INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION FORM

Course Name	**DIGITAL COMMUNICATIONS**			
Course Code	**A60420**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Total**
	4	**1**	**-**	**5**
Course Coordinator	**Dr. P. G. Krishna Mohan, Professor, ECE Dept**			
Course Faculty	**Dr. P. G. Krishna Mohan, Professor, ECE Dept** **Dr. V. Siva Nagaraju, Professor, ECE Dept** **Mrs. L. Shruthi, Assistant Professor, ECE Dept** **Mr. K. Sudhakar Reddy, Assistant Professor, ECE Dept**			

I. OBJECTIVES

The aim of this course is to provide students with a thorough understanding of sampling, quantizing and coding to convert the analog signals in to digital form. Various analog to digital conversion techniques like PCM and Delta Modulation along with the refined forms like DPCM and ADM are also discussed. In addition to baseband transmission of digital data over the channel, carrier modulation schemes like ASK, FSK, PSK, DPSK and QPSK are also covered. Also focuses on how information theory relates to the design of digital communications systems and to provide the knowledge and skills to perform design calculations on these systems.

II. PREREQUISITE(S):

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Knowledge of 1.Signals &Systems 2. Analog Communications

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each midterm exam shall contain 4 questions. The student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 objective type questions. The student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first 2 ½ units of syllabus and second midterm examination shall be conducted for the remaining 2 ½ units. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s).	**75**	**100**

IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1	I Mid Examination	80 minutes	20
2	I Assignment	--	05
3	II Mid Examination	80 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVES

The course should enable the students to:

I. Acquire the fundamentals of modern digital communication system design and to evaluate the performance of digital signaling schemes for digital communication channels.

II. Review the key characteristics and salient features of various digital carrier modulation and schemes for various receiver and transmitter requirements used in different applications.

III. Expose the students to the principles and practice of information theory, covering both theoretic and applied issues of recognized importance in data/information compression, transmission, and storage and processing.

IV. Understand the concepts of minimizing the effects of errors due to channel noise, with various channel coding techniques with basic knowledge for designing, analyzing, and comparing different digital communication schemes for social and environmental applications.

VI. COURSE OUTCOMES

After completing this course the student will be able to:

1. Understand the basic concepts of digital communications with an insight into practical applications.
2. Identify the importance of conversion of analog signals in to digital domain.
3. Differentiate between PCM and DM and to know their usage in specific applications.
4. Compare and contrast ASK, FSK, PSK digital carrier modulation schemes in terms of occupied bandwidth, complexity etc., and extend these into QPSK, MPSK, QAM for improved spectral efficiency.
5. Apply the basics of information theory to calculate channel capacity and other measures.
6. Distinguish between source coding and channel coding for optimization of discrete memory-less source (DMS) ,with error-free/min error transmission of data over a channel.
7. Interpret the differences between the usage of systematic linear block codes (LBC) and convolutional codes for non-burst and burst channel applications.
8. Competent to work as designer and/or implementation engineers in the field of Digital Communications, e.g., in research/ development groups of industry, as consultants, team members / leaders in latest projects which use digital-communication media, or as scientists in academia.

VII. HOW COURSE OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency Assessed by
PO 1	**Engineering Knowledge** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	S	Assignments and Exercises

PO 2	**Problem Analysis** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	H	Hands on Practice Sessions
PO 3	**Design/Development of Solutions** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	S	Lab Sessions
PO 4	**Conduct Investigations of Complex Problems** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	N	Exercises and assignments
PO 5	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations	S	Workshops
PO 6	**The Engineer And Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	N	Oral Discussions
PO 7	**Environment and sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development	N	-
PO 8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	N	-
PO 9	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	N	-
PO 10	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	S	Exams and seminars
PO 11	**Project management and finance** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments	H	Exercises and assignments
PO 12	**Life-long learning** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	S	Mini projects or projects

N = None **S = Supportive** **H = Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded	H	Lectures, Assignments

Program Specific Outcomes		Level	Proficiency assessed by
	systems etc., in the design and implementation of complex systems.		
PSO2	**Problem-solving skills:** An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	S	Tutorials
PSO3	**Successful career and Entrepreneurship:** An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	S	Seminars and Projects

IX. SYLLABUS:

UNIT I

ELEMENTS OF DIGITAL COMMUNICATION SYSTEMS

Advantages of Digital Communication Systems, Bandwidth-S/N Tradeoff, Bandwidth-S/N Tradeoff, Sampling Theorem.

PULSE CODE MODULATION

PCM Generation and Reconstruction, Quantization Noise, Non Uniform Quantization and Commanding, DPCM, Adaptive DPCM, DM and Adaptive DM, Noise in PCM and DM.

UNIT II

DIGITAL MODULATION TECHNIQUES

Introduction, ASK , ASK Modulator, Coherent ASK Detector, Non-coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum of FSK, Non-coherent FSK Detector, Coherent FSK Detector, FSK Detection using PLL, BPSK, Coherent PSK Detection, QPSK, Differential PSK.

UNIT III

BASE BAND TRANSMISSION AND OPTIMAL RECEPTION OF DIGITAL SIGNAL

Pulse **S**haping for Optimum Transmissions, A Baseband Signal Receiver, Probability of Error, Optimum Receiver, Optimal of Coherent Reception, Signal Space Representation and Probability of Error, Eye Diagrams for ASK,PSK,FSK, Cross Talk.

INFORMATION THEORY

Information and Entropy, Conditional Entropy and Redundancy, Shannon - fano coding, Mutual Information, Information Loss due to noise, Source Coding- Huffman code, Variable length Coding, Source Coding to increase Average Information per Bit, Lossy Source Coding

UNIT IV

ERROR CONTROLLING CODES

LINEAR BLOCK CODES

Matrix description of Linear Block codes, Error detection and error correction capabilities of Linear block codes.

CYCLIC CODES

Algebraic structure, Encoding, Syndrome calculation, Decoding.

CONVOLUTIONAL CODES

Encoding, Decoding using state, tree and trellis diagram, decoding using Viterbi Algorithm, Comparison of Error Rates in Coded and Uncoded Transmission.

UNIT V

SPREAD SPECTRUM MODULATION

Use of Spread Spectrum, Direct Sequence Spread Spectrum (DSSS), Code Division Multiple Access using DSSS, Frequency Hopping Spread Spectrum, PN-Sequences: Generation and Characteristics, Synchronization in Spread Spectrum Systems.

LIST OF TEXT BOOKS / REFERENCES / WEBSITES / JOURNALS / OTHERS

Text Books:

1. Principles of Communication Systems, Herbert Taub, Donald L. Schilling, 3rd edition, Tata McGraw Hill (2008).
2. Digital and Analog Communication Systems, K. Sam Shanmugam, John Wiley & Sons (2005).

Reference Books:

1. Digital Communications, John G. Proakis, Masoudsalehi, 5th edition, Tata McGraw Hill (2008).
2. Digital Communications, Simon Haykin, John Wiley(2005).
3. Digital Communications, Ian A. Glover, Peter M. Grant, 2nd Edition Pearson Edu.,2008.
4. Communication Systems, B.P. Lathi, BS Publication, 2006.

X. COURSE PLAN

Lecture No.	Course Learning Objective	Topics to be covered	Reference
1-3	Discuss the fundamentals of digital communication systems	Advantages of digital communication systems.	T1 1.1, T2 1.1, 1.2
4-5	Describe the relation between bandwidth and signal power in a communication channel.	Bandwidth–S/N trade off, Hartley Shannon law.	T1 13.3,
6	Employ the rules for converting analog signals into digital	Sampling theorem.	T15.1.1
7-10	Illustratebasic principle of conversion of analog signals into digital prototype, Re-conversion of digital signals into analog domain	Pulse code modulation: PCM generation, PCM reconstruction,	T1 5.4.3
11	Analyze different methods in PCM generation.	Quantization noise, on uniform quantization.	T1 5.4.1
12-13	Examine DPCM implementation, and converting Non-uniform quantization into uniform quantization	Differential PCM systems (DPCM), Adaptive DPCM.	T1 5.6.1, 5.6.2
14-16	Infer 2 level PCM systems (DM) and Model Adaptive DM, noise generated in PCM &DM	Delta modulation, Adaptive delta modulation, Noise in PCM and DM systems.	T1 5.6.3, 5.6.4
17-21	Demonstrateand analyze the role of modulation in digital communications: ASK, FSK	Digital modulation techniques: Introduction, ASK, ASK modulator, Coherent ASK detector, non-coherent ASK detector, FSK, bandwidth and frequency spectrum of FSK, Non-coherent FSK,	T1 6, T2 8

		coherent FSK detector, FSK detection using PLL.	
22-24	Demonstrate the role of modulation in digital communications: PSK and Analyze QPSK &DPSK	BPSK, coherent PSK detection, QPSK, Differential PSK.	T2 8.2
25-27	Examine principles of Base-band signal transmission and design optimum pulse shapes for Base-band signal transmission	Baseband transmission and reception of digital signal, Pulse shaping for optimum transmissions, A base band signal receiver, probability of error.	T1 11.1, 11.2, 11.4, 11.5, 11.6
28-30	Practice optimal of coherent reception and design of optimal receivers and Memorize the basics of vector representation of modulated signal spaces	Optimal receiver, optimal of coherent reception, signal space representation.	T1 11.3
31-34	Examine the probability of error in various communication systems: ASK, FSK, BPSK,QPSK,DPSK, Dramatizenoise effect on signal shape with the help of eye diagram	Probability of error for ASK, FSK, BPSK, QPSK, DPSK, Eye diagram, Cross talk.	T2 5.7
35-37	Explain the principle of information content in digital signals,	Information theory: Measure of Information, Entropy, and Entropy properties.	T2 4.2.1, 4.2.2
38-39	Obtain relation between information rate and signal rate (redundancy) and conditional entropy in analog signaling	Conditional entropy and redundancy, Mutual information.	T1 13.5
40-41	Calculate the loss of information due to noise, Develop maximum rates of information over a channel i.e., Channel capacity	Information due to loss, Channel capacity.	T1 13.5
42.	Designcoding for optimizing information in a signal entity	Source coding efficiency.	T1 13.2
43.	AppraiseShannon-Fano principle for optimizing information in a signal entity, Evaluate source coding efficiency in Huffman codes.	Shannon-Fano coding, Source coding- Huffman code.	T1 13.2.1, 13.2.2
45-47	Estimate the effect of probability on information content and code length of a signal entity, Explain the role of source coding to increase average information per bit and Define reasons for losses of information in source coding	Variable length coding, Source coding to increase average information per bit, Lossy source coding.	T1 13.2, 13.6
48.	Explain need for linear block codes for transmission over communication channels & their matrix representation	Linear Block code: Matrix description of Linear Block codes.	T2 9.2.1
49-51	Interpret error detection using Linear block codes, State correction properties of Linear Block code and Evaluate Error detection &correction using Linear block codes	Error detection of Linear block codes, Error correction capabilities of Linear block codes, Error correction of linear block codes.	T2 9.2.2
52-53	Describe properties of Cyclic codes and Discuss design of Cyclic codes	Cyclic codes: Algebraic structure, Encoding of cyclic codes.	T2 9.3.1, 9.3.2

54	Formulate error detection of Cyclic codes	Syndrome calculation.	T2 9.3.3
55	Operate the decoding procedures of cyclic codes	Decoding.	T2 9.3.4
56	Explain convolution codes	Introduction to Convolution codes.	T2 9.6
57-58	Express encoding of convolution codes by time domain and Extend convolution codes To understand Encoding of convolutional codes by transform domain	Encoding of convolution codes by time domain, Encoding of convolution codes by transform domain.	T2 9.6.1
59-60	Discuss encoding of convolutional codes by time domain To find Decoding using state, tree diagrams and Demonstrate Encoding, Decoding using trellis diagram,	Decoding using state, tree diagrams, Encoding, Decoding using trellis diagram.	T1 13.12.1
61-62	Explain VITERBI ALGORITHM for decoding convolution codes and Compare error rates in coded and un coded transmission	Decoding using Viterbi algorithm, Comparison of error rates in coded and un coded transmission	T1 13.12.2, 13.13
63-65	Discuss Spread Spectrum Modulation and Examinethe use of Spread Spectrum, Direct Sequence Spread Spectrum (DSSS), Code Division Multiple Access	Introduction to Spread Spectrum Modulation, Use of Spread Spectrum, Direct Sequence Spread Spectrum (DSSS) and Code Division Multiple Access	T1 15.1, 15.2, 15.3
66	InterpretRanging using DSSS, Frequency Hopping Spread Spectrum.	Ranging using DSSS, Frequency Hopping Spread Spectrum.	T1 15.4, 15.5
67-68	ExplainPN-Sequences, Generation and Characteristics and DiscussSynchronization in Spread Spectrum Systems.	PN-Sequences: Generation and Characteristics, Synchronization in Spread Spectrum Systems.	T1 15.6, 15.7

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S							S			S			S	S
II		S						H		S				H	
III		H		S				S				S	H		S
IV			S		S						S		S	S	

S – Supportive **H - Highly Related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		S	S					S							
2	S			S	S					S			S	H	S
3		H	S					H					H		
4	H			S	S					S				S	
5		S	S								S		S	S	
6	S	S	S							S			S	H	
7				H				S			S	S		S	
8												S			

S – Supportive **H - Highly Related**

Prepared by :
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HOD, ECE