Ref. No.: Ex/ET/PC/B/T/313/2024

Bachelor of Electronics and Telecommunication Engineering Examination, 2024
(Third Year, First Semester)
Subject: Digital Communication Systems

Time: Three hours **Full Marks: 100**

Answer must be written at one place for each attempted question. Mention proper Question no with OR if attempted

Answer must be brief and precise

Module -I CO1 Marks: 10

Q. 1 Answer all questions: 1+1+2+2+1+1+2

a. What type of message (analog/digital) are the text and human speech? Justify your answer.
b. Morse code is a binary message, whether temperature in a certain location is analog-justify.
c. Signal to Noise Ratio (SNR) is continuously decreasing along the length of the channel – why?
d. Message extraction is often easier from digital signal than in analog signal - explain with example (s).
e. Regenerative repeater is a boon to digital communication -why?
f. The distance over which an analog signal can be transmitted is limited by the transmitter power- is the statement true?
g. Draw block diagram of a very basic digital communication system.

Module -II CO2 Marks: 20

Q.2

a. Take an analog signal g(t) of your choice bandlimited to B Hz. Draw the analog signal and its spectrum G(w). Apply Nyquist natural sampling theorem on g(t) and show the sampled signal $g_s(t)$ and its spectrum. Show how from the sampled signal the original signal g(t) will be recovered. 05
b. The audio signal bandwidth is about 15 kHz and subjective test shows that if component above 3400 Hz is suppressed by a filter, signal articulation will not be affected. The resulting signal is oversampled at a rate 8000 samples per sec. If each sample is finally quantized **with 256 levels**, then what will be the resulting binary **pulses per sec**? If the quantized level is made 1024, then what will be the bandwidth requirement to store? 04
c. The inherent problem of uniform quantization is the larger variation of SNR (0 to 40 dB). How is this problem solved? In an A-law companding explain the meaning of A=1 and A=87.56. 07
d. A baseband signal x(t) be modelled as the sample function of a zero mean Gaussian random process X(t). The input signal x(t) to a quantizer varies $-4\sigma_x$ to $+4\sigma_x$, where σ_x is the variance of X(t). If the quantizer output is coded with R bit, find the output SNR of the quantizer in dB. 04

Q.2 OR

a. Distinguish between pulse code modulation (PCM) and differential PCM (DPCM). 03

b. For a given signal-to-quantization ratio, DPCM requires fewer bits /input sample -explain. 03

c. Draw the DPCM Transmitter and Receiver units and show how is delta modulator is derived from DPCM. 05

d. With pictorial representation explain the origin of Slope overload and Granular noise for DM. 05

e. Find the minimum sampling frequency (f_s), to avoid slope overload when x (t) = 2cos(2π 800t) and δ = 0.1. 04

Module III CO3 Marks: 15

Q.3

a. Line coding is also named as base band transmission - Why? Write five desirable properties of line coding. 05

b. With examples explain unipolar, polar and bi-polar line coding techniques. 05

c. For the bit stream 010110, draw the baseband transmission waveform for NRZ and RZ AMI (alternate mark inversion) transmission. Highlight advantages of this transmission. 05

Q.3 OR

a. Why Manchester Line coding is called bi-phase or split phase signaling? Write the advantages and disadvantages of this type. 05

b. The binary bit stream is to be transmitted in unipolar NRZ format. With equally likely 1 and 0 transmission. Find the expression for autocorrelation function $R_A(n)$ and hence power spectrum for this unipolar NRZ format. What is the spectral expression for unipolar RZ transmission. Compare the bandwidth requirement for the two cases. 10

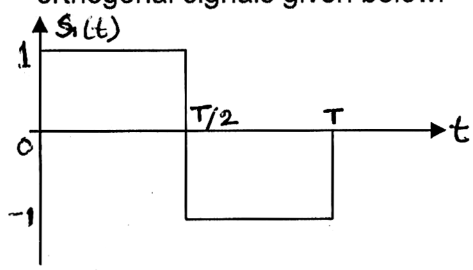
Module IV CO4 Marks: 15

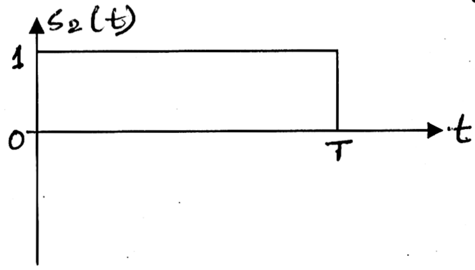
Q.4

a. What is the significance of Geometric representation of a signal. How is orthonormal basis function defined? 05

b. Response of a noisy signal at the receiver is completely determined by noise – how? 05

c. Construct the signal constellation for the bi-orthonormal signals corresponding to the pair of orthogonal signals given below. 05





Q.4 OR

a. Determine the expressions for bit error probability for equally likely binary bits transmission. 08

b. Establish the governing equation for the design of Maximum likelihood receiver and draw the optimum correlator receiver unit. 07

Module V CO5 Marks: 20

Q.5

a. Define general M-ary modulation scheme and show that bandwidth efficiency is better for M-ary communication. 05

b. How are the signals $S_i(t)$, i= 1, 2 expressed for BPSK and BFSK modulation schemes. Draw the signal waveforms for the two cases. Draw constellation diagrams. 08

c. With expressions show that bit error probability (BER) is better in BFSK than BPSK modulation. 07

Q.5 OR

a. Draw the generation and degeneration circuit diagram for QPSK modulation. Explain the generation of QPSK modulated signal for the bit stream 10 11 01 00. 10

b. Explain the reason for the name minimum shift keying (MSK). What is the similarity and dissimilarity in QPSK and MSK modulations. 06

c. Draw the constellation diagram for the signals. What type is modulation it follows. 04

$$s_1(t) = A_c\sqrt{1-k^2}\cos(2\pi f_c t) + A_c k \sin(2\pi f_c t). \text{ for symbol 1.}$$

$$s_2(t) = -A_c\sqrt{1-k^2}\cos(2\pi f_c t) + A_c k \sin(2\pi f_c t). \text{ for symbol 0.}$$

Module VI CO6 Marks 20

Q.6

a. Define the terms information and entropy of a source. Is there any relation between entropy and source compression? 04

b. An analog signal is band limited to B Hz, sampled at the Nyquist rate and then samples are quantized into 4-levels. The quantization levels Q1, Q2, Q3 and Q4 (messages) are assumed independent and occur with probabilities, P1=P2=1/8 and P3=P4=3/8, find the information rate of the source. If all probabilities are equally likely, then what will be the information rate? 06

c. A source Si ={ S0, S1, S2, S3, S4, S5} generated with probabilities Pi ={ 0.4, 0.2, 0.2,0.1, 0.1}. Applying Haffman code, find the code words and average length of the code words and hence entropy of the source. Repeat the problem using Shannon–Fano coding and comments on the resuts. 10

Q.6 OR

a. The Shannon capacity theorem with known Gaussian Noise is called Shannon-Hartley theorem. Write the expression for channel capacity of a white bandlimited Gaussian Channel. For a fixed power, find the Shannon's capacity limit when bandwidth is infinite. 05

b. Describe the Binary Symmetric Channel in terms of input (X), output (Y) and joint probability P (x_i, y_j). Provide expressions for H(X), H(Y) and H(Y|X) and mutual information I(X;Y). 10

c. If the channel characteristic is described as 05

$$P(X,Y) = \begin{vmatrix} 0.2 & 0.12 & 0.05 \\ 0.08 & 0.15 & 0.40 \end{vmatrix}$$

Find marginal probabilities $p(x_i)$ and $p(y_j)$ and marginal entropies.