GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering
Level: Diploma
Branch: Electronics & Communication / Information & Communication Technology
Subject Code : DI04000131
Subject Name : Digital & Data Communication

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	PCC

Prerequisite:	Basic knowledge of principle of electronics communication, mathematics, including probability will be helpful.
Rationale:	The course aims to provide a fundamental understanding of digital and data communication systems, covering topics such as communication system elements, digital modulation, source and channel coding, various data transmission techniques, standards and emerging trends. The course emphasizes hands-on learning through practical's, simulations, minor projects and exercises, allowing students to apply theoretical concepts to real-world scenarios. Upon completion, students will have a solid foundation in digital and data communication, preparing them for advanced studies or careers in advance communications, networking, and related technology fields.

Course Outcome:
After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
01	Enlist the basic elements and functions of a digital and data communication system.	R, U
02	Analyze the principles and characteristics of key digital modulation techniques.	R, U, A
03	Apply different coding techniques for source, channel and line.	U, A
04	Use data transmission modes for various data formats.	R, U, A
05	Apply knowledge of current trends to identify potential applications in industries	U, A

*Revised Bloom's Taxonomy (RBT)

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Digital and data communication System** 1.1. Elements of Digital Communication system with its Block diagram: Source, Channel, Transmitter, Receiver, Repeater. 1.2.Communication channel characteristics: bit rate, baud rate, bandwidth, Repeater distance 1.3.Communication channel types: telephone channels co-axial channels, optical fiber cables, wireless broadcast channel, satellite channel 1.4.Multiplexing – Need and methods of multiplexing: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code division multiplexing (CDM) block diagram and their comparison 1.5.Fundamental limitation of digital communication system-Nosie, bandwidth and equipment 1.6.Advantages and disadvantages of digital communication System.	8	17
2.	**Digital Modulation Techniques** 2.1.Amplitude Shift Keying (ASK) – Generation, reception, bandwidth, constellation diagram, waveforms, advantages and disadvantages 2.2.Frequency Shift Keying (FSK) – Generation, reception, bandwidth, constellation diagram, waveforms, advantages and disadvantages 2.3.Phase Shift Keying (PSK) –Generation, reception, bandwidth, constellation diagram, waveforms, advantages and disadvantages 2.4.Quadrature Phase Shift Keying (QPSK)- Generation, reception, bandwidth, constellation diagram, waveforms, advantages and disadvantages 2.5.Comparison of ASK, FSK, PSK and QPSK 2.6.Quadrature Amplitude Modulation (QAM) - Principle, constellation diagram, waveforms, advantages and disadvantages	10	23
3.	**Information Theory and Coding** 3.1.Basic definition of probability, properties of probability, conditional probabilities, probability of statistically independent events 3.2. Entropy and Information 3.3. Mutual Information 3.4.Channel Capacity	9	23

	3.5.Source coding techniques- need of source coding techniques, Huffman Code, Shannon - Fano code 3.6.Channel coding: introduction to Error in communication, causes and its effect of error, error detection & correction techniques: parity check, checksum, Hamming Code, Cyclic Redundancy Check (CRC). 3.7. Line Coding Techniques- properties of Line code, selection criteria of line codes, classification of line codes- Unipolar RZ and NRZ, Polar RZ and NRZ, Bipolar NRZ(AMI)		
4.	**Data Communication: techniques and standards** 4.1. Data Communication: Characteristics and Components of Data Communication 4.2.Data transmission mode: simplex, half duplex, full duplex 4.3. Data transmission techniques: I. Serial data communication: synchronous and asynchronous II. Parallel data communication 4.4.Switching techniques: circuit switching, message switching and packet switching. 4.5.Data representation: Audio, Video, Picture, text data Sensor data and streaming data formats 4.6.Multimedia Communications: Multimedia Communication Model, important Elements of Multimedia Systems 4.7. Multimedia processing for communication: digital media, signal processing elements, digital audio file formats, digital image file formats, digital video file formats, compression standards MP3, AAC, JPEG, MPEG, streaming codes. 4.8.Modern communication standards -Ethernet standards, Wi-fi standards, Bluetooth standards, 4.9.Communication ports-USB, HDMI, RCA,3.5mm audio and Ethernet	10	23
5.	**Emerging trend in Data communication** 5.1.Edge Computing 5.2.Block chain in Communication Security 5.3.Ethical and Privacy Considerations in Data Communication 5.4.AI-driven Networks: Intelligent traffic management, self-optimizing and self-healing communication systems 5.5.Green Communication: Energy-efficient networking and sustainable infrastructure	8	14
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	45	35	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:
(a) Books:

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Digital Communications	Dr. Sanjay Sharma	S.K. Kataria and Sons, New Delhi, Latest edition
2	Modern Digital and Analog Communications Systems	B.P. Lathi	Oxford University Press, New Delhi, Latest edition
3	Principles of Digital Communication	J.S.Chitode	Technical Publication Pune
4	Digital Communication	Rao. Ramkrishna P.	McGraw Hill, Delhi, latest Edition
5	Data Communication and Networking,	Behrouz A. Forouzan	Tata McGraw Hill, Education New Delhi (Latest edition)
6	Data Communications	William L.Schweber	TATA McGraw-Hill, latest Edition

(b) Open-source Software, Websites, YouTube channels, Free MOOC courses:

Category	Name
Open-Source Tools / Simulators	GNU Octave, Octave Signal Package – for modulation /demodulation, Digital Communication Toolbox
	– CommPy -for Simulation of digital communication systems: modulation (ASK, FSK, PSK, QPSK, QAM), channel models (AWGN, Rayleigh, Rician), error coding (Hamming, CRC), BER analysis -link - Python 3; GitHub: https://github.com/veeresht/CommPy

Free Websites / Tutorials / Lecture Collections	NPTEL: Digital Communication – Lectures
	MIT Open Course Ware: Principles of Digital Communication
	GeeksforGeeks: Basics of Data Communication
	Simulation of Communication Systems using Matlab, IIT Guwahati: https://nptel.ac.in/courses/108103191
	Introduction to Line Coding: https://www.youtube.com/watch?v=YWjTOS28Jrc
	Source Coding: https://www.youtube.com/watch?v=aVD1kmBJSsk&t=1s
	Blockchain and its application, IIT Kharagpur: https://nptel.ac.in/courses/106105235
	https://nptel.ac.in/courses/106104220
	Data communication: https://nptel.ac.in/courses/106105082
	Edge Computing, IIT Kharagpur: https://nptel.ac.in/courses/106105082
	Green Communication Networks: https://www.youtube.com/watch?v=rKezqktxD4U
Free Video Lectures / YouTube / MOOC	Gate Smashers – Data Communication Playlist
	Stanford Information Theory – YouTube Lectures
	IBM Skills Build: Edge Computing Basics (Video Lessons – Free)
	Coursera (Free Audit): Blockchain Basics – University at Buffalo
	YouTube: Cisco DevNet – AI in Networking

Suggested Course Practical List: The Suggested list of Practical.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	CO	Approx. Hrs required
1	Study the Elements of Digital Communication system with its block diagram: source, channel, transmitter and receiver.	1	CO1	2
2	Test the performance for 4 input Time Division Multiplexing (TDM) Circuit	1	CO1	2

3	Test the performance for 2 input Frequency Division Multiplexing (FDM) Circuit	1	CO1	2
4	Generate Frequency Division Multiplexing (FDM) signal using relevant simulation software	1	CO1	2
5	Generate Time Division Multiplexing (TDM) signal using relevant simulation software	1	CO1	2
6	Generate and analyze the waveform of Amplitude Shift Keying (ASK) modulator and demodulator	2	CO2	2
7	Generate and analyze the waveform of Frequency Shift Keying (FSK) modulator and demodulator	2	CO2	2
8	Generate and analyze the waveform of Phase Shift Keying (PSK) modulator and demodulator	2	CO2	2
9	Generation and detection the waveform of quadrature Phase Shift Keying technique using trainer kit or simulation software	2	CO2	2
10	Generate Huffman code using relevant simulation software	3	CO3	2
11	Generate Shannon-Fano code using relevant simulation software	3	CO3	2
12	Generate Error correcting code using relevant simulation software	3	CO3	2
13	Generate Error Detecting Code-Parity code using relevant simulation software	3	CO3	2
14	Check the performance of various line code techniques by encoding and decoding data.	3	CO3	2
15	Serial data transmission: reading and writing data using relevant simulation software	4	CO4	2
16	File formats supported by relevant simulation software for signal processing	4	CO4	2
17	Conversion of Audio & Video files into various format using “Format Factory”	4	CO4	2
18	Audio signal Processing using relevant simulation software	4	CO4	2
19	Video signal Processing using relevant simulation software	4	CO4	2
20	Simulate data processing at edge devices vs. cloud (latency, bandwidth usage) using simulation software	5	CO5	2
21	Implement a basic blockchain-based message integrity system using simulation software	5	CO5	2
22	Measure energy consumption of different network topologies using simulation software	5	CO5	2
	Minimum 15 Practical			Min 30 Hrs

List of Laboratory equipment /Learning Resources Required:

1. Laboratory Equipment

- Digital Communication System Trainer kit (ASK/FSK/PSK/QAM options).
- CRO (dual trace), Function generator, RF generator / spectrum analyzer (if available).
- Time Division and Frequency Division Multiplexing -Demultiplexing trainer
- Line coding encoder/ decoder trainer kit

2. Software / Learning Resources

- PC with MATLAB / Python (NumPy/Matplotlib) / Arduino IDE / Raspberry Pi OS.
- Wireshark, Format Factory (or similar), basic SDR (optional).

Suggested Project List:

1. **Simulation and Design Projects**
- Simulation of Digital Communication System Block Diagram using MATLAB/Scilab/Proteus
- Design and simulation of ASK/FSK/PSK modulator/demodulator using MATLAB/Proteus
2. **Hardware Implementation Projects**
- Hardware project: ASK/FSK/PSK modulation using 555 Timer, multiplier IC, and detector circuit
- Arduino-based ASK/FSK/PSK transmitter and receiver for wireless communication
3. **Coding and Compression Projects**
- Huffman Coding Implementation: Encode a text or image file and compare original vs. compressed size
- Shannon–Fano Coding Demonstration: Simulation with probability distribution of symbols
4. **Communication Protocol Projects**
- Arduino-based Serial Communication (UART) Demo: Send/receive data between two Arduinos or Arduino–PC
- Parallel vs. Serial Data Transfer Speed Test: Using microcontrollers or simulation tools
5. Advanced and Case Study Projects
- Energy-efficient Routing Simulation in Wireless Sensor Network (WSN)
- Case Study Project: Survey on Privacy Policies in WhatsApp, Signal, Telegram, and present findings

Suggested Activities for Students:

Activity / Task	Objective / Learning Outcome	Tools / Resources
1. Draw block diagrams of communication systems. 2. Compare channel types (wireless, coaxial, fiber) with real examples. 3. Demonstrate multiplexing techniques with time charts.	Understand system elements, channel characteristics, and need for multiplexing. Visual comparison to strengthen conceptual clarity	Pen & Paper, MATLAB/Octave, YouTube demos, Scilab Xcos
1. Simulate ASK, FSK, PSK, QPSK, and QAM using MATLAB/Octave. 2. Plot constellation diagrams for each modulation. 3. Measure bandwidth and compare modulation schemes.	Learn digital modulation principles, waveform generation, and spectral analysis.	MATLAB/Octave, Python (CommPy), GNU Radio, Scilab
1. Calculate entropy and mutual information for given data. 2. Encode messages using Huffman and Shannon-Fano coding. 3. Simulate error detection/correction: parity, checksum, Hamming, CRC 4. Implement line coding techniques and visualize waveforms.	Understand information measures, source/channel coding, and error control.	MATLAB/Octave, Python (CommPy), online coding simulators
1. Compare simplex, half-duplex, and full-duplex transmission using experiments. 2. Simulate serial (synchronous/asynchronous) and parallel communication. 3. Study switching techniques with flow diagrams. 4. Analyze multimedia data formats and compression techniques. 5. Explore modern communication standards (Ethernet, Wi-Fi, Bluetooth).	Develop practical understanding of communication modes, standards, and data representation. Encourages teamwork & creativity	MATLAB/Octave, Python, Packet Tracer, Wireshark, YouTube demos

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