AN INTRODUCTION TO CODING THEORY

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PRE-REQUISITES : An exposure to linear algebra and probability theory as well as a course in digital communications

INTENDED AUDIENCE : 3rd/4th year UG students, PG students & faculty in electronics and communications engineering

INDUSTRY SUPPORT : Telecommunication Companies

COURSE OUTLINE :

Error control coding is an indispensible part of any digital communication system. In this introductory course, we will discuss theory of linear block codes and convolutional codes, their encoding and decoding techniques as well as their applications in real world scenarios. Starting from simple repetition codes, we will discuss among other codes: Hamming codes, Reed Muller codes, low density parity check codes, and turbo codes. We will also study how from simple codes by concatenation we can build more powerful error correcting codes.

ABOUT INSTRUCTOR :

Prof. Adrish Banerjee received his Bachelors degree from Indian Institute of Technology, Kharagpur and Masters and Ph.D. degree from University of Notre Dame, Indiana, USA. He is currently the Next Generation Broadcasting Chair Professor in the Department of Electrical Engineering at Indian Institute of Technology, Kanpur. He is a recipient of Microsoft Research India young faculty award, Institute of Engineers India young engineer award, and IETE Prof. K. Sreenivasan memorial award. His research interests are in the physical layer aspects of wireless communications, particularly green communications, and error control coding.

COURSE PLAN :

Week 1-
Lecture 1: Introduction to error control coding
Lecture 2: Introduction to linear block codes, generator matrix and parity check matrix
Lecture 3: Properties of linear block codes: Syndrome, error detection

Week 2-
Lecture 4: Decoding of linear block codes
Lecture 5: Distance properties of linear block codes

Week 3-
Lecture 6: Some simple linear block codes: Repetition codes, Single parity check codes, Hamming codes, Reed Muller codes
Lecture 7: Bounds on size of codes: Hamming bound, Singleton bound, Plotkin bound, Gilbert-Varshamov bound

Week 4-
Lecture 8: Introduction to convolutional codes-I: Encoding, state diagram, trellis diagram
Lecture 9: Introduction to convolutional codes-II: Classification, realization, distance properties
Lecture 10: Decoding of convolutional codes-I: Viterbi algorithm

Week 5-
Lecture 11: Decoding of convolutional codes-II: BCJR algorithm
Lecture 12: Performance bounds for convolutional codes

Week 6-
Lecture 13: Low density parity check codes
Lecture 14: Decoding of low density parity check codes: Belief propagation algorithm on BSC and AWGN channels

Week 7-

Lecture 15: Turbo codes

Lecture 16: Turbo decoding

Week 8-

Lecture 17: Distance properties of turbo codes

Lecture 18: Convergence of turbo codes

Lecture 19: Automatic repeat request schemes

Lecture 20: Applications of linear codes