

## EE 575: Information Theory

- **Schedule:** Sundays and Tuesdays - 12:45 - 2:00PM.
- **Location:** 59-1013.
- **Instructor:** Prof. Salam A. Zummo, Office: 59-2086, Phone: 7776 -2844

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Web Site: <http://faculty.kfupm.edu.sa/ee/zummo/courses.htm> and Blackboard 9.0

- **Prerequisites:** EE370, EE315 or equivalent courses.
- **Course Description:**  
Measures of information, Entropy, Source Coding theory, Lossless data compression, Huffman Codes and Lempel-Ziv Codes, Arithmetic Codes, Run-length Encoding, Sources with memory, Lossy data compression, Rate distortion theory, Mutual Information, Memoryless channels, Channel capacity, Channel coding theory, Differential Entropy, Capacity of AWGN channels.
- **Course Outline:** (Time and emphasis may be adjusted as needed)
  - **Overview:** (1 Lecture)
  - **Review of Probability Theory:** (2 Lecture)
  - **Source Coding - Fixed Block Size:** (4 Lectures)  
Discrete memoryless sources, entropy, weak law of large numbers, asymptotic equipartition and typical sets, source coding theorem with fixed block size.
  - **Source Coding - Variable Block Size:** (3 Lectures)  
Uniquely decodable codes, source coding theorem with fixed block size, Huffman and Lempel-Ziv codes.
  - **Sources With Memory:** (2 Lectures)  
Markov chains and entropy rate of stochastic processes.
  - **Information Measures:** (3 Lectures)  
Mutual information, joint and conditional entropy, relative entropy and their properties, Jensen's inequality, data processing theorem and Fano's inequality.
  - **Channel Coding - Discrete Sources:** (5 Lectures)  
Discrete memoryless channels, symmetric channels, channel capacity and its properties, jointly typical sets, channel coding theorem and its converse.
  - **Channel Coding - Continuous Sources:** (2 Lectures)  
Asymptotic equipartition for continuous random variables, joint and conditional differential entropy and mutual information and their properties.

- **Gaussian Channels:** (2 Lectures)  
The Gaussian channel, channel coding theorem for Gaussian channels and band-limited channels.
- **Rate Distortion Theorem:** (2 Lectures)  
Quantization, rate distortion theorem and its converse and properties of the rate distortion function.
- **Estimation Theory:** (2 Lectures)

- **Textbook:**

- T. Cover and J. Thomas, Elements of Information Theory, Wiley & Sons, Inc., 2nd Ed. 2006
- Lecture notes.

- **References:**

1. R. Gallager, Information Theory and Reliable Communication, John Wiley & Sons, 1968.
2. R. Ash, Information Theory, Dover Publications, Inc., NY, 1965.
3. J. Wozencraft and I. Jacobs, Principles of Communication Engineering, John Wiley & Sons, 1965.
4. J. Proakis, Digital Communications, McGraw-Hill Prentice-Hall, 4th edition, 2001.
5. A. Papoulis, Probability, Random Variables, and Stochastic Processes, McGraw-Hill, 1965.

- **Homework Assignments:**

Homeworks will be issued about once every two weeks. Collaborative work is encouraged between students. However, solutions are to be worked out and submitted individually.

- **Grading Policy:**

- Homeworks 30%
- Exam I 20%                      Tuesday of Week 6 (Feb. 23- Class time)
- Exam II 20%,                      Tuesday of Week 12 (April 12 - Class time)
- Final Exam 30%,                      Sunday, May 10 at 7:00PM