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DIGITAL COMMUNICATION SYSTEMS **Course Code : 314326**

Programme Name/s	**: Digital Electronics/ Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics**
Programme Code	**: DE/ EJ/ ET/ EX/ IE**
Semester	**: Fourth**
Course Title	**: DIGITAL COMMUNICATION SYSTEMS**
Course Code	**: 314326**

I. RATIONALE

Digital communication technology is widely used across various sectors for instant and efficient information exchange. Digital communication course is instrumental in preparing students for the challenges and opportunities of the digital age. It equips them with essential skills and knowledge that are increasingly relevant in today's interconnected and technology-driven world. In this course basic concept of digital communication are covered to handle all the challenges of communication industries.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain following industry/employer excepted outcome through various teaching learning experiences:
Use basic concept of digital communication in various applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Implement different error control coding schemes for digital communication system.
- CO2 - Use various pulse code modulation techniques.
- CO3 - Analyze performance of different digital modulation techniques.
- CO4 - Interpret concept of multiplexing and multiple access techniques.
- CO5 - Interpret the concept of various spread spectrum techniques.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314326	DIGITAL COMMUNICATION SYSTEMS	DCS	DSC	4	-	4	2	10	5	3	30	70	100	40	50	20	25#	10	25	10	200

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe elements of digital communication system with its block diagram. TLO 1.2 Calculate entropy for a given data using concept of entropy. TLO 1.3 Construct the Huffman code for the given ‘n’ bit data. TLO 1.4 Apply the error detection and correction technique for the given length of data bit to generate data. TLO 1.5 Compare the given line codes.	**Unit - I Digital Communication System and Coding Methods** 1.1 Elements of basic digital communication system with its block diagram: Source encoder and decoder, Channel encoder and decoder, modulator and demodulator, Advantages and disadvantages of digital communication 1.2 Communication channel characteristics: bit rate, baud rate, bandwidth, repeater distance 1.3 Concept of entropy and information rate, channel capacity: Hartley’s law and Shannon-Hartley theorem for channel capacity, Source coding: Huffman coding 1.4 Error detection codes: Vertical Redundancy Check (VRC) code, Longitudinal Redundancy Check (VRC) code, Cyclic Redundancy Check (CRC) code and Checksum code 1.5 Error correction codes: Linear block code-calculation of minimum Hamming distance, error detection capability, error correction capability, Hamming code generation 1.6 Line coding: Need, properties, Unipolar RZ and NRZ, Polar RZ and NRZ, Bipolar NRZ (AMI), split phase and differential Manchester, Polar quaternary and their waveforms	Chalk-Board Presentations Video Demonstrations

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Compare natural and flat top sampling. TLO 2.2 Calculate the sampling frequency for given signal. TLO 2.3 Compare the performance of the given type of pulse modulation technique. TLO 2.4 Describe working of pulse code modulation transmitter and receiver.	**Unit - II Pulse Code Modulation Techniques** 2.1 Sampling & quantization process: Nyquist sampling theorem, types of sampling (natural & flat top sampling), aliasing effect, quantization process, quantization error, companding 2.2 PAM, PWM, PPM: Block diagram of transmitter and receiver with its working principle 2.3 Pulse code modulation (PCM), Differential pulse code modulation (DPCM) : Block diagram of transmitter and receiver with its working principle, Advantages and disadvantages 2.4 Delta modulation (DM): Block diagram of transmitter and receiver with its working principle, slope overload, granular noise. Advantages and disadvantages 2.5 Adaptive Delta modulation (ADM): Block diagram of transmitter and receiver with its working principle, Advantages and disadvantages 2.6 Comparison of pulse code modulation with continuous wave modulation	Chalk-Board Presentations Video Demonstrations
3	TLO 3.1 Compare coherent and noncoherent detection technique. TLO 3.2 Describe the generation of given type of shift keying signal. TLO 3.3 Write process of multiple data transfer using M-ary FSK and M-ary PSK. TLO 3.4 Draw the constellation diagram for given keying signals. TLO 3.5 Compare the salient feature of the given types of digital modulation techniques.	**Unit - III Digital Modulation Techniques** 3.1 Types of digital modulation techniques and their advantages, concept of coherent and non-coherent detection 3.2 Shift keying techniques: Block diagram of transmitter and receiver with its working principle for Amplitude Shift Keying (ASK), Frequency Shift keying (FSK), Phase Shift keying (PSK), Differential Phase Shift keying (DPSK), Quadrature Phase Shift keying (QPSK), constellation diagram and waveforms 3.3 M-ary encoding: Need, M-ary FSK and M-ary PSK 3.4 Quadrature amplitude modulation (QAM): Need, Block diagram of transmitter and receiver with its working principle, constellation diagram	Chalk-Board Presentations Visit to communication industry

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the working principle of given type of multiplexing technique. TLO 4.2 Choose the suitable multiplexing techniques for multiplexing the given number of signal. TLO 4.3 Classify with proper justification the given multiple access techniques on the basis of domain of working. TLO 4.4 Compare CDMA, TDMA, FDMA on basis of given parameters.	**Unit - IV Multiplexing and Multiple Access Technique** 4.1 Multiplexing: Need,Block diagram of transmitter and receiver with its working principle for Time Division Multiplexing(TDM), Frequency Division Multiplexing (FDM), Code Division Multiplexing(CDM) 4.2 Multiple Access techniques: Need, Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA), Advantages of TDMA over FDMA	Chalk-Board Presentations Visit to communication industry
5	TLO 5.1 Interpret the aspect of spread spectrum (SS) modulation for the given application. TLO 5.2 Generate the PN sequence for the given length of data bits. TLO 5.3 Explain jamming margin, processing gain and Eb/No ratio. TLO 5.4 Compare the performance of the fast and slow frequency hopping on the basis of given parameter.	**Unit - V Spread Spectrum (SS) Modulation** 5.1 Introduction to spread spectrum modulation: Advantages over fixed frequency, application of spread spectrum modulation, model of spread spectrum modulation system 5.2 Pseudo-noise (PN) sequences: Definition, generation and maximum length sequence. 5.3 Types of SS modulation: Direct sequence spread spectrum (DSSS), jamming margin, processing gain, Eb/No ratio, Frequency hopped spread spectrum, slow and fast frequency hopping.	Chalk-Board Presentations Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Observe line code for given data. LLO 1.2 Measure amplitude for various line code	1	*Generate- a)Unipolar-NRZ, RZ b)Bipolar- NRZ(AMI), Manchester Code for given data	2	CO1
LLO 2.1 Observe changes in output of various line coding scheme.	2	Implemention of various line coding scheme using suitable simulation tool	2	CO1
LLO 3.1 Generate even parity for given data sequence.	3	Determine error by LRC techniques using suitable simulation tool	2	CO1
LLO 4.1 Generate odd parity for given data sequence.	4	*Determine error by VRC techniques using suitable simulation tool	2	CO1
LLO 5.1 Calculate the 7 bit hamming code for given 4 bit data. LLO 5.2 Observe connections between the data lines.	5	*Generation of hamming code for 4 bit data	2	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Determine the position of error in given data. LLO 6.2 Correct the detected error.	6	Error correction using hamming code	2	CO1
LLO 7.1 Build connection of natural and flat top smapling circuit. LLO 7.2 Illustrate the diffrence observed in waveforms of natural and flat top sampled signal.	7	*Generation of natural and flat top sampling signal	2	CO2
LLO 8.1 Analyze Nyquist implications on signal generation and reconstruction.	8	Determine the Nyquist rate for given signal by using suitable simulation tool	2	CO2
LLO 9.1 Generate modulated and demodulated signal on DSO. LLO 9.2 Measure width of pulses according to input data.	9	*Performance of pulse width modulation and demodulation circuit	2	CO2
LLO 10.1 Determine the position of pulses as per change in input signal.	10	*Performance of pulse position modulation and demodulation circuit	2	CO2
LLO 11.1 Determine output binary data as per input data.	11	Generation of pulse signal using pulse code modulation	2	CO2
LLO 12.1 Generate and verify the DPCM signal using simulation software.	12	Implement differential pulse code modulation and demodulation by using suitable simulation tool	2	CO2
LLO 13.1 Observe and verify delta modulated and demodulated signal.	13	*Generation of delta modulation and demodulation signal	2	CO2
LLO 14.1 Observer how quantization error is removed in ADM. LLO 14.2 Measure the quantization error.	14	*Performance of adaptive delta modulation and demodulation circuit	2	CO2
LLO 15.1 Measure amplitude level of output signal according to binary data.	15	*Transmit and receive digital signal using Amplitude shift keying	2	CO3
LLO 16.1 Build connection for FSK kit. LLO 16.2 Observe demodulated signal as pers transmitted binary data.	16	*Transmit and receive digital signal using Frequency Shift Keying	2	CO3
LLO 17.1 Measure the phase shift according to binary data.	17	*Transmit and receive digital signal using Phase Shift Keying	2	CO3
LLO 18.1 Verify the transmitted digital signal according to the original binary data using QPSK modulation. LLO 18.2 Measure the phase shifts corresponding to the binary data.	18	Performance of QPSK modulation and demodulation	2	CO3
LLO 19.1 Measure the amplitude and phase shifts according to the binary data. LLO 19.2 Observe the transmitted signal in the time domain and frequency domain.	19	Performance of QAM modulation and demodulation	2	CO3
LLO 20.1 Build connection for TDM circuit. LLO 20.2 Measure the amplitude and frequency of TDM signal.	20	Multiplexing of signals in TDM using kit	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 21.1 Use simulation software to visualize the TDM signal. LLO 21.2 Determine the bandwidth and data rate of the TDM signal.	21	*Generation of TDM signal using suitable simulation software	2	CO4
LLO 22.1 Build connection for FDM kit. LLO 22.2 Measure frequency of FDM signal.	22	*Multiplexing of signals in FDM using kit	2	CO4
LLO 23.1 Use simulation software to visualize the FDM signal	23	Generation of FDM signal using suitable simulation software	2	CO4
LLO 24.1 Use simulation software to visualize the CDM signal.	24	*Generation of CDM signal using suitable simulation software	2	CO4
LLO 25.1 Select desired maximum length N for the PN sequence. LLO 25.2 Obtain the output bits of the PN sequence.	25	*PN sequence generator	2	CO5
LLO 26.1 Determine PN sequence.	26	Generation of PN sequence using suitable simulation tool	2	CO5
LLO 27.1 Observe CDMA signal with the spreading sequences for each channel. LLO 27.2 Recover original message signal from modulated signal.	27	*Generation of two channel CDMA-DSSS signal using suitable simulation tool	2	CO5
LLO 28.1 Modulate the data using spreading sequences for each channel. LLO 28.2 Recover original message signal from modulated signal.	28	Generation of two channel CDMA-FHSS signal using suitable simulation tool	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare seminar on how IoT relies on digital communication.
- Build a circuit to generate FSK signal.
- Build circuit to generate hamming code.
- Build sampling circuit.
- Build a circuit to generate PPM signal.
- Build a circuit to generate ASK signal.
- Build a circuit to generate PWM signal.
- Prepare report to evaluate the importance of low-latency communication in real-time AI application.
- Investigate the applications of digital communication in healthcare, including telemedicine and remote patient monitoring.
- Prepare presentation on 5G and its impact on digital communication.

Visit

- Visit nearby communication industry like BSNL/Airtel/Jio etc. and prepare report on techniques used for modulation demodulation.

Assignment

- Construct the hamming code for the data 1010 with odd parity.
- The probabilities of five source messages are m1 = 0.2, m2 = 0.3, m3 = 0.2, m4 = 0.15 and m5 = 0.15.Generate Huffman codes for the given source.
- Encode binary sequence 11010100 using unipolar RZ,unipolar NRZ, polar RZ,polar NRZ, AMI and differential Manchester line coding techniques.
- List importance of digital communication in the modern era.
- Prepare chart to add key details for each technique, such as advantages, disadvantages, and real-world applications.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Analog line coding and decoding trainer kit.	1
2	Cathode ray oscilloscope Dual Trace 20/30/100 Mhz,1 Mega ohm input impedance.	1,7,9,10,11,13,14,15,16,17,18,19,20,22,27,28
3	DSO with Bandwidth : 50-100 MHz TFT colour LCD Dual channel real time sampling1GSa/s equivalent sampling 25 GSa/s Memory 1Mbpts 10 waveforms and 10 Set upscan be stored.	1,7,9,10,11,13,14,15,16,17,18,19,20,22,27,28
4	Function generator : Frequency range 0.1 Hz to 30 Mhz.	1,7,9,10,11,13,14,15,16,17,18,19,20,22,27,28
5	Pulse code modulation and demodulation trainer kit.	11
6	Differential pulse code modulation and demodulation trainer kit.	12
7	Delta and Adaptive delta modulation and demodulation trainer kit.	13,14
8	ASK,FSK,PSK,QPSK and QAM trainer kit.	15,16,17,18,19
9	Time division multiplexing trainer kit.	20
10	Frequency division multiplexing trainer kit.	22
11	Simulation software suitable for communication experiments: MATLAB,SCILAB or any other relevant open source software.	4,3,8,12,21,23,24,27,28,2
12	Hamming code (7 bit) trainer kit.	5,6

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
13	Sampling (natural and flat top signal) and reconstruction trainer kit.	7
14	PPM, PWM trainer kit for signal generation and detection.	9,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Digital Communication System and Coding Methods	CO1	16	4	6	8	18
2	II	Pulse Code Modulation Techniques	CO2	14	4	4	6	14
3	III	Digital Modulation Techniques	CO3	12	4	4	6	14
4	IV	Multiplexing and Multiple Access Technique	CO4	10	4	4	4	12
5	V	Spread Spectrum (SS) Modulation	CO5	8	4	4	4	12
Grand Total				**60**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit test of 30 marks and average of two-unit test will considered for out of 30 marks.

For formative assessment of laboratory learning 50 marks.Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.

End semester summative assessment of 25 marks for laboratory lerning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	3	3	2	1	1	1			
CO2	2	2	2	2	1	1	1			
CO3	2	2	2	2	1	1	1			
CO4	2	2	1	2	1	1	1			
CO5	2	2	1	2	1	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	K.Sam Shanmugam	Digital and Analog Communication Systems	Wiley India Pvt Ltd, ISBN-9788126509140
2	Rao. Ramkrishna P.	Digital communication	McGraw Hill Education (1 July 2017),ISBN-9780070707764
3	Simon Haykin	Digital Communications	John Wiley and Sons,ISBN-9788126508242
4	B. P. Lathi	Modern Digital and Communication Systems	Oxford university press,ISBN-9780198073802
5	Bernard Sklar	Digital Communications: Fundamentals and Applications	Pearson 2021,ISBN-9780134588568

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/117101051	Introduction to Digital Communication by NPTEL
2	https://www.etti.unibw.de/labalive/experiment/qpsksignalgeneration/	virtual communication lab for practicals
3	https://nptel.ac.in/courses/106105082	Data Communication
4	http://www.digimat.in/nptel/courses/video/117105136/L13.html	Spread spectrum techniques

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students