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 **PRESIDENCY UNIVERSITY**

  **Bengaluru**

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| **End - Term Examinations – MAY 2025** |
| **Date:** 22-05-2025 **Time:** 09:30 am – 12:30 pm |

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| **School:** SOE | **Program:** B .Tech ECE |
| **Course Code:** ECE3011 | **Course Name:** DIGITAL COMMUNICATION |
| **Semester**: VI | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** | **CO6** |
| **Marks** | **24** | **26** | **24** | **26** | **-** | **-** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** |
| **1.** | To separate the in-phase and quadrature components of a signal for accurate detection in radar systems, a 90-degree phase shift is applied. What transform technique is typically employed to accomplish this phase shift? | **2 Marks** | **L1** | **CO1** |
| **2.** | During the digitization of an audio signal, if the sampling rate is too low, higher frequency components fold back into lower frequencies, causing distortion. What is this phenomenon called? | **2 Marks** | **L1** | **CO1** |
| **3.** | During the quantization of a speech signal for a voice compression system, two types of errors are commonly observed when the signal is approximated by discrete levels. What are the errors called when small variations in amplitude result in random noise, and when large variations in the signal are poorly tracked by the quantizer? | **2 Marks** | **L1** | **CO2** |
| **4.** | To transmit audio data over the internet for a VoIP (Voice over Internet Protocol) system, analog voice signals must be converted to digital form.What digital encoding technique is commonly used to sample, quantize, and encode the analog voice signal into binary data for efficient transmission? | **2 Marks** | **L1** | **CO2** |
| **5.** | A 10 kHz signal with an amplitude of 1V is quantized to achieve a signal-to-noise ratio (SNR) of approximately 45 dB. How many bits are required per sample to achieve this SNR? | **2 Marks** | **L1** | **CO2** |
| **6.** | For radar systems that detect moving objects by analyzing phase shifts, a modulation technique is used where both the transmitter and receiver share a synchronized carrier signal for accurate signal processing. What type of modulation is commonly applied in such systems, where phase synchronization at the receiver allows for precise target identification? | **2 Marks** | **L1** | **CO3** |
| **7.** | Wireless sensors used in industrial automation transmit data over low-power links by adjusting the amplitude of the carrier signal to indicate digital bits. What is the name of this modulation method that encodes information using two amplitude levels to represent binary values? | **2 Marks** | **L1** | **CO3** |
| **8.** | GPS satellites rely on a unique sequence to distinguish signals from different satellites and maintain synchronization with receivers on Earth, even in the presence of interference. Which kind of sequence is used in this context to modulate the transmitted signal while allowing reliable decoding and accurate positioning? | **2 Marks** | **L1** | **CO4** |
| **9.** | Industrial automation networks often rely on frequency-hopping techniques to ensure robust communication in environments with high electromagnetic interference, with the hop rate tailored to system latency and data needs. Which two frequency hopping spread spectrum methods are implemented here, and how are they classified according to the speed of frequency changes relative to the transmitted data rate? | **2 Marks** | **L1** | **CO4** |
| **10.** | Wireless sensor networks use pseudo-random sequences to spread their signals and avoid mutual interference while operating in shared frequency bands, making the sequence’s behavior crucial for reliable communication. Which two key characteristics of a PN sequence ensure minimal cross-interference and effective signal spreading in this context? | **2 Marks** | **L1** | **CO4** |

**Part B**

 **Answer the Questions. Total Marks 80M**

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| 11. | a. | Modern intelligent transportation systems rely on digital communication to transmit real-time traffic updates and vehicle telemetry to control centers with high accuracy and reliability. Describe the components of a basic digital communication system with a clear block diagram, and explain how each part contributes to enhancing performance under noisy conditions while supporting robust data transmission across varying traffic loads. | 20 Marks | L2 | CO1 |
| Or |
| 12. | **a.** | To design a high-resolution digital imaging system for satellite-based earth observation, engineers must convert continuous optical signals into digital data, requiring a precise understanding of how sampling works in signal processing. How does the sampling process function in digital signal processing, and why is the Sampling Theorem critical for accurate signal reconstruction? Include mathematical explanation, time and frequency domain illustrations, and discuss the effects and prevention of aliasing along with key factors to consider when choosing a sampling rate for imaging systems. | **20 Marks** | **L2** | **CO1** |

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| 13. | a. | Digital storage devices like SSDs face challenges in maintaining data integrity due to timing errors and signal reflections during read/write operations, resulting in overlapping of data pulses. How does Inter Symbol Interference affect the reliability of these systems, and what role does the eye diagram play in evaluating the severity of ISI and ensuring optimal system design with a clear visual aid? | 20 Marks | L2 | CO2 |
| Or |
| 14. | **a.** | Modern cockpit voice recorders in aviation systems require clear and distortion-free audio logging under extreme conditions, prompting engineers to use a robust digital communication technique. What is the operating principle of a Pulse Code Modulation system used in this application, and how do the components in its block diagram contribute to accurate analog-to-digital conversion and effective signal recovery during playback? | **20 Marks** | **L2** | **CO2** |

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| 15. | a. | Designing a low-power digital communication link for satellite telemetry data transmission demands efficient modulation techniques that offer robustness and simplicity for sending binary information. How do Binary Phase Shift Keying (BPSK) and Binary Frequency Shift Keying (BFSK) operate in such a setup, and what do their modulator and demodulator block diagrams, mathematical representations, time-domain waveforms, and constellation diagrams reveal about their performance? | 20 Marks | L2 | CO3 |
| Or |
| 16. | **a.** | An underwater acoustic telemetry system transmitting binary sensor data from submerged equipment requires a modulation technique that balances spectral efficiency with tolerance to synchronization issues caused by channel distortion. What are the operational principles of QPSK and DPSK for this use case, and how do their waveform characteristics, constellation diagrams, and system complexities influence performance? Compare their suitability in terms of power efficiency, error resilience, and synchronization robustness, and recommend the better option for reliable underwater data communication. | **20 Marks** | **L2** | **CO3** |

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| 17. | a. | Designing a wireless communication system for a smart farming network in a rural area where multiple devices operate in close proximity and environmental factors like heavy rain and interference from nearby cellular towers affect signal quality. What communication technique would you recommend to ensure reliable transmission under these conditions, considering multipath propagation, limited bandwidth, and security requirements? Explain your choice with appropriate block diagrams, signal waveforms, and the underlying principles. | 20 Marks | L2 | CO4 |
| Or |
| 18. | **a.** | Consider the signals s1(t), s2(t), s3(t) and s4(t). $$s1\left(t\right)=1 for 0<t\leq \frac{T}{3}$$$$s2\left(t\right)=1 for 0<t\leq \frac{2T}{3}$$$$s3\left(t\right)=1 for \frac{T}{3}<t\leq T$$$$s4\left(t\right)=1 for 0<t\leq T$$Use Gram Schmidt orthogonalization procedure to find the orthonormal basis for this set of signals. | **20 Marks** | **L3** | **CO4** |