GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Digital Communication
(Course Code: 3341102)

Diploma programmer in which this course is offered	Semester in which offered
Electronics and Communication Engineering	4th Semester

1. RATIONALE

Digital communication plays vital role in the field of electronic communication systems which includes wired and wireless communications viz. telecommunication, radio, mobile and satellite communication systems. This course will enable Electronics and communication engineering diploma engineers to maintain digital communication and networking equipment and circuits used in the practical field. This course also lay the foundation to understand the advanced communication courses in the subsequent semesters.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Maintain electronic digital communication systems.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be performed in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

a) Define digital communication and its characteristics.
b) Explain the function of various bandpass modulation techniques.
c) Discuss various coding techniques used in data transmission.
d) Distinguish between various multiplexing and multiple access techniques.
e) Illustrate digital communication based application.

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

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

*Note: (*) 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 It is the responsibility of the institute heads that marks for CA of theory & ESE and CA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (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'.

Sr. 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	02*
2	Generate and analyze the waveform of Amplitude Shift Keying (ASK) modulator and demodulator	2	02*
3	Generate and analyze the waveform of Frequency Shift Keying (FSK) modulator and demodulator	2	02*
4	Generate and analyze the waveform of Phase Shift Keying (PSK) modulator and demodulator	2	02*
5	Identify the different phase shifts generated in Quadrature Phase Shift Keying Modulation	2	02*
6	Sketch the constellation diagram for 8- Phase Shift Keying modulation	2	02*
7	Check the performance of 8- Phase Shift Keying modulation and demodulation	2	02*
8	Check the performance of Minimum Shift Keying modulation and demodulation	2	02*
9	Generate Huffman code using relevant simulation software	3	02
10	Generate Shannon Fano code using relevant simulation software	3	02*
11	Generate Error correcting code using relevant simulation software	3	02
12	Generate Error Detecting code using relevant simulation software	3	02*
13	Test the performance for 4 input Time Division Multiplexing (TDM) Circuit	4	02*
14	Test the performance for 2 input Frequency Division Multiplexing (FDM) Circuit	4	02*
15	Generate Time Division Multiplexing (TDM) signal using relevant simulation software	4	02
16	Generate Frequency Division Multiplexing (FDM) signal using relevant simulation software	4	02
17	Familiarization with Arduino/ Raspberry Pi and perform necessary software installation.		

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
18	To interface LED/Buzzer with Arduino/ Raspberry Pi and write a program to turn ON LED for 1 second after every two second.		
19	Capturing the Packets using Wireshark		
20	Study of the features of firewall in providing network security and to set Firewall Security in windows.		
21	Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome)		
22	File formats supported by MATLAB for signal processing		
23	Conversion of Audio & Video files into various format using "Format Factory"		
24	Audio signal Processing using MATLAB		
25	Video signal Processing using MATLAB		
	Minimum 10 – 12 Practical Exercises		**32**

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.*

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	30
3	Follow safe practices measures	10
4	Record observations correctly	30
5	Interpret the result and conclude	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. 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).	1,2,3,4
2.	CRO – Dual trace, 20 MHz Choice of any one built-in option, 30 MHz Bandwidth	1,2,3,4,5
3.	RF generator/wideband oscillator Wide Frequency Range 100 KHz to 150 MHz.	1,2,3,4,5
4.	Function Generator: Frequency Range 0.1 Hz to 1 MHZ.	1,2,3,4
5.	Digital Communication Trainer, In-build internal data generator, Type of Modulations and Demodulations: ASK, FSK, BPSK, QPSK, 8-PSK, 16-QAM , Time Division Multiplexing -Demultiplexing and Frequency Division Multiplexing -Demultiplexing	1,2,3,4

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 Elements of Digital Communication System	1a. Signal and its classification 1a. Explain function of the given block of digital communication system. 1b. Describe with sketches the given type of characteristics of communication channels.	1.1 Signal and Classification, Continues time and discrete time signals, Real and complex signals, Determination and random signals, Even and odd signals, Energy and power signals, Singularity function, Unit step function, Unit impulse function, Unit ramp function.

		1.2 Elements of Digital Communication system with its block diagram: source, channel, transmitter and receiver 1.3Communication channel characteristics: bit rate, baud rate, bandwidth, repeater distance, applications
Unit-II Digital Modulation Techniques	2a. ASK signal generation and detection- Modulation and Demodulation of ASK 2b. FSK signal generation and detection- Modulation and Demodulation of FSK 2c.PSK signal generation and detection with its functional diagram. 2d. Comparison between ASK, FSK and PSK 2d. Principle & process of QPSK signal generation and detection with its constellation diagram and waveform. 2e. Principle, constellation	2.1 Amplitude Shift Keying (ASK) 2.2 Frequency Shift Keying (FSK) 2.3 Phase Shift Keying (PSK) 2.4 Quadrature Phase shift Keying (QPSK) 2.5 8ary- PSK 2.6 16-Quadrature Amplitude Modulator (QAM) 2.7 Minimum Shift Keying (MSK)
Unit-III Information Theory and Coding	3a. Significance of probability in communication 3b. Entropy and Information with its physical significance, their units 3c. Channel Capacity in terms of SNR and its importance 3d. Define Huffman code, Error detecting and correcting code (Parity Codes, Hamming Codes)	3.1 Probability 3.2 Entropy and Information 3.3 Mutual Information 3.4 Channel Capacity 3.5 Huffman Coding and Shannon Fano coding 3.6 Error, types of error 3.7 Define error detection and list types of error detection. 3.8 Define error correction and list common error correcting code
Unit-IV Multiplexing and Multiple Access Techniques	4a. Classify the given multiplexing techniques based on domain of working. 4b. Choose the suitable multiplexing techniques for multiplexing the given number of signals. 4c. Interpret the given multiplexing hierarchy.	4.1 Need and methods of multiplexing: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code Division multiplexing (CDM), definition, block diagram and their comparison 4.2 E1 and T1- carrier multiplexing hierarchy 4.3 Access techniques: Need and methods- Time Division Multiple Access (TDMA), Frequency Division Multiple Access

	4d. Contrast the given type of multiplexing techniques and multiple access techniques. 4d. Describe the procedure to troubleshoot the specified multiplexing circuit.	(FDMA), Code Division Multiple Access (CDMA)
Unit-V Applications of Digital Communication	5a. Network Security 5b. Digital telephone exchange 5c. Wireless multimedia communication 5d. Internet of things	5.1 Security Components: Confidentiality, Integrity and Availability, Threats, Security policy and its elements, Steps in Cracking a Network, Types of Malwares, Types of Attacks 5.2 Block diagram of Digital telephone exchange, elements of hardware sub systems: DLU, LTG, SN, CP 5. 3 Form of information representation: text, audio, image and video, multimedia applications, different standard formats of audio, image and video 5.4 IoT – Concept , Key Features, Characteristics, Advantages and Disadvantages, Technology

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	Elements of Digital Communication System	10	05	10	06	21
II	Digital Modulation Techniques	10	05	10	06	21
III	Information Theory and Coding	07	01	03	03	07
IV	Multiplexing and Multiple Access Techniques	08	04	05	05	14
V	Applications of Digital Communication	07	01	03	03	07
Total		**42**	**14**	**32**	**24**	**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:

- Teacher guided tutorial exercises to solve problems based on all units.
- Implement all circuits on breadboard and verify the design.

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) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) 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.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

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 duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Design sample and hold circuit.
b) Explore ASK Modulator and Demodulator circuit.
c) Explore FSK Modulator and Demodulator circuit.
d) Explore circuit of PSK Modulator and Demodulator
e) Explore circuit of Modulator and Demodulator (modem)

f) Mini project should be prepared based on - Using Arduino or Raspberry Ri boards and its software platforms.
g) Prepare a brief report to illustrate digital communication based applications being used in various sectors (Banking, Medicine, Defense, E- commerce, Education, Environment, Industries etc.)
h) Industrial visit to telephone exchange and mobile switching center / EPABX manufacturing unit.

13. SUGGESTED LEARNING RESOURCES

S.No.	TitleofBook	Author	Publication
1	Digital Communication (2nd Edition)	R.N. Mupagi	Oxford University Press, New Delhi, Latest edition
2	Analog and Digital Communication	T. L. Singal	Tata McGraw Hill, India Latest edition
3	Modern Digital and Analog Communications Systems (3rd Edition)	B.P. Lathi	Oxford University Press, New Delhi, Latest edition
4	Electronic Communications Modulation and Transmission	Robert J. Schoenbeck	PHI Learning, New Delhi, 2nd Edition
5	Electronics Communication System (Fundamental to Advance)	Wayen Tomasi	Pearson Education, New Delhi, 5th edition
6	Communication System(Analog and Digital)	Sanjay Sharma	S.K. Kataria and Sons, New Delhi, Latest edition
7	Electronic Communication Systems	George Kennedy and Bernard Davis	Tata McGraw Hill, New Delhi, 5th edition or latest
8	Data Communication and Networking	Behrouz A. Forouzan	Tata McGraw Hill, New Delhi, 3rd edition or latest
9	Introduction to IoT	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Cambridge University Press, Latest edition

14. SOFTWARE/LEARNING WEBSITES

a) http://en.wikipedia.org/wiki/Data_transmission
b) http://www.mathworks.in/matlabcentral/fileexchange/28416-pulse-code-modulation/
c) http://www.gobookee.org/amplitude-shift-keying-advantages-and-disadvantages/
d) http://ninjacraze.hubpages.com/hub/What-is-Data-Communication
e) http://www.lincolnelectric.com/assets/US/EN/literature/nx320.pdf
f) http://www.amazon.com/Information-Theory-Network-Coding-Technology/dp
g) http://www.gobookee.org/information-theory-coding-by-k-giridhar/
h) MATLAB/Scilab/Labview software/ Electronics work bench software for the simulation
i) National Digital Library, IIT KGP.
j) Virtual Lab by IIT Bombay.

15. PO-COMPETENCY-CO MAPPING

Semester III	**Electronic Circuits & Networks (Course Code:** 4331101**)**						
	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, Experimen-tation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Manage-ment**	**PO 7 Life-long learning**
Competency	**Maintain electronic digital communication systems.**						
Course Outcomes CO1 Define digital communication and its characteristics.	3	2	1	3	2	2	2
CO2 Explain the function of various bandpass modulation techniques.	3	1	2	2	1	1	3
CO3 Discuss various coding techniques used in data transmission	3	2	2	2	1	2	2

CO 4 Distinguish between various multiplexing and multiple access techniques.	3	1	1	2	2	2	3
CO 5 Illustrate digital communication based application.	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. Sanjay. N. Sampat, HOD EC	LE College, Morvi
2.	Smt. Kerolin Shah, Lecturer EC	GP, Ahmedabad
3.	Mr. Ramesh Hun, Lecturer EC	GPG, Surat