Alexandria University
Faculty of Engineering
Electrical Engineering Department
First Semester, 2009-2010

جامعة الإسكندرية
كلية الهندسة
قسم الهندسة الكهربية
الفصل الدراسى الاول ٢٠٠٩-٢٠١٠

Course:

Introduction to Statistical Communications and Information Theory (EE 106831)

Instructor: Dr. Mostafa El-Khamy
Assistant Professor,
Electrical Engineering Dept.
Alexandria University
m_elkhamy@ieee.org
www.elkhamy.com

Course Group Page:
http://groups.google.com/group/vtmena-it-09
Handouts, assignments and discussions will be posted on the course group page.

Course Outline:
An introduction to information theory methods used in the analysis and design of communication systems. Typical topics include: entropy, relative entropy and mutual information; the asymptotic equipartition property; entropy rates of stochastic process; data compression; channel capacity; differential entropy; the Gaussian channel; maximum entropy and mutual information; rate distortion theory; network information theory; algebraic codes.

Course Objectives:
This course covers many concepts from information theory which are fundamental to the analysis and design of wired and wireless communication systems, compression techniques and data storage systems. The objectives are to understand these concepts and to develop rigorous mathematical skills to contribute information theoretic proofs and results.
Upon completion of the course, the student should be able to

- apply the information theoretic concepts studied in their fields of research such as telecommunications, networking, physics, statistical mechanics, mathematics, economics and complexity.
- understand the fundamental limits of operation of communication systems, compression systems and data storage.
- use software packages such as MATLAB or MATHEMATICA in problem solving.

Prerequisites:
Probability and Random Variables or equivalent (undergraduate course).

Teaching Hours per Week:

- Lectures: 2 hours
- Quizzes and Tutorials: 1 hour

Grading and Assessment:

- Closed Book Exams: 65%
  - (max{45% Final Exam + 20% Midterm Exam , 65% Final Exam})
- Quizzes: 10%
- Theoretical Assignments: 10%
- Seminar Project & Presentation: 10%
- Programming Project: 5%
- Bonus Project: 5% (extra bonus)

References and Textbooks:

Title	Author	Publisher	ISBN Code
Elements of Information Theory, 2nd edition	T. Cover and J. Thomas	Wiley-Interscience; 2006	978-0471241959
Information Theory, Inference and Learning	David Mackay	Cambridge University Press, 2002	978-0521642989
The Theory of Information and Coding: Student Edition (Encyclopedia of Mathematics and its Applications)	Robert McEliece	Cambridge University Press, 2004	978-0521831857

Course Outline:

Week	Contents
1	Introduction to Information Theory, Channel Capacity & Repetition Coding
2	Entropy function and its properties, convexity
3	Joint Entropy, Conditional Entropy, Mutual Information, Gibb's Inequality, Kullback-Liebler Distance
4	Chain rules for entropy and mutual information, binary symmetric channel
5	Data processing inequality, Capacity of discrete memoryless channels, binary symmetric channels, erasure channels
6	Capacity of symmetric channels, capacity of parallel channels, Fano's Inequality
7	Capacity of extension of discrete memoryless channels, capacity of feedback channels
8	Continuous random variables, differential entropy, entropy of Gaussian random variables, capacity of the Gaussian channel, capacity of band-limited channels, capacity of M-PSK modulation schemes
9	Source codes, uniquely decodable codes, instantaneous prefix free codes, lossless source coding theorem, lossless source codes: Shannon Fano code, Huffman codes
10	Typicality, Law of large numbers, asymptotic equipartition property (AEP), joint typicality, joint AEP, random codes
11	Typical set decoding, achievability and converse of Shannon's channel coding theorem, noisy channel coding theorem
12	Rate distortion theory, calculation of rate distortion function, Shannon source coding theorem, source-channel coding theorem
13	Advanced Topics & Student Seminars: e.g. Network information theory, Gaussian multiple user channels, multiple access channel
14	Advanced Topics & Student Seminars: e.g. Practical applications of information theory