GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS & COMMUNICATION (WIRELESS COMMUNICATION SYSTEMS & NETWORKS) (27)

ADVANCED DIGITAL COMMUNICATION

SUBJECT CODE: 2722703

SEMESTER: II

Type of course: Major Elective-III

Prerequisite: Digital Communication fundamentals

Rationale: This course discusses advanced digital communication concepts which is useful for wireless communication. This course is useful to the students those who have not studied it in their UG programme.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Elements of a digital communication system:** Communication channels and their characteristics, Mathematical models for channels. Representation of digitally modulated signals – Performance of Memory-less modulation methods – signalling schemes with memory – CPFSK – CPM Review of probability and Stochastic Processes. Characterization of Communication Signal and System. Geometric Representation of Signals and its use in communication.	**8**	15%
2	**Optimum Receivers for AWGN Channels:** Waveform and vector channel models. Detection of signals in Gaussian noise. Optimum detection and error probability for band limited signalling and power limited signalling, Non coherent detection, Comparison of digital signalling methods, Lattices and constellations based on lattices, Detection of signalling schemes with memory – Optimum receiver for CPM, Performance analysis for wire line and radio communication systems. Introduction to partially coherent, double Differentially coherent communication systems.	**12**	25%

3	**Channel Coding:** Introduction to linear block codes, Convolution coding –Tree, Trellis and State diagrams, Systematic, Non-recursive and recursive convolutional codes, The inverse of a convolutional Encoder and Catastrophic codes, Decoding of convolutional codes - Maximum likelihood decoding, Viterbi algorithm and other decoding algorithms, Distance properties, Punctured convolutional codes, Dual-k codes, Concatenated codes, MAP and BCJR algorithms, Turbo coding and Iterative Decoding, Factor graphs and sum-product algorithms, LDPC codes, Trellis coded modulation - Performance comparison.	**12**	25%
4	**Pulse Shaping and Equalization:** Pulse shaping: Characterization of Band limited channels, ISI, Nyquist criterion, Controlled ISI, Channels with ISI and AWGN, Pulse shaping for optimum transmissions and reception. Equalization: MLSE – Linear equalization, Decision feedback equalization ML detectors, Iterative Equalization, Turbo equalization. Adaptive linear equalizer – Adaptive decision feedback Equalization – Blind equalization.	**8**	20%
5	**Synchronization:** Signal parameter Estimation, Carrier phase Estimation, Symbol timing Estimation, Joint estimation of carrier phase and symbol timing, Performance characteristics of ML Estimators.	**8**	15%

Reference Books:

1. Proakis J.J.,D Wozencraft J.M. and Jacobs I.M., Principles of Communication Engineering, John Wiley.
2. Carison A., Communication System, 3rd. McGraw Hill.
3. Van Trees H.L., Detection Estimation and Modulation Theory, Vol. 1. Wiley.
4. John G. Proakis and Masoud Salehi, "Digital Communications," 5th edition, Tata McGraw Hill, 2008.
5. Ian A. Glover and Peter M. Grant, "Digital communications," 2ndedition, Pearson education, 2008.
6. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005

Course Outcomes:

After completion of this course students should be able to:

- Identify and describe different techniques in modern digital communications, in particular in source coding, modulation and detection, carrier modulation, and channel coding.
- Carry out, analyse and report simple hardware-based experiments.
- Develop simple software, for example using Matlab, and use this software to simulate and analyse problems within the field, as well as report the development and results.
- Describe and motivate the fact that the implementation and development of modern communication technology requires mathematical modeling and problem solving.
- Apply mathematical modelling to problems in digital communications, and explain how this is used to analyse and synthesize methods and algorithms within the field.
- Formulate a mathematical model which is applicable and relevant in the case of a given problem.

- Use a mathematical model to solve a given engineering problem in the field, and analyse the result and its validity.

List of Tutorials:

1. To observed random process and implement in MATLAB/SCILAB
2. To define signal characteristic and representation in MATLAB/SCILAB
3. To implement match filter in MATLAB/SCILAB (Coherent signal)
4. To implement different modulation schemes in MATLAB/SCILAB
5. To observe signal space diagram with different modulation schemes in MATLAB/SCILAB
6. To analyze and design multicarrier modulation in MATLAB/SCILAB
7. Write MATLAB/SCILAB code for Maximum Likelihood Estimation
8. Write program to Equalize signal using MATLAB/SCILAB
9. Implement an end-to-end wireless data transceiver capable of performing "over-the-air" digital transmission.
10. Compare symbol and bit error probabilities of common digital communication systems in AWGN channels between theoretical and computer simulated
11. Implement the optimum receiver structure for digital transmission through an AWGN channel.

Major Equipment:

1. Spectrum Analyzer
2. Wireless Module (Tx and Rx)
3. SNR (dBm) Analyzer
4. Channel Response Analyzer

List of Open Source Software/learning website:

NPTEL Video lectures: http://www.nptel.ac.in/

MATLAB/SCILAB

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website