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Department: Electronics and Communication Engineering

Digital Communication (ECE325)

Exam Type: Mid Term

Duration: 90 Minutes **Date: 28.09.2022** **Max. Marks: 30**

Total Questions	Total Marks	CO1	CO2	CO3	CO4
5	30	Q1 – 5, Q3 - 2	Q1 – 3, Q2 – 2, Q3 – 3, Q5 - 1	Q2 – 3, Q5 - 3	Q1 – 2, Q4 – 5, Q5 - 1
CO weightage		7/ 30 = 23%	9/ 30 = 30%	6/ 30 = 20%	8/ 30 = 27%

Instruction: Answer must be brief and to the point. All parts of the question must be answered at one place and the Question Number should be mentioned clearly. Read questions carefully. Please make suitable assumptions wherever required (if necessary).

Q.1 **(a)** In what way(s) the efficiency of a pulse code modulation (PCM) technique can be improved?
(b) How inter-symbol interference (ISI) can be pictorially displayed?
(c) A frequency shift keying (FSK) modulated signal undergoes phase discontinuities at zero-crossings. How this can be solved?
(d) Draw the differential phase shift keying (DPSK) modulated signal with respect to an input bit sequence: 01100111.
(e) What kind of distortions may happen in a delta modulator? How can these be avoided?
(f) What is the maximum possible phase in a $\pi/4$-QPSK modulated signal?
(g) By what amount (in dB), the SNR of QPSK must be increased so that its symbol error probability is same as that of a BPSK?
(h) Why AWGN is called as white noise?
(i) Mathematically express the Cauchy-Schwartz inequality.
(j) "BPSK is 3dB superior to BFSK" - True/ False? Justify your answer.

[10×1 = 10]

Q.2 **(a)** Let a message signal $m(t) = 10\cos(6\pi ft)$ be modulated using a stair-case approximation, thereby generating a bit sequence. If the height of the stair-case is 0.7 units, then:
(i) Calculate one possible value of f, so that the above approximation is accurate.
(ii) Draw the corresponding demodulator schematic diagram.
(b) Generate a pseudo random binary sequence (PRBS) of length 7, which is to be sent over a digital communication channel. At the receiver, although the signal does not suffer from signal droop but it does suffer from synchronization problems. For this system, draw an appropriate line-coded signal waveform. Moreover, draw the corresponding power spectral density curve.

[(2×1) + 3 = 5]

Q.3 **(a)** Consider a uniform quantizer in a PCM system. If the length of the dynamic range of the quantizer is 20 and the number of bits required to encode the system is 5, then:
(i) What is the possible range of the number of quantization intervals (QIs)?
(ii) Choose an appropriate value of QI, to calculate the quantization noise in decibels.

(b) Consider a digital communication system, in which the carrier pulse $p(t)$ is used to modulate a baseband signal defined as: $p(t) = q(t) - \delta(t\text{-}2) * q(t)$; where, $q(t) = s(t) * s(t)$ and $s(t) = u(t) - u(t\text{-}1)$. Design an optimum digital communication receive filter for the above system, assuming $*$, $\delta(t)$, and $u(t)$ to be the convolution operator, unit impulse, and unit step functions, respectively.

[(2×1) + 3 = 5]

Q.4 (a) In a typical digital modulation scheme, suppose the voltage level corresponding to bit '1' is 8V and bit '0' is -4V. Given that the probability of occurrence of bit '1' is 0.75,

(i) Calculate the expected value of energy per bit.

(ii) Calculate the bit error rate (BER) in terms of $Q(.)$ function assuming one-sided noise spectral density $N_0 = 0.01$ W/Hz.

(b) Let there be two orthogonal sinusoids $x(t) = A\sin(30\times10^6\pi t)$ and $x(t) = A\sin(90\times10^6\pi t)$. What can be the possible value of time period T? If these sinusoids are taken as the two carrier pulses for designing a frequency shift keying (FSK) modulated system, then find the probability of error after calculating the appropriate value of A.

[(1+2) + 2 = 5]

Q.5 (a) A QPSK system uses four constellation points: $0.707(1+j)$, $0.707(-1+j)$, $0.707(-1-j)$, $0.707(1-j)$ for symbols s_1, s_2, s_3, s_4 respectively. If the receiver detects an output as $r = 0.2 - 0.8j$, then which symbol is most likely to be transmitted? Explain in detail.

(b) Draw the schematic diagram of QPSK demodulator structure at the receiver.

(c) Suggest a digital modulation scheme which can increase the data rate of a BPSK/ ASK modulated signal by 6 times. Draw its constellation diagram. Further, also mention a few possible disadvantages of the above scheme.

[1+1 +3 = 5]