Approval: 5th Senate Meeting

Course Name : Advance Communication Theory
Course Number : EE-503
Credits : 3-0-0-3

Prerequisites : IC-210: Probability, Statistics and Random Processes, EE-304:Communication Theory and the instructor's consent
Intended for :UG/MS/PhD
Distribution : Elective for EE
Semester :Odd/Even

Preamble: This course builds advanced communication concepts on the top of course Communication Theory, to be taught in the 5th semester as per the new curriculum design for EE. This course tries to demonstrate to the students how more practical and complex communication concepts/technologies are built on the top of whatever they learnt in Communication Theory course. Thus, this course attempts to establish a bridge between Communication Theory and Wireless Communications course to be taught in the 7th semester. This allows the Wireless Communications course to provide more in depth treatment of various advanced concepts (such as fading, MIMO, STBC, etc) as well as the use of these concepts and the topics in Advanced Communication Theory course in the design and performance analysis of multiuser systems.

Course Outline: The objective of the course is to introduce the students to advanced topics in digital communications. The course aims to provide the students an understanding of the fundamental concepts and techniques, used in the design, performance analysis, and implementation of current communication systems and useful in the development of the communication systems of the future.

Course Modules:

1. Review of digital modulation schemes for baseband and bandlimited channels and their corresponding optimal detectors and error probabilities (6 contact hours)
2. Carrier and Symbol Synchronization: importance in signal demodulation, carrier frequency and phase estimation – decision directed and power of N methods, timing estimation - spectral-line, MMSE, and ML methods, joint carrier and symbol synchronization. (6 contact hours)
3. Equalization: Optimal zero-forcing equalization, Linear, Decision-feedback, Adaptive Linear, Adaptive Decision-feedback, and Blind equalization. (6 contact hours)
4. Multichannel and Multicarrier Systems: AWGN multichannels, Multicarrier communications: OFDM – modulation and demodulation, spectral characteristics, bit and power allocation, channel coding. (6 contact hours)
5. Spread Spectrum Communications: model, Direct sequence SS, PN sequences, Frequency-hopped SS, synchronization, jamming, CDMA. (5 contact hours)
6. Introduction to Information and Coding Theories:

a. Information Theory: information measures, Shannon entropy, differential entropy, mutual information, capacity theorem for point-to-point channels with discrete and continuous alphabets. (4 contact hours)
b. Coding Theory: linear block codes – definitions, properties, bounds on minimum distance (singleton, Hamming, GV, MRRW), soft versus hard decision decoding, some specific codes (Hamming, RS, Concatenated); Convolutional codes – structure, decoding (the Viterbi and BCJR algorithms); Turbo codes, LDPC codes. (9 contact hours)

Reference Books:

1. T. Cover and J. Thomas, Elements of Information Theory, 2/e, Wiley, 2006.
2. R. G. Gallager, Principles of Digital Communication, Cambridge Univ. Press, 2008.
3. A. Lapidoth, A Foundation in Digital Communication, Cambridge Univ. Press, 2009.
4. S. Lin and D. Costello, Error Control Coding, 2/e, Prentice Hall, 2004.
5. J. G. Proakis and M. Salehi, Digital Communications, 5/e, McGraw-Hill, Prentice Hall, 2007.
6. B. Sklar, Digital Communications: Fundamentals and Applications, 2/e, Prentice Hall, 2001.