Carleton University

Department of Systems and Computer Engineering

SYSC 4604 Digital Communication Theory ***Fall 2011***

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Course Outline

Instructor: Prof. Mohamed El-Tanany
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Office Hours: TBA

Course Description and Objectives:
Advanced topics in digital communications, Information theory, Source coding, Error control coding, Bandwidth-efficient modulations, Trellis coding, Synchronization, Phase locked loops. Selected topics of current interest: spread spectrum; digital wireless communications.

Prerequisites:
SYSC 3503, precludes additional credit for SYSC 4600. Students who have not satisfied the prerequisites for this course must either a) withdraw from the course, or b) obtain a prerequisite waiver from the Registrar's office, or c) will be de-registered from the course after the last day of registration for courses in the Fall term.

Required Course Material:

Textbook:

B. Sklar, *Digital Communications: Fundamentals and Applications*, 2nd ed., Prentice Hall, 2001.

Other References:

- John G. Proakis, Digital Communications, Fourth edition, McGraw Hill, 2001
- S. Lin and D. J. Costello, Jr., *Error Control Coding: Fundamentals and Applications*, Prentice Hall, 1983 (2nd edition, 2004).
- E. Biglieri, D. Divsalar, P. J. McLane and M. K. Simon, *Introduction to Trellis-Coded Modulation with Applications*, Macmillan Publishing Co., 1991.
- S. Haykin, *Communication systems*, 4th Edition, John Wiley & Sons, Inc., 2001.
- T.S. Rappaport, Wireless Communications principles and practice, Prentice Hall, second edition, 2002

Grading:

To pass the course, a student must obtain at least 50% in the final exam.

- Labs: 15%
- Midterm exams 15%
- Assignments 15%
- Final Exam: 55%

Dates for Midterm Tests:
Mid-term test1: Tuesday, October 11th, in-class

Mid-term test2: Tuesday, November 8th, in-class

Midterm Tests Policy: The Midterm Tests are to be written at the scheduled class time. A missed midterm will be recorded as a zero. If a midterm is missed for circumstances beyond your control, you should submit appropriate documentation within 5 business days for consideration.

Health and Safety Manual
An electronic version of our health and safety manual is available on our department web page at

http://www.sce.carleton.ca/courses/health-and-safety.pdf

Final Exam Policy:
The final exam is for evaluation purposes only and will not be returned to the student.

Attendance:
Lecture attendance and laboratory attendance is compulsory. You are expected to attend a minimum of 90% of all lectures and 100% of all labs to satisfy attendance requirements. If you must miss a lab session, please email me or the TA of this course to see if other arrangements can be made.

Assignments

Five (5) assignments are anticipated throughout the semester. The assignments will contain analytical problems as well as Matlab based problems. Students are required to complete all assignments.

Laboratories

- Even weeks, Monday 11:30a.m-2:30 pm., Architecture Annex508, even weeks.
- The starting week is the week of Sept. 19th, where there will be a 3-hour tutorial.
- There will be three software (MATLAB-based) labs. Lab manual for each session will be posted on the website the week before the session is held. The date for the first software lab will be announced later.
- Labs are based on the following text: J. G. Proakis and M. Salehi, Contemporary Communication Systems using MATLAB, BookWare Companion Series, 2000.
- Lab attendance is a compulsory component of this course. Laboratories will be three hours alternate weeks as per the registration schedule.
- The first lab is a Tutorial to be given by Mr. Yaser Eftekhari,

Students with disabilities:
Students with disabilities requiring academic accommodations in this course must register with the Paul Menton Centre for Students with Disabilities for a formal evaluation of disability-related needs. Registered PMC students are required to contact the Centre, 613-520-6608, every term to ensure that I receive your Letter of Accommodation, no later than two weeks before the first assignment is due or the first in-class test/midterm requiring accommodations. If you require accommodation for your formally scheduled exam(s) in this course, please submit your request for accommodation to PMC by November 11th 2011 for Fall term (December exams).

Academic Accommodation for Religious Obligations
Students who require accommodations due to religious obligations must follow the procedures described in Section 2.10 of the *Academic Regulations of the University*.

Plagiarism

Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated. All suspected cases of plagiarism and other instructional offenses, will be forwarded to the Associate Dean of Engineering for investigation. Please refer to the section on instructional offenses in the Undergraduate Calendar for additional information.

Topics to Be Covered

Week 1	Source Coding, models for information sources, average mutual information and Entropy, measures for continuous random variables, coding for discrete memoryless sources, discrete stationary sources, the Lempel-Ziv Algorithm, coding for analog sources, scalar and vector quantization.
Week 2	Nyquist minimum bandwidth, Shannon-Hartley Capacity theorem, Entropy, Modulation and coding tradeoff's
Week 3-4	Channel Coding part1: Waveform coding, structured sequences, Linear block codes, Error-detecting and correcting capability of linear block codes, standard array, cyclic codes, Hamming codes, extended Golay codes, BCH codes.
Week 5-6	Channel Coding part2: Convolutional Encoding, encoder representation (connection representation, state diagram, tree diagram and trellis diagram), Maximum likelihood decoding, hard and soft-decision decoding, the Viterbi algorithm, path memory and synchronization, properties of convolutional codes, other decoding algorithms.
Week 7-8	Modulation and coding for band-limited channels, OFDM, trellis coded modulation.
Week 10-11	Spread spectrum communications, Pseudo-noise sequences, direct sequence spread spectrum, frequency-hop spread spectrum, Jamming, applications in cellular systems
Week 12-13	Fading channels, characterizing mobile radio propagation, signal time spreading, flat and frequency selective fading, mitigating the effects of flat fading, diversity combining, mitigating the effects of frequency selective fading, wireless systems examples.