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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Fourth Semester

Electronics and Communication Engineering

EC3491 — COMMUNICATION SYSTEMS

(Common to Computer and Communication Engineering/Electronics and Telecommunication Engineering)

(Regulations 2021)

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Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate DSB & SSB in AM modulation.

2. Draw the schematic diagram of Superheterodyne Receiver for AM.

3. What are the effects of aliasing?

4. What is Companding? List its different types.

5. What are the advantages of DPCM over PCM?

6. Write the formulae for Shannon's channel capacity.

7. Compare QPSK vs DPSK in terms of BER and bandwidth.

8. What is non-coherent receiver?

9. What is inter-symbol-interference (ISI)? What are the ways to reduce this?

10. Why is noise modelled as AWGN?

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PART B — (5 × 13 = 65 marks)

11. (a) An AM signal is generated by modulating the carrier $f_c = 800$ kHz by the signal $m(t) = \sin(2000\pi t) + 5\cos(4000\pi t)$. The AM signal $s(t) = 100[1 + m(t)]\cos(2\pi f_{ct})$ is fed to a 45 Ω load. Determine the following:

(i) Average power in the carrier and in the sidebands. (3)

(ii) Modulation index (3)

(iii) Bandwidth of the modulated signal (2)

(iv) Peak power delivered to the load. (2)

(v) Carrier power if AM broadcast radio radiates 10 Kw of power if modulation index is 70%. (3)

Or

(b) An angle-modulated signal has the form: $s(t) = 100\cos[2\pi f_{ct} + 4\sin 2\pi f_{mt}]$, where $f_c = 10$MHz and f_m = 1000 Hz. Determine the following:

(i) Assuming that this is an FM signal, determine the modulation index and the transmitted-signal bandwidth. (4)

(ii) Repeat part (i) if f_m is doubled. (2)

(iii) Assuming that this is a PM signal, determine the modulation index and the transmitted-signal bandwidth. (4)

(iv) Repeat part (iii) if f_m is doubled. (3)

12. (a) (i) Derive the output signal-to-noise ratio of AM receiver and assuming that the noise is additive, white and Gaussian. (10)

(ii) Write short note on threshold effect in angle modulation. (3)

Or

(b) (i) Find the Nyquist rate and the Nyquist Interval for the following signals:

(1) $S_1(t) = \sin c(300t) + \sin c(500t)$ (4)

(2) $S_2(t) = 2\sin(4(pi)t)\cos(2(pi)t)$. (4)

(ii) Compare and distinguish following pulse modulation schemes: PAM, PWM and PPM. (5)

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13. (a) Consider a PCM System with an accuracy of ±0.1%. The analog signal has a maximum frequency of 1000 Hz with an amplitude ranging from –3 V to +3V. Compute the following:

(i) maximum required sampling rate (4)

(ii) number of bits required to represent the PCM code word (3)

(iii) bit rate (3)

(iv) bandwidth (3)

Or

(b) A data communication system employs Hamming code for single-bit error detection and correction. Consider a 12-bit data sequence given as 100101110110.

(i) Determine how many redundant (parity) bits must be included to construct a valid Hamming code and clearly show how these redundant bits are inserted into appropriate bit positions (1, 2, 4, 8, etc.) within the codeword according to the Hamming code convention. (5)

(ii) Derive the logic conditions for each Hamming bit based on the chosen bit positions. Then, assume that a single-bit transmission error occurs at bit position 9 during transmission. Demonstrate the step-by-step analysis of how the Hamming code detects and locates this single-bit error, thereby proving its ability to ensure reliable data communication. (8)

14. (a) Draw and explain the BASK transmitter and receiver system. Also, derive its probability of error under coherent reception criteria. (8+5)

Or

(b) Draw and explain the QPSK transmitter and receiver system. Also, derive its probability of error under coherent reception criteria. (8+5)

15. (a) Derive the expression for the probability of bit error in a coherently detected binary communication system where the two message waveforms are antipodal in nature, occupying opposite positions in the signal space along a single orthonormal basis function. Express the result in terms of the energy per bit (E_b) and noise spectral density (N_o).

Or

(b) Explain the Nyquist's criterion for distortionless baseband binary transmission. Also, explain on eye-pattern. (10+3)

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PART C — (1 × 15 = 15 marks)

16. (a) Design a digital Telemedicine system that uses a heartbeat ECG signal sampled at the rate of 32,000 samples/sec and characterized by peak value of 2 volts. Assume bandwidth of signal is 4 kHz.

(i) Determine the value of step size to avoid slope-overload. (7)

(ii) What is quantization noise power Nq and corresponding SNR? (8)

Or

(b) A digital communication system transmits binary data over an additive white Gaussian noise (AWGN) channel using a binary frequency shift keying (BFSK) modulation scheme with orthogonal signaling. The transmission bit rate is R_b = 2 Mbps. The receiver employs coherent orthogonal detection with perfect carrier and timing synchronization. The channel noise is modelled as AWGN with single-sided power spectral density $N_0/2 = 1 \times 10^{-10}$ W/Hz. The design requirement specifies that the average probability of bit error must satisfy $P_e \leq 10^{-3}$. Assume d = 0 and $\Delta f = 2$ MHz.

(i) Determine the minimum average carrier power that ensures the specified error probability requirement is satisfied. (10)

(ii) Compute the bandwidth requirement of this system. (5)

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