Reg. No. :

Question Paper Code : 20931

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Fourth/Fifth Semester

Electronics and Communication Engineering

EC 3491 – COMMUNICATION SYSTEMS

(Common to : Computer and Communication Engineering/Electronics and Instrumentation Engineering/Electronics and Telecommunication Engineering/and Instrumentation and Control Engineering)

(Regulations 2021)

Time : Three hours　　　　Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define Superheterodyne Receiver and give a brief on its characteristics.

2. In DSB-SC AM system, the message signal is given by $m(t) = \sin(50t)$, and modulates a carrier signal $c(t) = 2\cos(1000t)$. Plot the spectrum of the modulated signal $y(t)$.

3. Elucidate Aliasing effect and elaborate the remedies to control it.

4. Explain the terms "white noise" and "additive white gaussian noise (AWGN)".

5. Define and classify Pulse Modulation.

6. A telephone line of 4 MHz bandwidth is having an SNR of 38 dB. What is its channel capacity?

7. Define bit error rate (BER) and explain the significance of BER Vs SNR plot in judging the efficiency of a digital system.

8. What is DPSK? Explain it with an example.

9. What is inter symbol interference (ISI)? Illustrate it with a sample data.

10. The output signal to noise ratio of a12-bit PCM is expected to be 40 dB, but it was found to be 26 dB. For enhancing the SNR towards the expected value, the number of quantization 10 levels have been increased. Find the fractional increase in transmission bandwidth required for enhancing the SNR.

PART B — (5 × 13 = 65 marks)

11. (a) (i) State and illustrate Hilbert transform. (3)

(ii) State and prove any three properties of Hilbert transform. (6)

(iii) Find the Hilbert transform of the function $g(t) = m(t)\sin(2\pi f_c t)$, given that $m(t) \leftrightarrow M(f)$. (4)

Or

(b) (i) Elaborate on pre-envelope and complex envelope amplitude modulation techniques. (7)

(ii) Derive the mathematical expressions for DSB-SC and SSB-SC modulated signals. (6)

12. (a) (i) Compare PAM, PPM and PWM. (6)

(ii) If the analog signal to be quantized (unipolar quantization with 4 bits) has a range from 0 V to 10 V, determine number of quantization level, quantization step (resolution), quantization error when the analog input is 7.4 V, quantization level when the analog voltage is 7.4 V, and its binary code. (7)

Or

(b) (i) Differentiate between TDM and FDM. Give one application for each. (8)

(ii) Consider the signal $x(t) = e^{j20\pi t} + e^{j30\pi t}$, where '$t$' is in seconds. A new signal $y(t) = x(2t+6)$ is formed. Find out the Nyquist sampling rate of $y(t)$. (5)

13. (a) For $(n = 7, k = 4)$ linear block code (LBC) with the following generator matrix

$$G = \begin{pmatrix} 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{pmatrix}$$

(i) Construct the codebook and find the value of the minimum hamming distance $d_{\min}$. (3)

(ii) Calculate the error correction and error detection capabilities of this code. (3)

(iii) Construct the parity check matrix for the above code. (3)

(iv) Decode the received message $r = (0;0;1;1;0;1;0)$ using syndrome decoding. (4)

Or

(b) Consider the $(n=7, k=4)$ cyclic code defined by the generator polynomial $g(x)=1+x^2+x^3$.

(i) Develop the encoder. (3)

(ii) Determine its generator matrix C and parity-check matrix H. (3)

(iii) Determine the systematic code word of the message sequence (1100). (3)

(iv) Suppose a code word is sent over a noisy channel with the received word as 1001001. What would be the error polynomial $e(x)$? (4)

14. (a) (i) Compare the merits and demerits of BPSK and QPSK w.r.t power spectral density (PSD) and bit error rate (BER) with essential illustration. (6)

(ii) The bit error probability characterizations for BPSK and QPSK in a given communication channel reveals that the required E_b/N_0 to achieve P_b of 10^{-4} and 10^{-7} are 8.2 dB and 11.2 dB, respectively. What is the bandwidth efficiency for BPSK and QPSK for a bit error probability of 10^{-7} on that communication channel with an SNR of 12 dB? Compare the bandwidth efficiency of QPSK at P_b of 10^{-4} and 10^{-7} on that communication channel with an SNR of 12 dB. (7)

Or

(b) (i) Explain the detail about QAM with a neat sketch and show the signal constellation diagram for 16-QAM. (4)

(ii) QAM typically consists of two-dimensional PAM. Under AWGN channel of zero mean and 2 side PSD $N_0/2$, find the following by assuming symbol period as T.

(1) Signal constellation of 16-QAM (4-PAM in I and 4-PAM in Q channel) with minimum energy. (3)

(2) Average symbol rate in terms of E_s/N_0 (ratio of energy per symbol and noise). (3)

(3) Design modulator and demodulator. (3)

15. (a) Illustrate and elaborate the following concepts with mathematical expressions.

(i) Receiver Noise. (4)

(ii) Probability of False Alarm. (4)

(iii) The Matched Filter. (5)

Or

(b) Explain in detail about Channel Equalizer by focusing more on zero forcing equalizer (ZFE) and minimum mean-square error equalizer (MMSEE) with necessary figures, block diagrams and mathematical expressions. (13)

PART C — (1 × 15 = 15 marks)

16. (a) An analog source produces a baseband voltage signal $x(t)$ with bandwidth equal to 12 KHz. Assume that sample functions of $x(t)$ follows a probability density given by:

$$f_x(x) = \begin{cases} \frac{1}{2}e^{-x/2}, & x > 0 \\ 0, & Otherwise \end{cases}$$

The source output is quantized according to the rule:

$$y_i = \begin{cases} i - 0.5, & i-1 \leq x < i; \ for\ 1 \leq i \leq 5 \\ 6.0, & x \geq 5.0,\ i = 6 \end{cases}$$

Each quantized level y_i is denoted as a discrete source symbol g_i for $i = 1, 2, \ldots, 6$.

(i) Determine the average quantization distortion. (3)

(ii) What is the minimum required bit rate of a fixed-length encoder for the quantizer output? (3)

(iii) Determine the discrete source average entropy. (3)

(iv) Design a Huffman code for $\{g_i\}$ and calculate:

(1) Average codeword length

(2) Code efficiency

(3) Encoder minimum bit rate. (6)

Or

(b) A discrete memoryless information source has an alphabet consisting of three symbols a_1, a_2, a_3 with respective probabilities 0.45, 0.35, 0.2. Symbols are emitted at a rate of 2400 symbols per second. A binary Huffman code is designed to represent the source output (call this Code A). Another binary Huffman code is designed to represent the 2^{nd} extension of the source output (call this Code B). Determine the following:

(i) Codewords of Code A and Code B. (5)

(ii) Code efficiencies of Code A and Code B. (5)

(iii) Bit rates of encoders A and B. (5)