Information Theory and Coding Techniques(304189)

Teaching Scheme:
Lectures:4 Hrs/ Week

Examination Scheme:
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

Course Objectives:

- To understand information theoretic behavior of a communication system.
- To understand various source coding techniques for data compression
- To understand various channel coding techniques and their capability.
- To analyze performance of communication system with coding and modulation.

Course Outcomes:

After successfully completing the course students will be able to

- Perform information theoretic analysis of communication system.
- Design a data compression scheme using suitable source coding technique.
- Design a channel coding scheme for a communication system.
- Evaluate performance of a communication system.

Unit I : Information Theory and Source Coding 7L

Introduction to information theory, Entropy and its properties, Source coding theorem, Huffman coding, Shannon-Fano coding, The Lempel Ziv algorithm, Run Length Encoding, Discrete memory less channel, Mutual information, Examples of Source coding-Audio and Video Compression. Case Study: Huffmans coding in image compression/Detail overview of JPEG.

Unit II : Information Capacity and Channel Coding 8L

Channel capacity, Channel coding theorem, Differential entropy and mutual Information for continuous ensembles, Information Capacity theorem, Linear Block Codes:Syndrome and error detection, Error detection and correction capability, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes, Repetition codes and dual codes, Hamming code, Golay Code, Interleaved code. Case Study: Shannon's Publications on information theory.

Unit III : Cyclic Codes 8L

Galois field, Primitive element & Primitive polynomial, Minimal polynomial and generator polynomial, Description of Cyclic Codes, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Circuit implementation of cyclic code.

Unit IV : BCH and RS Codes 7L

Binary BCH code,Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes, Cyclic Hamming code and Golay code, CRC code, FEC and ARQ systems. Case Study: RS Coding in CD recording. Case Study: CRC used in Ethernet LAN.

Unit V : Convolutional Codes 7L

Introduction of convolution code, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Sequential decoding and Viterbi decoding, Known good convolution code, Introduction to LDPC and Turbo codes.

Unit VI : Coding and Modulation 8L

Goals of a communication System designer, Error Probability plane, Nyquist minimum bandwidth, Shannon Hartley theorem, Bandwidth efficiency plane, Modulation and coding tradeoffs, Defining, designing and evaluating digital communication system.Trellis Coded Modulation:Concept of TCM and Euclidean distance, Asymptotic coding gain, Mapping by set partitioning, Ungerboeck's TCM design rule. Case Study : TCM used in MODEMs

Text Books

1. Ranjan Bose, "Information Theory coding and Cryptography", McGraw-Hill Publication, 2nd Edition
2. J C Moreira, P G Farrell, "Essentials of Error-Control Coding", Wiley Student Edition.

Reference Books

1. BernadSklar, "Digital Communication Fundamentals & applications", Pearson Education. Second Edition.
2. Simon Haykin, "Communication Systems", John Wiley & Sons, Fourth Edition.
3. Shu lin and Daniel j, Cistellojr., "Error control Coding" Pearson, 2nd Edition.
4. Todd Moon, "Error Correction Coding : Mathematical Methods and Algorithms", Wiley Publication
5. Khalid Sayood, "Introduction to Data compression", Morgan Kaufmann Publishers