(3-0-0; ——) **Information Theory** MATH-474*

Textbook: *Elements of Information Theory*
by T. M. Cover and J. A. Thomas (John Wiley & Sons)
Class Notes

Prerequisite: STAT-251* *or* 356*.

Corequisite: STAT-455* *or* permission of the instructor.

Instructor: F. Alajaji

Evaluation:		
	Final Examination	60%
	Midterm Examination	30%
	Homework	10%

Outline:

The reliable transmission of information bearing signals over a noisy communication channel is at the heart of what we call communication. *Information theory* – founded by Claude E. Shannon in 1948 – provides a mathematical framework for the theory of communication; it describes the *fundamental limits* to how efficiently one can encode information and still be able to recover it with negligible loss. This course will examine the basic concepts of this theory. What follows is a list of topics to be covered.

1. *Shannon's Measures of Information:* entropy, divergence, mutual information; properties of information measures; the data processing theorem; Fano's inequality.
2. *Fundamentals of Fixed-Length Lossless Source Coding (Data Compression):* discrete memoryless sources, asymptotic equipartition property (AEP), block or fixed-length coding, fixed-length source coding theorem for discrete memoryless sources; entropy rate of stationary sources with memory, Markov sources, stationary ergodic sources, fixed-length source coding theorem for stationary ergodic sources; source modeling and computation of data redundancy.
3. *Fundamentals of Variable-Length Lossless Source Coding:* variable-length encoding, unique decodability, Kraft inequality, prefix codes, variable-length source coding theorem for discrete memoryless sources and for stationary sources with memory; design and construction of data compression codes: Shannon-Fano and arithmetic codes, optimal Huffman codes, adaptive Huffman codes.
4. *Fundamentals of Channel Coding:* discrete memoryless channels, channel capacity and properties; noisy channel coding theorem for discrete memoryless channels; the lossless joint source-channel coding theorem; channel coding techniques.
5. *Information Theory for Continuous Alphabet Systems:* differential entropy, divergence and mutual information; differential entropy of the multivariate Gaussian distribution; AEP for continuous alphabet memoryless sources, capacity of discrete-time and band-limited continuous-time memoryless Gaussian channels; parallel Gaussian channels and waterfilling.