

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING & COMMUNICATION) (41)

DIGITAL MODULATION AND CODING

SUBJECT CODE: 2714106

SEMESTER: I

**Type of course:** Theory and simulation based course

**Prerequisite:** Fundamental of Electronic Communications

**Rationale:**

This course introducing the fundamental concepts in both digital modulation and coding. It comprise fundamentals of communications concepts, and demodulation techniques, performance analysis, synchronization techniques, coding theory (block codes and convolution codes), and multi-carrier modulation and coding.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

**Content:**

Sr.No.	Content	Total Hrs	% Weightage
1	<b>Basic Modulation Techniques:</b> Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous, phase modulation (QPSK and variants, MSK, GMSK), different multiplexing techniques, Basics of OFDM.	10	25
2	<b>Block codes:</b> introduction of maximum likelihood decoding, Types of errors, Introduction to linear block codes, syndrome and error detection, minimum distance of block codes, error detecting and error correcting capabilities of block code, syndrome decoding, hamming codes, Description of cyclic codes, generator and parity matrix of cyclic codes, encoding of cyclic codes, syndrome computation and error detection, decoding of cyclic codes, cyclic hamming codes, shortened cyclic codes, problems.	8	20
3	<b>BCH Codes and Reed-Solomon Codes:</b> Description of BCH codes, decoding of BCH codes, implementation of error detection, non binary BCH codes and Reed-solomon code, Finite Fields, Reed-Solomon Encoding, Reed-Solomon Decoding,, problems, single burst error correcting codes, interleaved codes.	8	20

4	<b>Convolution codes:</b> Encoding of convolutional codes, encoding of convolutional codes using time-domain approach, encoding of convolutional codes using transform-domain approach, state diagrams and code tree of convolutional codes, trellis diagram, problems.	7	20
5	<b>Modern coding:</b> Introduction to Turbo Coding, iterative decoding. Introduction to Low Density Parity Check Code	7	15

### Reference Books:

1. Error Control Coding: Fundamentals and Applications , Shu Lin and Daniel J. Costello Prentice Hall Series
2. Digital Communications Fundamentals and Applications Bernard Skalar Prentice Hall
3. Digital Communication (Forth edition) John G. Proakis McGraw-Hill

### Course Outcome:

Students will be able to explain the concept of modulation, theories and details of modulation schemes. explain the need for error correction in data communication and storage systems. Apply mathematical tools from groups and finite fields in the design of codes and sequences. Design an error correcting code for a given application. Describe the fundamental limits of error correction.

### List of Simulation Studies and Experiments:

1. Comparison of different digital modulation techniques
2. Given a \*wave file, find the hamming distance between successive samples of it.
3. Design linear block code using standard array table method.
4. Design hamming code.
5. Design encoder and decoder for cyclic code
6. Design convolution code in time domain
7. Design convolution code in transfer domain
8. Write a program for Viterbi decoding

### Major Equipments:

1. Software Defined Radio Platform
2. Data Formatting and Carrier Modulation Transmitter

### List of Open Source Software/learning website:

1. NPTEL website and Website of various IITs for Remote Labs.

### Open Ended Problem

1. Design encoder and decoder for RS code
2. Design Turbo code encoder and decoder
3. Design encoder and decoder for BCH code

4. A case study of error control coding in video communication
5. A case study of communication of baseband signal using digital modulation techniques
6. Design coding scheme for image signal and its transmission