course Website
The subject website is http://subjects.ee.unsw.edu.au/tele4653.
Check this regularly, as important announcements about the course will be posted on this website. All lecture notes, tutorials and solutions, past exam papers, and laboratory information can be found on the website. WebCT Vista will also be used for on-line quizzes at the beginning of each laboratory class.

Syllabus
Provides detailed understanding of techniques used to process digital information in order to ensure its reliable delivery over noisy channels. Examines the fundamental resources available to telecommunication systems and develops techniques for understanding the implications of different modulation and coding techniques on these fundamental quantities. The course also provides a general understanding of the role of digital modulation and coding in practical digital communication systems.

Brief review of key concepts from signal processing, linear systems, sampling theory and source coding. Digital transmission through AWGN channels. Baseband signalling and pulse shaping. Carrier amplitude, phase and frequency modulation techniques. Spread spectrum modulation. Carrier and clock synchronisation. Channel capacity. Forward error correction coding. Applications of these techniques in typical digital communications systems.

Course Outline
- Revision of Basic Mathematical Concepts: Vector spaces, convolution, Fourier transforms, random processes, Gaussian statistics.
- Baseband Signalling: Additive White Gaussian Noise (AWGN) Channels, Amplitude Shift Keying (ASK), matched filters, Bit Error Rate (BER) and Symbol Error Rate (SER), Inter-Symbol Interference (ISI) and pulse shaping.
- Bandpass Amplitude Modulation: Bandpass ASK, Baseband equivalents, Quadrature components of noise, Quadrature Amplitude Modulation, Bandwidth efficiency.
- Signal Space Methods: Phase Shift Keying (PSK), Differential PSK, M-ary orthogonal signals, Shannon bound.
- Frequency Modulation: Frequency Shift Keying (FSK), Non-coherent detection, Continuous Phase Modulation (CPM).
- Carrier and Symbol Synchronisation: Phase Locked Loops (PLL), Carrier synchronisation with a pilot tone, synchronisation without a pilot tone, Phase ambiguity and differential encoding, Noise sensitivity, Decision feedback circuits, Symbol clock recovery.
- Information Theory: Entropy, Shannon’s source coding theorem, Channel capacity and the channel coding theorem, Joint source-channel coding.
- Linear Block Codes: Coding gain, (n,k) codes, Hard and soft decoding, Hamming codes, Syndrome Codes, Cyclic codes.
- Convolutional Codes: State and trellis diagrams, Viterbi algorithm, Transfer functions, Error probability analysis.
- Combined Modulation and Coding: Straight forward concatenation, Trellis coded modulation (TCM).
Resources for students

- Comprehensive lecture and tutorial notes on all material will be distributed. The printed lecture notes were written by Dr. D. Taubman, and these will be supplemented with additional weekly notes produced by the lecturer. All notes can be found on the subject website.