BI/K/TX

Reg. No: 22BEC0623

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BECE306L - Digital Communication Systems
Class NBR(s): 2818 / 2825 / 2828 / 2829 / 2832
Slot: C1+TC1
Time: Three Hours
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instructions : Error Function Table is permitted

Answer ALL Questions
(10 X 10 = 100 Marks)

1. a) Sketch the schematic diagram of digital communication system. [3]

   b) A sinusoidal signal $x(t) = \cos(1500\pi t)\cos(500\pi t)$ is sampled at a rate of 1500 samples per second. The sampled signal is passed through an ideal low pass filter (LPF) with cut off frequency at 750 Hz. Sketch the spectrum and determine the LPF output frequency/frequencies. [7]

2. The signal $x(t) = 3\sin(2\pi \times 2 \times 10^3 t)$ is sampled at four times the Nyquist rate. Assume the quantization levels are eight. [10]

   i) Draw the sampled signal diagram with proper specification/scaling. Encode the signal $x(t)$ using differential pulse code modulation (DPCM). Select the quantizer based on mid-riser type. Assume first order linear prediction filter.

   ii) Encode the signal $x(t)$ using delta modulation (DM).

3. a) Discuss the quantization noise introduced by delta modulation scheme. Suggest a scheme to overcome the effects of quantization noise. [5]

   b) In linear delta modulator, the bit rate of the speech signal is 6 kHz. The modulator sampled at five times of the Nyquist rate and step size is 75 mV. The modulator is tested with 1.8 kHz sinusoidal signal. Determine SNR and maximum amplitude of this test signal required to avoid slope overload. [5]

4.(a) Consider a line coded wave $x(t)$ that uses non-return to zero bipolar format. Derive the power spectral density of the given line coded signal. Represent the following sequence [1 0 0 1 1 0] using NRZ Bipolar format. [10]

OR

4.(b) Consider a line coded wave that uses NRZ ON-OFF format. Derive the power spectral density of the given line coded signal. Represent the following sequence [0 1 1 0 0 1] using NRZ ON-OFF format. [10]

5. Discuss the basic elements of baseband binary PAM system. Derive the condition to avoid ISI. [10]

6. A band pass data transmission scheme transmits '1' and '0' bits. This binary data is transmitted at the rate of 15 kbps. During the transmission, white Gaussian noise of zero mean and power spectral density 10^{-9} W/Hz is added to the signal. The maximum amplitude of the received sinusoidal wave is 12 mV. BPSK and BFSK modulation schemes are used for the above condition. [10]

i. Find the average probability of symbol errors.

ii. If the bit rate is increased to 10 Mbps, then what values of amplitude of the received sinusoidal wave are needed to attain the same value of probability of symbol error as in part (i).

7. Consider the four signals given below and apply Gram-Schmidt Orthogonalization Procedure (GSOP) [10]

$$S_1(t) = 1 \qquad (0 \le t \le 2)$$

$$S_2(t) = \begin{cases} 1 & (0 \le t \le 1) \\ -1 & (1 \le t \le 2) \end{cases}$$

$$S_3(t) = \begin{cases} 1 & (0 \le t \le 2) \\ -1 & (2 \le t \le 3) \end{cases}$$

$$S_4(t) = -1 \qquad (0 \le t \le 3)$$

i) Determine the orthonormal basis functions.

ii) Represent all the signals by using basis functions.

8. a) A quadrature signaling scheme modulates phase of the carrier based on the incoming Gray coded dibits. Identify the signaling scheme used. Find the message signal points and draw the constellation diagram. [4]

b) In coherent binary frequency signaling system, region Z_1 belongs to signal $s_1(t)$ and region Z_2 belongs to signal $s_2(t)$. The corresponding message points (MP) are MP_1 and MP_2 respectively. Signal $s_1(t)$ is transmitted. Due to noise the received signal falls inside region Z_2 so the receiver decides in favor of signal $s_2(t)$. Here $s_1(t)$ and $s_2(t)$ are represented as symbol 1 and symbol 0 respectively. Derive its probability of error. [6]

9.(a) i) Generate the pseudo-noise (PN) sequence for the feedback shift register of [4, 1] with initial state of the register is 1110. Verify all properties of the PN sequence. [6]

ii) A pseudo-noise (PN) sequence is generated using a feedback shift register with length m= 6. The chip rate is 10^6 chips per second. Find the PN sequence length and chip duration of the PN sequence. [4]

OR

9.(b) i) A 4-stage linear feedback shift register generates the sequence {0 1 0 1 1 1 1 0 0 0 1 0 0 1 1}. Determine the period of the given infinite sequence. Also verify the three properties of the PN sequence. [6]

ii) Illustrate a technique used to generate orthogonal codes of length 8 in a CDMA system. [4]

10. A transmitter transmits symbols X_1, X_2, X_3, X_4 and the receiver receives symbols Y_1, Y_2, Y_3. The joint probability matrix of discrete memoryless channel is given below. [10]

$$P(X,Y) = \begin{bmatrix} 0.3 & 0.05 & 0 \\ 0 & 0.25 & 0 \\ 0 & 0.15 & 0.05 \\ 0 & 0.05 & 0.15 \end{bmatrix}$$

Determine H(X), H(Y), H (X, Y), H(X/Y) and H(Y/X).

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