GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester -IV

Course Title: Digital and Data Communication

(Course Code:4343201)

Diploma program in which this course is offered	Semester in which offered
Information and Communication Technology Engineering	Fourth

1. RATIONALE

Students of diploma Information and Communication Technology Engineering need to have a thorough understanding of concepts of Digital and data Communication. Diploma students undertaking this course are expected to apply the fundamentals of digital and data communication system to analyze the different digital communication (Modulation and Demodulation) methods and recent trends in the field of digital and data communication, this course develop skills required to manage digital communication systems to meet the expectations of the industry. Students also can learn how to stay updated on emerging communication tools and trends.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

● Maintenance and implementation of digital Communication Systems.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Understand the principles of digital and data communication.
b) Analyze the principles and characteristics of key digital modulation techniques.
c) Apply different coding techniques for source, channel and line.
d) Use data transmission modes for various data formats.
e) Familiarize with recent trends and challenges in digital/data communication.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (in Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the Cos

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA -**

Continuous Assessment; **ESE** -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. Some of the PrOs marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain.

S.NO.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Study the Elements of Digital Communication system with its block diagram: source, channel, transmitter and receiver	1	2*
2	Generate and analyze the waveform of Amplitude Shift Keying (ASK) modulator and demodulator	2	2*
3	Generate and analyze the waveform of Frequency Shift Keying (FSK) modulator and demodulator	2	2*
4	Generate and analyze the waveform of Phase Shift Keying (PSK) modulator and demodulator	2	2*
5	Identify the different phase shifts generated in Quadrature Phase Shift Keying Modulation	2	2*
6	Test the performance for 4 input Time Division Multiplexing (TDM) Circuit	1	2*
7	Test the performance for 2 input Frequency Division Multiplexing (FDM) Circuit	1	2*
8	Generate Time Division Multiplexing (TDM) signal using relevant simulation software	1	2
9	Generate Frequency Division Multiplexing (FDM) signal using relevant simulation software	1	2
10	Generate Huffman code using relevant simulation software	3	2*
11	Generate Shannon Fano code using relevant simulation software	3	2
12	Generate Error correcting code using relevant simulation software	3	2
13	Generate Error Detecting code-Parity code using relevant simulation software	3	2*
14	Check the performance of various line code techniques by encoding and decoding data.	3	2*
15	Serial data transmission: reading and writing data using relevant simulation software	4	2*
16	File formats supported by relevant simulation software for signal processing	4	2*
17	Conversion of Audio & Video files into various format using "Format Factory"	4	2*
18	Audio signal Processing using relevant simulation software	4	2

19	Video signal Processing using relevant simulation software	4	2
20	Study the Elements of satellite Communication system with its block diagram.	5	2
21	Study the 5G system standards	5	2*
		TOTAL	42

Note

i. More Practical Exercises can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
ii. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed Practical Exercises of this course required which are embedded in the COs and ultimately the competency.

S.NO.	Sample Performance Indicators for the (PrOs)	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices	20
4	Record observations correctly	20
5	Interpret the result and conclude	20
	TOTAL	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical's in all institutions across the state.

S.NO	Equipment Name with Broad Specifications	PrO No.
1	Spectrum analyzer, 9 kHz to 1.5 GHz Frequency Range, Typical -135 dBm Displayed Average Noise Level (DANL).	2,3,4,5
2	CRO – Dual trace, 20 MHz Choice of any one built-in option, 30 MHz Bandwidth	2,3,4,5
3	RF generator/wideband oscillator Wide Frequency Range 100 KHz to 150 MHz	2,3,4,5
4	Function Generator: Frequency Range 0.1 Hz to 1 MHZ.	2,3,4,5
5	Digital Communication Trainer, In-build internal data generator, Type of Modulations and Demodulations: ASK, FSK, BPSK, QPSK, 8-PSK, 16-QAM ,	2,3,4,5
6	Time Division and Frequency Division Multiplexing -Demultiplexing trainer	6,7
7	Line coding encoder/ decoder trainer kit	14
8	Computer system with operating system: Windows 7 or higher Ver., macOS, and Linux, with 4GB or higher RAM, Python latest version, MATLAB latest version.	ALL

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Prepare the list of equipment required in laboratory session.
b) Complete experiment within given time.
c) Adhere to laboratory guidelines.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year.
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Introduction to Digital and data communication system	1a. Explain function of given block of digital communication system 1b. Define bit rate, baud rate and bandwidth 1c. Selection of communication channel based on need. 1d. Classify the given multiplexing techniques based on domain of working 1e. State Advantages and disadvantages of digital system	1.1Elements 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 1.3Communication channel types: telephone channels co-axial channels, optical fiber cables, wireless broadcast channel, satellite channel 1.4Multiplexing – Need and methods of multiplexing: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code division multiplexing (CDM) block diagram and their comparison 1.5Basic modes of communication – broad casting and point to point communication. 1.6Fundamental limitation of digital communication system- Nosie, bandwidth and equipment 1.7Advantages and disadvantages of digital communication system

Unit-II Digital Modulation Techniques	2a. Summarize the shift keying techniques 2b. Explain generation of given type of shift keying signals 2c. Compare salient features of the given type of digital modulation techniques.	2.1Amplitude Shift Keying (ASK) – Generation, reception, bandwidth, constellation diagram, waveforms, advantages and dis advantages 2.2Frequency Shift Keying (FSK) – Generation, non-coherent and coherent detection, waveforms, advantages and disadvantages 2.3 Phase Shift Keying (PSK) –BPSK, QPSK (Generation, detection, waveforms, advantages and disadvantages) 2.4 Comparison of ASK, FSK, PSK 2.5Quadrature Amplitude Modulation (QAM) Principle, constellation diagram, waveforms, advantages and dis- advantages
Unit-III Information Theory and Coding	3a. State the significance of probability in communication 3b. Define Entropy and Information and its physical significance, their units 3c. State Channel Capacity in terms of SNR and explain its importance 3d. Use appropriate source coding technique based on need. 3e. Apply error detection and correction techniques for given data bits. 3f. Use different line coding techniques	3.1 Probability – basic definitions related to probability, properties of probability, conditional probabilities, probability of statistically independent events 3.2 Entropy and Information 3.3 Mutual Information 3.4 Channel Capacity 3.5 Source coding techniques- Huffman Code, Shannon - Fano code 3.6 Channel coding: Error, causes of error and its effect, error detection & correction using parity, checksum, Hamming Code, Cyclic Redundancy Check (CRC). 3.7 Line Coding Techniques- Line coding properties, selection of line codes, classification of line codes-Unipolar RZ and NRZ, Polar RZ and NRZ, Bipolar NRZ(AMI)
Unit-IV 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. Data representation 4.5. Multimedia Communications: Multimedia Communication Model, Elements of Multimedia Systems 4.6. Multimedia processing for communication: digital media, signal	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. Data representation 4.5. Multimedia Communications: Multimedia Communication Model, Elements of Multimedia Systems 4.6. Multimedia processing for communication: digital media, signal processing elements, digital audio file formats, digital image file

	processing elements, digital audio file formats, digital image file formats, digital video file formats 4.7.RS -232, 422 and 485 standard	formats, digital video file formats 4.7.RS -232, 422 and 485 standard 4.8.Communication ports-USB, HDMI, RCA,3.5mm audio, Ethernet 4.9. Industrial standards
Unit-V **Emerging trend in Data communication**	5a. Explain block diagram of satellite communication 5b. Interpret the aspects of spread spectrum techniques 5c. familiarize with edge computing, quantum communication. 5d. Identify privacy considerations in data communication	5.1. Satellite Communication 5.2.5G Technology in data communication 5.3 Spread spectrum communication 5.4. Edge Computing 5.5 Block chain in Communication Security 5.6. Ethical and Privacy Considerations in Data Communication

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R level	U level	A level	Total Marks
I.	Introduction to Digital and data communication system	08	04	07	03	14
II.	Digital Modulation Techniques	08	04	06	04	14
III.	Information Theory and coding	10	04	07	05	16
IV.	Data Communication: techniques and standards	10	03	08	05	16
V.	Emerging trend in Data communication	06	04	03	03	10
Total		42	19	31	20	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews:

- Simulate the learned circuit using any circuit simulation software.
- Prepare Presentation on any one topic learned.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (MOOCs) may be used to teach various topics/subtopics.
b) Guide student(s) in undertaking micro-projects.
c) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature can be given to the students for self-learning, but to be assessed using different assessment methods.
d) Using different instructional methods for teaching.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, in the fifth and sixth semesters, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-based, workshop- based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total work load on each student due to the micro-project should be about 16 (sixteen) student engagement hours (i.e., about one hour per week) during the course. The students ought to submit micro project by the end of the semester (so that they develop the industry-oriented COs).

A suggestive list of micro-projects is given here. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

- ASK, FSK, PSK, QPSK and QAM Modulator and Demodulator: Implement a simple various digital modulator and demodulator using a microcontroller /PYTHON/MATLAB
- ASK, FSK, PSK, QPSK and QAM Modulator and Demodulator Wireless Communication: Develop a wireless communication system using various digital modulator and demodulator
- Implement source coding techniques like Arithmetic coding, Run-Length Encoding, Delta coding
- Implement channel coding techniques like error correction code, Convolution Coding and Viterbi Decoding, Turbo Codes, BCH code, LDPC (Low-Density Parity-Check) Codes
- Serial Communication with Python
- Serial Bluetooth Communication
- Parallel Data Transfer using General Purpose Input/output (GPIO)
- 5G Massive MIMO (Multiple Input Multiple Output): Build a micro project that demonstrates the benefits of Massive MIMO in 5G.
- Satellite Ground Station Setup: Create a satellite ground station using a software-defined radio (SDR) or other communication equipment
- Orbital Mechanics Simulation: Develop a simulation program that models satellite orbits using basic orbital mechanics equations
- LEO, MEO and GEO satellite model tracker

13. SUGGESTED LEARNING RESOURCES

Sr.No.	Title of book	Author	Publication
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	Digital Communication	Rao. Ramkrishna P.	McGraw Hill, Delhi, latest Edition
4	Digital Communication	Sklar, Bernald	Pearson Education India, 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

14. SOFTWARE/LEARNING WEBSITES

a. Hamming code: **https://www.youtube.com/watch?v=hn1H84V4ve0**

b. **https://nptel.ac.in/courses/117101053**

c. https://www.gobookee.org/amplitude-shift-keying-advantages-and-disadvantages/

d.http://ninjacraze.hubpages.com/hub/What-is-Data-Communication

e. https://www.youtube.com/watch?v=cXFyR9oI1Zo

f.https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000574EE/P001538/M017167/ET/1470201656p8m30_etext.pdf

g. **https://www.youtube.com/watch?v=dt4Ce8gQPns&t=1471s**

h. **https://www.youtube.com/watch?v=YWjTOS28Jrc**

i. **https://www.youtube.com/watch?v=aVD1kmBJSsk&t=1s**

j. **https://www.youtube.com/watch?v=p6lze5nPkzk**

15.PO-COMPETENCY-CO MAPPING

Semester IV	**Digital and Data Communication (Course Code:** 4343201)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ develop-ment of solutions**	**PO 4 Engineering Tools, Experimentation& Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	**Maintenance and implementation of digital Communication Systems.**						
Course Outcomes CO1 Understand the principles of digital and data communication.	3	2	1	3	2	2	1
CO2 Analyze the principles and characteristics of key digital modulation techniques.	3	1	2	2	1	1	2
CO3 Apply different coding techniques for source, channel and line.	3	2	2	2	1	1	2
CO 4 Use data transmission modes for various data formats.	3	1	1	2	2	1	2
CO 5 Familiarize with recent trends in digital/data communication.	3	1	1	3	2	2	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Sr. No.	Name and Designation	Institute
1.	Dr.S.N.Sampat HOD EC Dept. -BOS -ICT member	L.E.College(Diploma),Morbi
2.	Smt. Kerolin Shah, Lecturer EC	Government Polytechnic, Ahmedabad
3.	Ku.G.I.Nagpara, Lecturer EC	L.E.College(Diploma),Morbi