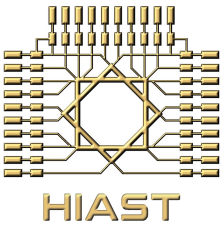
Syrian Arab Republic

Higher Institute for Applied Sciences and Technology



Course Specification Document

Title	Information Theory

Credits	2.5 ECTS

Aims	This course aims to provide the student with the necessary information to understand the basics of information theory and answer important questions in communication theory, computer science, probability science, and statistics, enabling him to understand the technical literature in this field and apply it in more advanced fields such as theory of information networks and others.

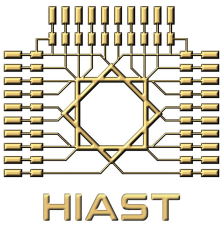
Intended learning outcomes

On successful completion of this course, the student will be able to:

- Understand the concept of ambiguity, entropy, mutual information and the entropy rate of random processes.
- Understand data compression, channel capacity and Gaussian channel.
- Know the entropy of natural languages (Arabic, English) and Kolmogorov complexity.
- Use the capabilities provided by MATLAB environment to solve information compression issues and to code error detection and correction.
- Simulate the calculation of entropy using a computer.
- Use mathematical and physical methods in applying the foundations of information theory to measure the amount of transmitted information, source coding and channel coding.

Syllabus

- **Entropy, relative entropy and mutual information:** Definition of ambiguity and entropy, joint entropy and conditional entropy, relationship between entropy and mutual information, chain rules in entropy, relative entropy and mutual information, signal processing inequality.
- **Entropy rate of random processes:** Entropy rate, Markov chains, applications of Markov chains.
- **Information compression:** Examples of encoding, Shannon's theory, Kraft's inequality for single-detection encoders, optimal encoding, Huffman coding, properties of Huffman coding, disadvantages of Huffman coding, examples of Huffman coding, Shannon-Fano-Elias coding.
- **Channel capacity:** Examples of channel capacity, binary channel without noise, noiseless channel without overlapping, symmetrical binary channel, symmetric channel, characteristics of symmetric channel capacity, definitions related to channel coding theory, channel coding theory, zero-error coding, Fano’s inequality in theory channel coding.



- **Differential entropy:** Definitions, relationship between differential entropy and discrete entropy, joint and conditional differential entropy, relative entropy and mutual information, properties of relative entropy and mutual information.
- **Kolmogorov complexity:** Models of computation, Kolmogorov complexity, Kolmogorov Complexity and entropy, Kolmogorov complexity of integers.
- **Networks information theory:** Single user Gaussian channel, multi-user Gaussian channel, Gaussian channel multi-user multiple access, broadcast diving channel, correlated source coding.