Approval: 9th Senate Meeting

Course Name: Information Theory

Course Number: EE-518

Credits: 3-0-0-3

Prerequisites: IC-210 Signal and Systems, EE-304 Communication Theory or equivalent and the instructor's consent

Intended for: UG/PG

Distribution: Elective

Semester: Even/Odd

Course Objective: The objective of the course is to provide the first detailed treatment of Information Theory – a discipline that formally defines the notion of "information", allows us to compute the fundamental limits of source compression and channel coding, and also allows us to objectively evaluate the performance of any source compression or channel coding scheme. Specifically, this course introduces the basic tools and techniques usually used in this discipline and which are also useful in the areas such as estimation and detection, communication, inference, and learning.

Course Modules:

1. Concept of information, Information measures: Hartley measure, Shannon Entropy. (3 hours)

2. Basic notions: Entropy, joint and conditional entropy, relative entropy, mutual information, KL-distance, Jensen and Log-sum inequalities. (6 hours)

3. Source compression: Asymptotic Equipartition Property (AEP) and its consequences for data-compression, types of codes, Kraft inequality, optimal codes and bounds of their lengths, Huffman codes and their optimality, Shannon code, Arithmetic coding. (6 hours)

4. Channel coding: the notion of channel capacity, discrete memoryless channels, channel capacity computation for elementary DMC channels, symmetric channels, jointly typical sequences, data-processing and Fano's inequalities, channel coding theorem (achievability and converse), feedback capacity, source-channel separation theorem and joint source-channel coding: multimedia communications. (9 hours)

5. Differential entropy: AEP for continuous variables, joint and conditional differential entropy, relative entropy and mutual information. (3 hours)

6. Gaussian channel: Coding theorem for Gaussian channels, Bandlimited channels, parallel Gaussian channels, channels with colored Gaussian noise: water-filling argument. (9 hours)

7. Advanced topics: Rate-distortion theory, Network coding, Introduction to Network Information Theory. (6 hours)

Reference Books:

1. I. Csiszár and J. Körner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, Cambridge Univ. Press, August 2011.

2. R. G. Gallager, *Information Theory and Reliable Communication*, Wiley, 1968.

3. T. M. Cover and J. A. Thomas, Elements of Information Theory, Wiley, 2006, 2/e.

4. D. J. C. MacKay, Information Theory, Inference and Learning Algorithms, Cambridge Univ. Press, 2003.