ELEC ENG 4TK4
Digital Communications Systems

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Digital modulation systems, intersymbol interference, equalization, synchronization; ASK, FSK, PSK, MSK, optimal receiver, noncoherent detection; introduction to information theory; entropy, source coding, mutual information, channel capacity.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in level III or greater in any Computer or Electrical Engineering Program; ELECENG 3TR4

SCHEDULE

Lecture: Monday, Wednesday and Thursday 5:30pm – 6:20pm (ABB-163)
Tutorial: Thursday 12:30pm – 2:20pm (ABB-271)
Lab: (None)

INSTRUCTOR

Dr. Jian-Kang Zhang
Email: jkzhang@mail.ece.mcmaster.ca
Office: ITB-A220
Phone: 905-525-9140 ext. 27599
Office Hours: Friday 3:00pm - 5:00pm; and by appointment

TEACHING ASSISTANTS

Contact information and office hours are provided on the course website.

- Peiyao Chen - chenp36@mcmaster.ca
- Xiaoxuan Chu - chux7@mcmaster.ca

COURSE WEBSITE/S

https://www.ece.mcmaster.ca/~jkzhang/4TK4_Course_digital%20communications.pdf

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Understand the basic structures and fundamental principles of modern digital communication systems
- Learn the commonly used techniques of modulation, source coding and channel coding
- Understand the concepts of information theory, entropy and channel capacity and use them to study communications and coding.

ASSUMED KNOWLEDGE

Fundamental probability theory, linear algebra and calculus.

COURSE MATERIALS

Required Texts:
K.M.Wong, Lecture Notes on Digital Communications, Courseware, McMaster University, 2018.

Calculator:
Only the McMaster Standard Calculator (Casio fx-991 MS or MS Plus) will be permitted in tests and examinations. This is available at the Campus Store.

Other:
[1] U. Madhow, *Fundamentals of Digital Communication*, Cambridge University Press, 2008
R. G. Gallager, *Principal of Digital Communication*, Cambridge University Press, 2008.
[2] J. M. Wozencraft and I. M. Jacobs, *Principal of Communication Engineering*, Wiley, New York, 1966.
[3] John G. Proakis, *Digital Communications*, 4th edition, McGraw-Hill, 2001.
[4] Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, Wiley-Interscience Publication
[5] Shu Lin and Daniel J. Costello, Jr, *Error Control Coding*, Pearson Prentice Hall, 2004.

COURSE OVERVIEW

Week	Topic	Readings
1	Introduction (1 hour) - General concept of digital communication systems; Digitization of Signals (2 hours)-Sampling, quantization; Companding	Ch. 1
2	Digital Transmission Systems (3 hours) - PCM, Delta modulation; Adaptive delta modulation; Differential PCM.	Ch. 1

3	Intersymbol Interference (3 hours) - Non-ideal channel transmission, Eye diagram, pulse shaping, adaptive equalization, partial response signaling	Ch. 1
4	Synchronization (1 hour) and Optimal Receiver Design (2 hours)	Ch. 2
5	Coherent receivers (3 hours): ASK, FSK, PSK modulations; Incoherent receivers	Ch. 2
6	Detection of M-ary signals (3 hours)	Ch. 3
7	Entropy for discrete signals; Randomness; Self information, mutual information (3 hours)	Ch. 3
8	Entropy rate for Markov sources; Huffman coding; Shannon-Fano coding (3 hours)	
9	Shannon's first theorem; Entropy for continuous random variables (3 hours)	Ch. 3
10	Channel capacity; Shannon's second theorem; Capacity of a bandlimited Gaussian channel (3 hours)	Ch. 4
11	Linear block codes (3 hours)	Ch. 4

A more detailed time line is available on the course web site.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Component	Weight
Two Projects	30 % (each 15 %)
Midterm Exam	0 % or 25 % (see below)
Tutorial Attendance	7 %
Lecture Attendance	8 %
Final Exam	55 % or 30 % (see below)
Total	100 %

No make-up midterm tests will be granted. Weights of a missed midterm test and the missed attendance for either Tutorial or lecture will be transferred to final exam. 25% of the mark is taken as the best of the midterm and exam.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Outcomes* defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of

the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: http://www.engineerscanada.ca .

Outcomes	Indicators	Measurement Method(s)
To understand the basic structures and fundamental principles of modern digital communication systems.	1.1; 1.3	Final exam
Solve simple problems including but not limited to the commonly used techniques of digital modulation, information theory, source coding, and channel coding.	2.2	Final exam
Apply basic digital communication concepts to the study of channel capacity and error performance for various modulation schemes in addition to performing simulations to verify results.	2.2	Final exam

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.
Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.
It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at www.mcmaster.ca/academicintegrity .
The following illustrates only three forms of academic dishonesty:
• Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
• Improper collaboration in group work.
• Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca . For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to the Engineering Student Services office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations.

Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

www.eng.mcmaster.ca/ece