

Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title : Digital Communication	Course Code : 15EC43T
Semester : 4	Course Group : Core
Teaching Scheme in Hrs (L:T:P) : 4:0:0	Credits : 4
Type of course : Lecture + Assignments	Total Contact Hours : 52
CIE : 25 Marks	SEE : 100 Marks

Prerequisites

Knowledge of analog communication, analog electronic circuits and digital electronics.

Course Objectives

1. Understand the working of Digital Communication Systems.
2. Understand and analyze the different coding, digital modulation and multiplexing techniques.
3. Know the types of transmission media and elements of optical fiber system.

Course Outcomes

On successful completion of the course, the students will be able to attain the following COs

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand the digital communication techniques	R/U/A	1,2,3,9,10	09
CO2	Recognize the digital coding of analog signals and line coding techniques	R/U/A	1,2,3,9,10	07
CO3	Distinguish the digital modulation schemes.	U/A	1,2,3,9,10	12
CO4	Recognize the different types of multiplexing and multiple access methods.	U/A	1,2,3,4,9,10	06
CO5	Analyze the error detection and correction methods.	R/U/A	1,2,3,9	06
CO6	Differentiate types of transmission media and understand fiber optic system.	R/U/A	1,2,3,9,10	12
Total				52

Legends: PO-Program Outcome, CO-Course Outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply

Course-PO attainment matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Digital Communication	3	3	3	1	--	--	--	--	3	3
<p style="text-align: center;">Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.</p> <p>Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO. If $\geq 40\%$ of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3 If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2 If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1 If $< 5\%$ of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.</p>										

Course content and pattern of marks for SEE

Unit No	Unit Name	Hour	Questions to be set For SEE			Marks Weightage	Weightage (%)
			R	U	A		
1	Digital communication techniques	09	05	10	10	25	17
2	Digital coding of analog Signals	07	05	05	10	20	13
3	Digital modulation techniques	12	05	05	20	30	23
4	Multiplexing techniques and multiple Access	06	05	05	10	20	12
5	Error Detection and Correction	06	05	05	10	20	12
6	Transmission Media	12	05	10	15	30	23
Total		52	30	40	75	145	100

Legend: R- Remember, U-Understand A-Application

Course Contents

Unit - 1: Digital communication techniques

09 Hours

Definition of signal and classification. Functional Block diagram of digital communication system. Comparison of analog and digital communications. Base band and pass band transmission. Definition of information capacity, entropy, bit-rate, baud rate and bandwidth of digital data and solve simple problems. Shannon's theorem, Shannon-Hartley theorem, amount of

information, sampling process, and sample and hold circuit. Types of sampling. Sampling theorems for low pass and band pass signals. Nyquist criterion and aliasing effect. Analog pulse modulation techniques-PAM, PPM, PWM.

Unit - 2: Digital coding of analog Signals **07 Hours**

Quantization. Definition, process and classification. Pulse-code modulation system and DPCM Quantization noise and companding process. Delta modulation system and adaptive delta modulation. Applications, advantages and disadvantages in each case. Comparison of different pulse modulation methods. Line coding and types - unipolar RZ and NRZ, Polar RZ and NRZ, bipolar NRZ (AMI), split phase Manchester format with examples.

Unit – 3: Digital modulation techniques **12 Hours**

Base band transmission of binary data. Significance of inter symbol interference (ISI) and eye pattern. Digital modulation techniques-Binary and M-ary. Generation and detection(coherent and non-coherent) of Binary ASK, FSK, PSK, QPSK(Coherent only), DPSK. Merits/demerits and applications. Concept of Minimum Shift Keying (MSK) and GMSK. Comparison of different modulation techniques.

Unit - 4: Multiplexing techniques and multiple Access **06 Hours**

Concept of FDM and TDM, 4-channel PAM/TDM system, signaling rate, transmission bandwidth, synchronization, crosstalk and guard time. Digital multiplexers-principle, classification. Performance factors- bit rate, transmission channel bandwidth. Solve simple problems. Advantages and disadvantages of TDM. Working principle of T1 digital carrier system. Multiple access methods-TDMA, FDMA and CDMA and Comparison.

Unit -5: Error Detection and Correction **06 Hours**

Definition of error, types of errors and redundancy, error control strategies, error control codes, Parity check bit coding, LRC, VRC, CRC, Checksum with examples.

Unit- 6: Transmission Media **12 Hours**

Classification of transmission media: guided and unguided media, construction, merits, demerits and applications of twisted pair, co-axial and optical fibers. Block diagram of basic fiber optic communication system. Optical fiber-principle of operation, numerical aperture, angle of acceptance, configurations, losses, splices, connectors, couplers and switches. Optical emitters-LED and semiconductor LASERS, Optical detectors-APD and PIN diode and concepts of WDM.

References

1. *Digital Communication Systems*, Simon Haykin, Wiley India, ISBN:9788126542314
2. *Digital and analog communication systems*, K.Sham Shanmugam, Wiley India, ISBN:978126536801.
3. *Fiber Optic Communication systems*, 3ed, w/cd, Agarwal, Wiley India, ISBN:9788126513864.
4. *Analog and Digital Communications*, T. L. Singal, McGraw Hill Education (india) Pvt. Ltd. New Delhi. ISBN 10: 0071072691 ISBN 13: 9780071072694.
5. *Digital Communications*, P. Ramkrishna Rao, McGraw Hill Education (india) Pvt. Ltd. New Delhi. ISBN-10:0-07-070776-6, ISBN-13:978-0-07-070776-4.
6. *Principles of Electronic Communication Systems*, Louis E. Frenzel, Tata McGraw Hill Education Pvt. Ltd. New Delhi, ISBN-13:978-0-07-066755-6, ISBN-10:0-07-066755-1.
7. *Introduction to Analog & Digital Communications*, 2ed, Haykin, Wiley India, ISBN:9788126536535.
8. *Fiber Optic Communication Systems*, Dr.R.K.Singh, Wiley India, ISBN:9788126531349.

9. <http://electronicdesign.com/communications/understanding-modern-digital-modulation-techniques>
10. https://www.youtube.com/watch?v=Q_-Bts76Tfl
11. <https://www.youtube.com/watch?v=YJmUkNTBa8s>
12. <https://www.youtube.com/watch?v=7h2xr-pi5VQ>
13. <https://www.youtube.com/watch?v=Wh9knsYSodI>
14. <https://www.youtube.com/watch?v=PWaNMjimtP0>
15. <https://www.youtube.com/watch?v=9VmA2S2XiCo>
16. <https://www.youtube.com/watch?v=ifgs0uypC78>
17. <https://www.youtube.com/watch?v=pIIBINW7sOo>
18. <https://www.youtube.com/watch?v=aNqiTCZ-nko>

Course Delivery

The course will be delivered through lectures, presentations and support of modern tools.

Course Assessment and Evaluation Scheme

Master Scheme

Assessment Method	What		To Whom	Assessment mode /Frequency /timing	Max. Marks	Evidence Collected	Course Outcomes
Direct assessment	CIE	IA	Students	Three tests ⁺	20	Blue Books	1 to 6
				Activity*	05	Activity Sheets	1 to 6
	SEE	End exam		End of the course	100	Answer Scripts at BTE	1 to 6
				Total	125		
Indirect assessment	Student feedback on course		Students	Middle of the Course	Nil	Feedback Forms	1 to 3 Delivery of course
	End of course survey			End of the Course	Nil	Questionnaires	1 to 6 Effectiveness of delivery instructions & assessment methods

Legends: CIE-Continuous Internal Evaluation, SEE- Semester End-exam Evaluation

⁺ Every I.A. test shall be conducted for 20 marks. Average of three tests, by rounding off any fractional part thereof to next higher integer, shall be considered for IA.

*Students should do activity as per the list of suggested activities/ similar activities with prior approval of the teacher. Activity process must initiated well in advance so that it can be completed well before the end of the term.

Questions for CIE and SEE will be designed to evaluate the various CLs as per the weightage shown in the following table.

Sl. No.	Cognitive Levels (CL)	Weightage (%)
1	Remembering	20
2	Understanding	30
3	Applying	50
Total		100

Continuous Internal Evaluation (CIE) pattern

(i) Student Activity (5 marks)

The following student activities or similar activities can be assigned for assessing CIE/IA marks

Sl. No.	Activity
1	Collect and prepare a handwritten brief report on the functional blocks in digital communication system such as scramblers, unscramblers, equalizers or clock recovery circuits with specifications and applications.
2	Recognize/identify the digital modulation technique and line coding for the voice signal transmission in telephone system and Prepare a brief handwritten report with specifications and applications.
3	Visit a nearest telephone exchange, collect and prepare a handwritten brief report on optical fibers for the communication purpose with specifications.
4	Identify the type of multiplexing and multiple access technique used for the mobile communication purpose and Prepare a handwritten brief report on any one with specifications and applications.
5	Recognize the optical emitters or optical detectors used for optical fiber communications and prepare a handwritten report that includes specifications, cost, applications, etc.

Execution Mode

1. At least one activity is mandatory for each batch of 2 students; carried throughout the semester and submit the report before the end of the semester.
2. Report shall be qualitative and not to exceed 6 pages.
3. Activity can be carried out off-class; however, demonstration/presentation should be done in the class room.
4. Teacher is expected to observe and record the progress of students' activities
5. Assessment is made based on quality of work as prescribed by the following **rubrics** table.

(ii) Model of rubrics for assessing student activity

Dimension	Scale					Marks (Example)
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	
1. Research and gathering information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	3
2. Full-fills team roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	2
3. Shares work equality	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	5
4. Listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	3
Total marks						ceil(13/4)= 4

(iii) CIE/IA Tests (20 Marks)

Three tests have to be conducted, during specified schedule, in accordance with the test pattern given below and their average-marks shall be considered for CIE/IA.

(iv) Format of CIE/IA test question paper

CIE Question Paper							
Institution Name and Code							
Course Coordinator/Teacher							
<i>Program Name</i>		<i>Test No.</i>		<i>Units</i>			
<i>Class/Sem</i>		<i>Date</i>		<i>CL</i>			
<i>Course Name</i>		<i>Time</i>		<i>COs</i>			
<i>Course Code</i>		<i>Max. Marks</i>		<i>POs</i>			
Note to students: Answer all questions							
Question No.	Question			Marks	CL	CO	PO
1							
2							
3							
4							

Legends: PO-Program Outcome, CO-Course outcome, CL-Cognitive Level, R-Remember, U-Understand, A-Apply
Note: Internal choice may be given in each CO at the same cognitive level (CL).

(v) Model question paper for CIE

CIE Question Paper					
Institution Name and Code					
Course Co-ordinator/Teacher					
Program Name	Electronics and Communication	Test No.	1	Units	1 & 2
Class/Sem	4 th Sem	Date	1/1/2017	CL	R/U/A
Course Name	Digital Communication	Time	10-11AM	COs	1 & 2
Course Code	15EC43T	Max. Marks	20	POs	1, 2 & 3
Note to students: Answer all questions					
No.	Question	Marks	CL	CO	PO
1	Define signal and classify them.	05	U/A	1	1,2,3
2	State the sampling theorem for the low pass signals	05	R/A	1	1,2
3	Mention the merits, demerits and applications of data compression	05	R	2	1,2
4	Describe briefly the delta modulation system with the help of block diagram.	05	A	2	1,2

Semester end-exam evaluation (SEE)

(i) End-exam question-paper pattern

Unit No.	Unit Name	Study Duration (Hrs.)	No. Questions for End-exam	
			5 Marks PART - A	10 Marks PART - B
1	Digital communication techniques	09	01	02
2	Digital coding of analog signals	07	02	01
3	Digital modulation techniques	12	02	02
4	Multiplexing techniques and multiple access	06	01	1.5
5	Error detection and correction	06	01	1.5
6	Transmission media	12	02	02
	Total	52	09 (45 Marks)	10 (100 Marks)

(ii) Model question paper

Course Title : Digital Communication

Course Code : 15EC43T

Time : 3 Hrs

Semester : Fourth

Max. Marks: 100

Instructions: 1. Answer any **SIX** question from **Part A** (5x6=30 Marks)

2. Answer any **SEVEN** full questions from **Part B** (7x10=70 Marks)

Part A

1. Define signal and classify them.
2. Describe the working of sample and hold circuit.
3. Illustrate briefly RZ and NRZ format for the unipolar signaling format with waveform.
4. Write a brief note on eye pattern.
5. What do you mean by inter symbol interference? Name the types of digital carrier modulation schemes.
6. What is multiplexing? Mention the advantages.
7. What is error in digital communication? Describe briefly the types of errors.
8. Describe briefly the types of transmission media.
9. Mention the advantages of optical fiber media.

Part B

1. (a) State the sampling theorem for the low pass signals. (4)
(b) Describe briefly the generation of PAM signal. (6)
2. Describe briefly the functional block diagram of digital communication system. (10)
3. (a) Define quantization and name the types. (3)
(b) Describe briefly the quantization process of an analog signal. (7)
4. Explain the block diagram of pulse code modulation system. (10)
5. (a) Describe binary ASK scheme with the help of waveform. (4)
(b) Explain briefly the coherent detection of binary ASK. (6)
6. (a) Describe briefly the generation of binary PSK signal. (5)
(b) List the advantages and disadvantages of error control codes (5)
7. (a) Describe the working of 4 channel PAM/TDM system. (6)
(b) Write a brief note on CDMA. (4)
8. (a) Write a note on error control strategies. (6)
(b) Differentiate bit error and burst error. (4)
9. (a) Describe briefly the principle of operation of optical fiber. (6)
(b) What is angle of acceptance and numerical aperture? (4)
10. (a) Describe briefly the principle of operation of LED. (6)
(b) List the advantages and limitations of optical fiber. (4)

Institutional activities (No marks)

The following are suggested institutional activities, to be carried out at least one during the semester. The course teacher/coordinator is expected to maintain the relevant record (Containing, Activity name, Resource persons and their details, duration, venue, student feedback, etc) pertaining to Institutional activities.

Sl. No.	Activity
1	Organize seminar, workshop or lecture from experts on the modern trends in digital communication
3	Motivate students to take case study on different digital communication-based mini projects (small applications such as applications specified in student activity) to inculcate self and continuous learning

Model Question Bank

Note: The questions in the question bank are indicative but not exhaustive. Sub-questions on different CLs may be combined in 10-marks questions or 10-marks questions can be splitted into if necessary keeping weightage of CLs approximately intact.

UNIT-1

5-mark questions

1. Define signal and classify them.
2. Mention the merits and demerits of pass band transmission.
3. Define information capacity and state Shannon's theorem.
4. Define bit-rate, entropy and baud rate.
5. Write note on aliasing effect.
6. Compare analog and digital communication systems.
7. Describe briefly the sampling process.
8. State the Shannon-Hartley theorem.
9. Write a brief note on baseband and pass band transmission.
10. A discrete information source generates one of five possible messages during
11. each message interval. The probabilities of these messages are $P_1=1/2$, $P_2=1/4$,
12. $P_3=1/8$, $P_4=1/8$ and $P_5=1/16$. Find the information content of each of these messages.

10-mark Questions

1. Define the following signals: (2x5=10)
 - a. Continuous and Discrete time signals
 - b. Analog and Digital signals
 - c. Deterministic and Random signals
 - d. Even and Odd signals
 - e. Periodic and Non-periodic signals
2. Describe briefly the functional block diagram of digital communication system. (10)
3. (a) State the sampling theorem for the low pass signals. (5)
4. (b) State the sampling theorem for the band pass signal. (5)
5. (a) Describe briefly the sample and hold circuit. (6)
6. (b) Define the terms: (i) Amount of information (ii) Baud rate. (4)
7. (a) Describe briefly the generation and detection of PAM signals.(8)
8. (b) Mention the types of analog pulse modulation. (2)
9. (a) Describe the generation of PWM. (6)
10. (b) Mention the merits and demerits of PWM. (4)
11. (a) Describe the generation of PPM. (6)
12. (b) Write the merits and demerits of PPM. (4)

UNIT-2

5-mark questions

Remember

1. Define quantization and quantization noise.
2. Mention the advantages, disadvantages and applications of PCM.
3. Mention the merits, demerits and applications of data compression.
4. List the merits, demerits and applications of bipolar signaling.

Understand

1. Describe RZ and NRZ unipolar signaling format with waveforms.
2. Describe RZ and NRZ polar signaling format with waveforms.
3. Describe RZ and NRZ bipolar signaling format with waveforms.
4. Describe briefly the distortion in delta modulation.
5. Write a brief note on companding process.

10-mark Questions

Understand

1. (a) Describe briefly the delta modulation system with the help of block diagram. (8)

- (b) Mention the merits and demerits of delta modulation system. (2)
- 2. (a) Describe briefly the DPCM system. (8)
- (b) Mention the merits and applications of DPCM. (2)
- 3. (a) Compare different pulse code modulation systems. (4)
- (b) Write the advantages and disadvantages of bipolar and Manchester formats. (6)
- 4. (a) Name the types of quantization techniques. (2)
- (b) Describe briefly the quantization process. (8)

Application

- 1. (a) Describe briefly the Manchester format with waveform. (5)
- (b) Illustrate the NRZ unipolar signaling format with an example. (5)
- 2. Describe briefly the pulse code modulation system with the help of functional block diagram. (10)

UNIT-3

5-mark Questions

- 1. Write a brief note on base band transmission.
- 2. Explain briefly about eye pattern.
- 3. What is the significance of inter symbol interference?
- 4. What is digital modulation? Name the types of digital modulation techniques.
- 5. Describe briefly the generation of binary ASK.
- 6. Explain briefly the generation of binary PSK.
- 7. Write a brief note on MSK.
- 8. Mention the merits and demerits of MSK.
- 9. Mention the merits and demerits of DPSK.

10-mark Questions

- 1. (a) Describe briefly the coherent detection of binary ASK. (7)
- (b) Write the merits, demerits and applications of binary ASK. (3)
- 2. (a) Describe briefly the binary ASK with the help of waveforms. (4)
- (b) Explain briefly the non-coherent detection of binary ASK. (6)
- 3. (a) Describe briefly the generation of binary FSK. (7)
- (b) Explain briefly the binary FSK with the help of waveforms. (3)
- 4. (a) Describe briefly the coherent detection of binary FSK. (7)
- (b) Mention the merits, demerits and applications of binary FSK. (3)
- 5. (a) Explain briefly the non-coherent detection binary FSK. (7)
- (b) Describe briefly the binary FSK with the help of waveforms. (3)
- 6. (a) Describe briefly the coherent detection of binary PSK signals. (7)
- (b) Mention the merits, demerits and applications of binary PSK. (3)
- 6. (a) Describe briefly the QPSK transmitter. (8)
- (b) Mention the advantages and disadvantages of QPSK. (2)
- 7. (a) Describe briefly the coherent QPSK receiver. (8)
- (b) Mention the applications of QPSK. (2)
- 8. Describe briefly the transmission and detection of DPSK signal. (10)
- 9. (a) Write a brief note on GMSK. (5)
- (b) Compare the different digital modulation techniques. (5)

UNIT-4

5-mark Questions

- 1. What is multiplexing? Write the advantages of multiplexing.
- 2. Write the concept of TDM.
- 3. Write the concept of FDM.

4. Explain briefly about of crosstalk and guard time.
5. What is multiple access technique? Name the types.
6. Write a brief note on FDMA.
7. Mention the limitations of FDMA.

10-mark Questions

1. (a) Write briefly about the working principle of T1 carrier system. (6)
(b) Write the advantages and disadvantages of TDM. (4)
2. (a) Describe the working of 4 channel TDM/PAM system. (6)
(b) Describe signaling rate and synchronization. (4)
3. (a) Write briefly about CDMA technique. (6)
8. (b) Write the benefits of CDMA. (4)
4. (a) What is multiplexing? Determine the minimum bandwidth required for PAM/TDM system in which six different message signals with each signal bandwidth of 10KHz are to to be multiplexed and transmitted. (5)
(b) Write a brief note on TDMA. (5)

UNIT-5

5-mark Questions

1. Describe briefly about an error and name the types.
2. Describe briefly about single bit error and burst error.
3. Write a brief note on redundancy.
4. Write a brief note on ARQ error control scheme.
5. Describe briefly about forward error detection and correction.
6. Write a brief note on block code.
7. Write a brief note on checksum coding technique.

10-mark Questions

1. (a) Describe parity bit check coding method. (5)
(b) Explain briefly the VRC method of coding. (5)
2. (a) Write a brief note on CRC coding method. (6)
(b) Write the merits demerits and applications of parity bit method. (4)
3. (a) Describe briefly about LRC coding method. (6)
(b) Mention the merits, demerits and applications of checksums method. (4)
4. (a) Describe briefly the convolution encoding operation. (6)
(b) Mention the applications of error control schemes. (4)

UNIT-6

1. What do you mean by transmission media and name the types.
2. Write a brief note on twisted pair cable.
3. Write the merits and demerits of twisted pair cable.
4. Mention the applications of twisted pair cable.
5. Write a brief note co-axial cable.
6. Write the merits, demerits and applications of coaxial cable.
7. Describe the construction of an optical fiber.
8. List the advantages of an optical fiber.
9. Write the applications of optical fiber.
10. Mention the demerits of an optical fiber.
11. Describe briefly about an optical window.
12. Write the merits, demerits and applications of LED.

10-mark Questions

1. (a) Write the principle of light propagation in an optical fiber. (6)
(b) Describe numerical aperture and angle of acceptance. (4)
2. (a) Describe briefly the types of optical fiber configurations. (6)
(b) Write the limitations of an optical fiber. (4)
3. (a) Write a brief note on different types fiber optic connectors. (6)
(b) Write a brief note on splices. (4)
4. (a) Explain briefly the construction of LED. (7)
(b) Compare LED and semiconductor lasers. (3)
5. Describe the block diagram of an optical fiber communication system. (10)
6. (a) Write a brief note on step index and graded index cables. (6)
(b) Write the multimode step-index cable advantages, disadvantages and applications. (4)
7. (a) Write a note on multimode step-index fiber.(5)
(b) Mention the advantages, disadvantages and applications of multimode step-index fiber. (5)
8. (a)What do you mean fiber losses? Describe briefly the different fiber lossess.(10)
9. Describe briefly about optical couplers and optical switches. (10)
10. (a) Describe briefly the construction of semiconductor LASER. (6)
(b) Mention the merits, demerits and applications of laser diode. (4)

End