Program Name : **Diploma in Electronics and Telecommunication Engineering**

Program Code : **EJ/EN/ET/EX/EQ**

Semester : **Fourth**

Course Title : **Digital Communication Systems**

Course Code : **22428**

1. RATIONALE

Communication technologies have undergone radical changes, especially due to convergence of computers and communication.No industry is untouched by the digital communication.This course will enable the diploma engineers to apply facts, concepts and working principles of Digital commincation for the troubleshooting and maintenance of digital communication system. This course is intended to develop the skills to diagnose and rectify the errors occure in Digital communication system. The concepts and principles of digital communication will also lay the foundation to understand the various modern communication systems.

2. COMPETENCY

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

- **Maintain basic digital communication systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Analyse various error detection and correction codes in digital communication systems
b. Use various pulse code modulation techniques
c. Maintain systems based on digital modulation techniques.
d. Multiplex and demultiplex digital signals.
e. Maintain spread spectrum based systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment 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,*
***ESE** - End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

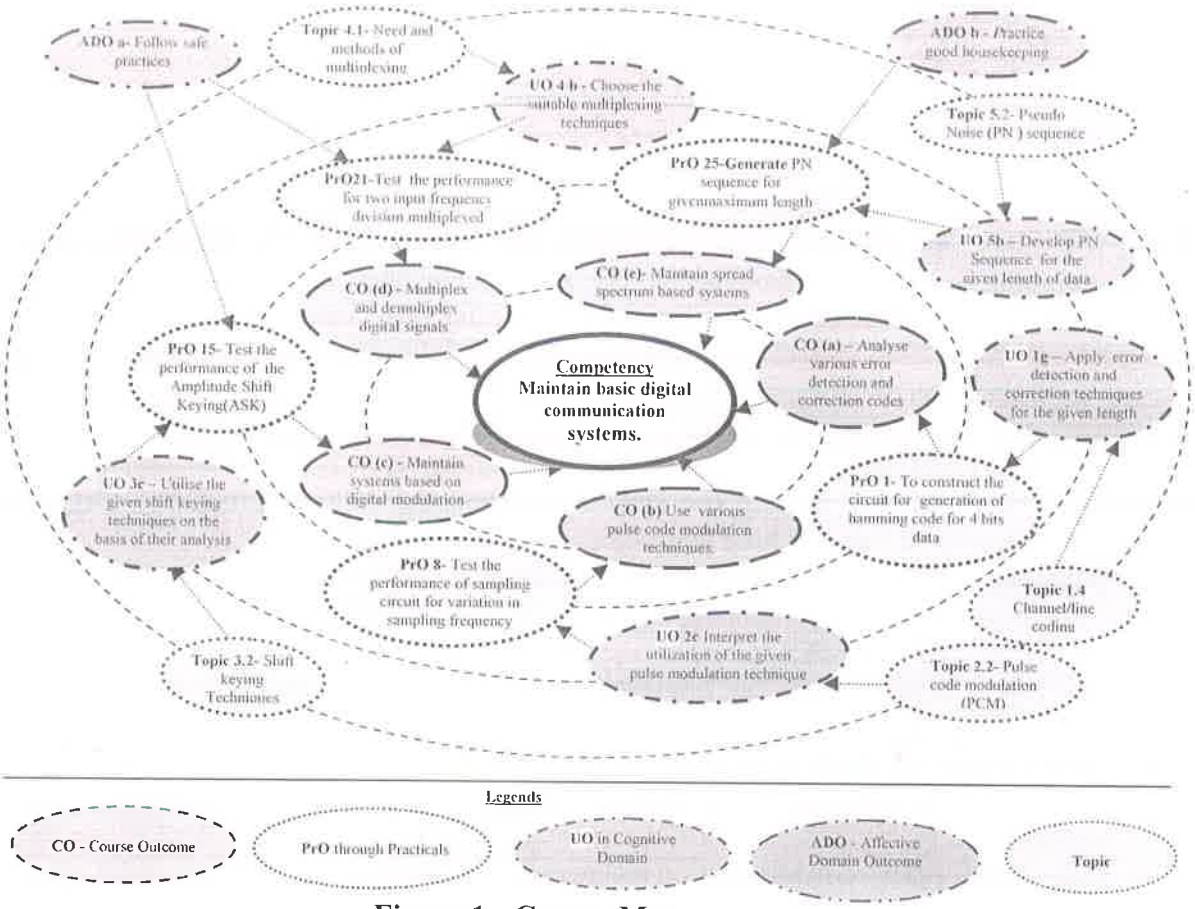

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	To construct the circuit for Generation of hamming code for 4 bits data.	I	02*
2	To construct the circuit for one bit error correction using hamming code.	I	02*
3	Generate: (a) Unipolar –NRZ, RZ (b) Bipolar- NRZ (AMI), Manchester for given data.	I	02
4	Observe the effect of average DC value and bit duration for unipolar non return zero(UPNRZ) and polar return zero(PRZ).	I	02
5	Detect error by VRC techniques using relevant simulation tool.	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Detect error by LRC techniques using relevant simulation tool.	I	02*
7	Test the performance of natural and flat top sampling circuit.	I	02*
8	Test the performance of sampling circuit for variation in sampling frequency.	II	02
9	Test the performance of the Pulse Code modulator/ demodulator circuit.	II	02*
10	Test the performance of the delta modulator/ demodulator circuit. .	II	02
11	Test the performance of the adaptive delta modulator/ demodulator circuit..	II	02
12	Test the performance of the differential pulse code modulator (DPCM) modulator/ demodulator circuit..	II	02*
13	Write a program using a relevant simulation tool to observe sampling process for sampling rate less than, equal to and greater than the Nyquist rate.	II	02
14	Test the performance of the Amplitude Shift Keying(ASK) modulator / demodulator circuits.	II	02*
15	Test the performance of the Amplitude Shift Keying(ASK) using relevant simulation software.	III	02
16	Test the performance of the Binary Phase Shift Keying(BPSK) Modulator and Demodulator circuits.	III	02*
17	Test the performance of Frequency Shift Keying(FSK) Modulator and Demodulator circuits.	III	02
18	Test the performance of the Differential Phase shift keying(DPSK) modulator / demodulator circuits.	III	02*
19	Test the performance of Quadrature Phase shift keying(QPSK) modulator and demodulator circuits.	III	02
20	Test the performance of Quadrature Amplitude Modulation (QAM) modulator and demodulator circuits.	III	02
21	Test the performance for 4-input time division multiplexing circuit.	IV	02*
22	Test the performance for 2- input frequency division multiplexing (FDM) circuit.	IV	02*
23	Generate a TDM signal using relevant simulation software.	IV	02
24	Generate a FDM signal using relevant simulation software.	IV	02
25	Generate PN sequence for given maximum length.	IV	02
26	Generate PN sequence for given maximum length using relevant simulation software.	IV	02
27	Generate two channel CDMA-DSSS signal and demodulate it.	IV	02*
28	Generate two channel CDMA-FHSS signal and demodulate it.	V	02
	Total		**56**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practicals need to be performed, out of which, the practicals marked as '' are compulsory, so that the student*

reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices
b. Practice good housekeeping
c. Practice energy conservation
d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	CRO – Dual trace, 50 MHz and above bandwidth, component tester	1 to 28
2	Spectrum analyzer, 9 kHz to 1.5 GHz Frequency range, Typical -135 dBm Displayed Average Noise Level (DANL)	20-28
3	Function Generator: Frequency Range 0.1 Hz to 30MHZ.	1 to 28
4	RF generator/wideband oscillator Wide Frequency Range 100 KHz to 150 MHz	20-28
5	Digital Communication Trainer, In-built internal data generator, Type of Modulations and Demodulations:Sampling, Line coding, PCM,DPCM,DM,ADM, ASK, FSK, BPSK,DPSK, QPSK, QAM,TDM,FDM,TDMA,FDMA,CDMA,FHSS,DSSS	2 to 28

S. No.	Equipment Name with Broad Specifications	PrO. No.
6	Digital storage oscilloscope, 50MHz and above,dual trace,component tester	20 -28

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Digital Communication System and Coding Methods	1a. Explain function of the given block of digital communication system. 1b. Describe with sketches the given type of characteristics of communication channels. 1c. Determine the channel capacity for the given channel noise level. 1d. Construct a Huffman code for the given 'n' bit data. 1e. Interpret Shannon Hartley Theorem for the given sampling rate. 1f. Compare the given line codes on the basis of average DC value, bit period, bandwidth. 1g. Apply error detection and correction techniques for the given length of data bits to generate the coded data. 1h. Describe the procedure to troubleshoot the specified digitial communication equipment	1.1 Elements of Digital Communication system with its block diagram: source, channel, ,transmitter, receiver advantages and disadvantages of digital communication 1.2 Communication channel characteristics :bit rate, baud rate, bandwidth, repeater distance, applications 1.3 Concept of Entropy and Information rate,channel capacity : Hartley's law, Shannon Hartley's theorem, Source coding: Huffman coding 1.4 Channel/line coding : Error, causes of error and its effect ,error detection and correction using parity, checksum, Vertical redundancy Check (VRC) , Longitudinal Redundancy Check (LRC), Cyclic Redundancy Check(CRC), Linear block code,Hamming code 1.5 Line coding formats: Classification of line codes,Uni polar- RZ, RZ,NRZ-I,NRZ-L,Polar -NRZ and RZ,Bipolar-NRZ /AMI, RZ,Manchester -Split Phase and Differential Manchester, Polar quaternary and their waveforms
Unit-II Pulse Code Modulation Techniques	2a. Explain sampling and quantization process for the given 'q' levels of quantization. 2b. Calculate sampling frequency for the given frequency of signals. 2c. Interpret the utilization of bandwidth for the given pulse modulation technique. 2d. Compare the performance of the given types of pulse	2.1 Sampling and quantization process: types of sampling,Nyquist sampling theorem (only statement), Aliasing effect,Quantization process , Quantization error/noise, Companding 2.2 Pulse code modulation (PCM), Differential pulse code modulation (DPCM): Transmitter and Receiver block diagram and its working, advantages and disadvantages 2.3 Delta Modulation (DM): Block diagram of Transmitter and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	modulation techniques. 2e. Describe the procedure to troubleshoot the specified pulse code modulation circuit.	Receiver,slope overload and Granular noise, Advantages and disadvantages of DM 2.4 Adaptive Delta modulation (ADM): Transmitter and Receiver block diagram. advantages and disadvantages of ADM
Unit– III Digital Modulation Techniques	3a. Summarise the given types of shift keying techniques. 3b. Explain generation of the given type of shift keying signals. 3c. Utilise the given shift keying techniques on the basis of their analysis. 3d. Interpret the constellation diagram for the given keying signals. 3e. Compare the salient features of the given types of digital modulation techniques for the following: bandwidth requirement, SNR, detection method. 3f. Describe the procedure to troubleshoot the specified digital modulation circuit	3.1 Types of Digital modulation techniques and their advantages, concept of Coherent and Non coherent detection 3.2 Shift keying Techniques : Amplitude Shift Keying (ASK) Frequency shift keying (FSK), Phase shift keying (PSK), Differential Phase shift keying (DPSK), Quadrature Phase shift keying (QPSK), Constellation diagram , transmitter and receiver block diagram and their working with waveforms 3.3 M-ary encoding :Need, M-ary FSK and M-ary PSK 3.4 Quadrature amplitude Modulation(QAM): Need, transmitter and receiver block diagram and their working with waveforms, Constellation diagram
Unit– IV Multiplexing and Multiple Access Techniques	4a. Classify the given multiplexing techniques on the basis of domain of working. 4b. Choose the suitable multiplexing techniques for multiplexing the given number of signals. 4c. Interpret the given multiplexing hierarchy. 4d. Contrast the given type of multiplexing techniques and multiple access techniques. 4e. Describe the procedure to troubleshoot the specified multiplexing circuit.	4.1 Need and methods of multiplexin: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code Division multiplexing (CDM), definition, block diagram and their comparison 4.2 E and T- carrier multiplexing hierarchy 4.3 Access techniques :Need and methods- Time Division Multiple Access (TDMA), Frequency Division multiple Access (FDMA), Code Division Multiple access (CDMA)
Unit –V Spread Spectrum Modulation	5a. Interpret the aspects of spread spectrum (SS) Modulation for the given application. 5b. Develop PN Sequence for the given length of data bits.	5.1 Introduction to spread spectrum (SS) Modulation: advantages over fixed frequency, applications of SS modulation. block diagram of Spread Spectrum modulation system

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	5c. Interpret the given spread spectrum Modulation technique. 5d. Compare the performance of the fast and slow frequency hopping on the basis of given parameters.	5.2 Pseudo Noise (PN) sequence: definition, generation and maximum length sequence 5.3 Types of SS Modulation: Direct sequence spread spectrum signal (DSSS)and Frequency hopped spread spectrum (FHSS)

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Digital Communication System and Coding Methods	16	06	08	04	18
II	Pulse Code Modulation Techniques	16	04	08	04	16
III	Digital Modulation Techniques	16	04	04	08	16
IV	Multiplexing and Multiple Access Techniques	10	04	04	04	12
V	Spread Spectrum Modulation	06	02	02	04	08
Total		**64**	**20**	**26**	**24**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note: *This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) 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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Use various meters to test electric/electronic equipment and component.
d. Library /Internet survey of electrical circuits and network.
e. Prepare power point presentation or animation for understanding different circuits behavior.

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/sub topics.

b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

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-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, 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 duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Build a parity generator/checker circuit using gates/IC. Create an error in one bit and check for parity at the o/p .
b. Build the checksum generator using adder and invertor Gate.Create one bit error and check for the data at the o/p.
c. Build a transistorized chopper circuit to check the natural smapled signal.
d. Build the circuit using sample and hold amplifier to check the flat top sampled signal.
e. Generate an ASK signal generator for two different bit patterns.
f. Develop a circuit to generate FSK.
g. Build a circuit to tranmit 2 data signals simultaneously using the same medium.
h. Develop a PN Sequence generator and test for various input sequence.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Communication systems	Tomasi, Wayne	Pearson Education, Delhi, 2009, ISBN: 9788131719534
2	Digital Communication	Rao. Ramakrishna P.	McGraw Hill,Delhi, 2011, ISBN: 9780070707764

S. No.	Title of Book	Author	Publication
3	Data Communication and Networking	Forouzan, Behrouz	McGraw Hill, Delhi, 2013, ISBN: 9781259064753
4	Digital Communication	Sklar, Bernald	Pearson Education India, Delhi,Second Edition, 2014, ISBN: 9781292026060

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. Hamming code:- https://www.youtube.com/watch?v=1A_NcXxdoCc
b. Information theory :-https://www.youtube.com/watch?v=nvmo9voRiSs
c. Video lecture:- www.nptelvideos.in/communication engineering.
d. Digital Modulation technique:-https://www.youtube.com/watch?v=GLnGVB92K78
e. Multiple access:-https://www.youtube.com/watch?v=vtiup1w1c4E
f. Multiple access:-https://www.youtube.com/watch?v=AKXFwwcww_E
g. CDMA:-https://www.youtube.com/watch?v=vdbc9P3U-Xo
h. Digital Communication:-https://www.slideshare.net/lineking/digital-communication-system?qid=2ad04efb-5203-4d01-ad26-65e2c9224c8e&v=&b=&from_search=2www.youtube.com /Digital communication circuits
i. Digital communicaton tutorial :-http://www.nptelvideos.in/2012/12/digital-communication.html
j. Data communication and Networking:- http://datacombasic.blogspot.in/2011/03/e-and-t-carrier.html


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