Ref: Ex/ET/T/313/2019

Bachelor of Electronics and Telecommunication Engineering Examination, 2019
(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
Answer 5 questions (all questions carry equal marks)

Q1. (a) **Digital** signals maintain their quality over long distance better than analogue signals – How? **02**

(b) Digital systems can handle voice, data, video together – explain how. **02**

(c) Digital communication system is more flexible in terms of good processing techniques- What are they? **02**

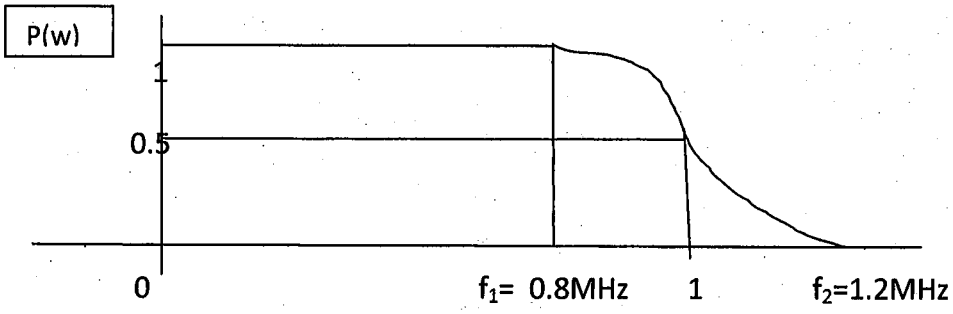
(d) Resource sharing among multiple users is most important digital communication component for better spectrum utilization – name three most common techniques used for. **01**

(e) Define the goals of digital communication system in terms of data rate, system utilization, bit error rate and signal to noise ratio. **02**

(f) Digital communication is not 100% advantageous! What are the three difficult constraints for digital communication system? **01**

(g) Give the condition for **Nyquist criterion** for distortion less baseband transmission in absence of noise? What is the purpose of this condition to be satisfied? **03**

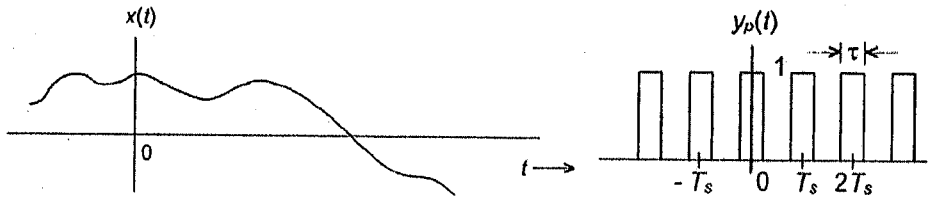
(h) A pulse p(t) whose spectrum P(w) is shown in the figure below satisfies the Nyquist criterion. If f_1=0. 8 MHz and f_2 =1.2 MHz, determine the maximum rate at which binary data can be transmitted by this pulse using the Nyquist criterion. What is the roll-off factor? **04**



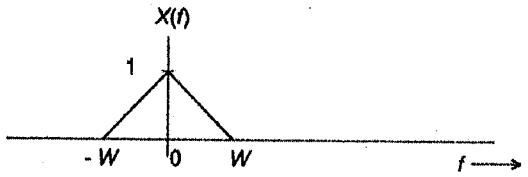
(i) The band width utilization for QPSK modulation is twice that of BPSK modulation where as error probability remains same –justify the statement. **03**

[Turn over

Q.2 (a) Let x(t) is the analog signal given in the figure below, $y_p(t)$ is the periodic rectangular pulses used for sampling. Generate the PAM signal $x_s(t)$, give expressions for Yp(f) and $X_s(f)$. Comment on the results generated. **02+04+02**



(b) Now if X(f) is the spectrum of x(t) as given below, provide pictorial representation for PAM spectrum Xs(f) when *fs (sampling frequency) is >, = , < 2W* **06**



(c) A sinusoidal, with an amplitude of 3.5 volts is applied to a uniform quantizer of the midtread type whose output takes on the values 0, ±1, ±2,±3 volts. Sketch the resulting waveform of the quantizer output for one complete cycle of the input. Repeat the evaluation for the case when the quantizer of midriser type whose output takes ±0.5, ±1.5, ±2.5 , ±3.5. Will there be any difference in the output signals for the two cases. **06**

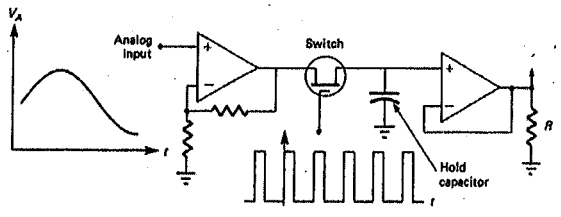
OR

Q.2 (a) Draw the PCM modulator and demodulator circuit. What is the error associated with quantizing process? On what factors does this error depend? **03+02+01**

(b) Define output signal to quantization noise ratio for the PCM system. Show that SNR value is dependent on code rate R. **04**

(c) Let m(t), a sinusoidal signal with the peak value of A be the input to a uniform quantizer. Calculate the (SNR)q, assuming R -bit code word per sample. **04**

(d) What does the following figure stand for? Draw the output wave form for the input analog signal given. Explain the operation of the circuit. Will there be any effect of sample duration T_s on the output? **06**



Q3. (a) Delta Modulation scheme is a special case of DPCM (differential PCM)- How? Explain the operation of DM by taking an analog signal. Explain the slope overload and granular noise effects. What benefit is obtained from DM over PCM? Draw the DM modulator and demodulator circuits. **10**

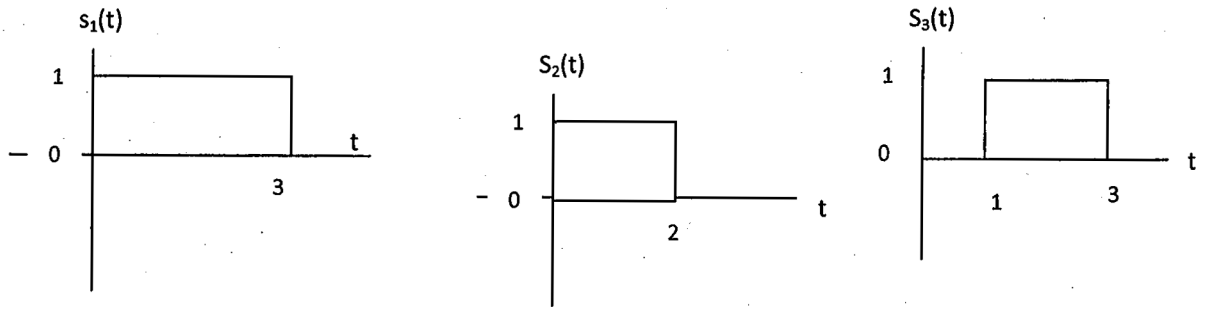
(b) Let a message signal m(t) be the input to a delta modulator where $m(t)= 6 \sin(2\pi x10^3 t) + 4 \sin(4\pi x10^3 t)$ V, with t in seconds. Determine the minimum pulse rate that will prevent slope overload, if step size is 0.314 V. **03**

(c) A sequence of binary bits 011010001 is transmitted using some line coding format. Draw the wave form for Unipolar, Polar RZ and Manchester coding. Explain the pros and cons of each line coding. **07**

Q4. (a) Starting from the Maximum Likelihood rule for any binary communication system, find the decision rule for the optimum receiver in terms of energy of the signal transmitted. 08

(b) In terms of ML rule, draw the optimum receiver circuit. Show the decision boundary regions for four message points within a signal space diagram. **02+02**

(c) Apply Gram-Schmidt procedure fot the set of signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ in terms of orthonormal set of functions. Construct the signal constellation for $s_1(t)$, $s_2(t)$ and $s_3(t)$. **08**



OR

Q4. (a) How are Binary PSK and Binary FSK signals represented? Draw the waveforms and constellation diagrams for these signals. **05**

(b) Minimum Shift Keying is based on the principle of continuous phase shift keying with orthogonality condition among the frequencies - explain. Why the name is MSK? **04**

(c) Show that MSK signals use the pulse shaping for 1 and 0 bits transmission. What benefit is obtained for pulse shaping? **04**

(d) Draw the phase trellis for MSK for 01101000 bits sequence? Explain the four possible rules of MSK signal transmission in terms of $\theta(0)$ and $\theta(T_b)$. **04**

(e) The input binary data stream to a QPSK system is 01101000. Show the waveforms representing the two components of QPSK signals $s_{i1}\,\varphi_1(t)$ and $s_{i2}\,\varphi_2(t)$. **03**

Q5. (a) Describe the relationship between uncertainty, information and entropy for a discrete memory less source. What are the lower and upper bounds of entropy? **08**

(b) Consider a discrete memoryless source with source alphabet S= $\{s_0,s_1,s_2\}$ and probabilities $p_0 = p_1 = 1/4$ and $p_2 = ½$, find the entropy of the source. **02**

(c) The five source symbols of the alphabet of a discrete memoryless source and their probabilities are given as S= $\{s_0, s_1, s_2, s_3, s_4\}$, P={ $p_0 = 0.4$, $p_1 = 0.2$, $p_2 = 0.2$, $p_3 = 0.1$, $p_4 = 0.1$} using Haffman algorithm, find the code words and average code word length. **04**

(d) For a discrete memoryless channel with input alphabet X and output alphabet Y, and the transition probabilities $p(y_k / x_j)$, define the mutual information of the channel. What is the importance of this parameter? **03**

(e) In a binary FSK system, symbol 0 and 1 are transmitted with equal probability. The system parameters are as given: Average transmitted power = 1W, Noise power spectral density = 10^{-5} W/Hz, Transmitted bit rate = 10^{-4} b/s, viewing the system as binary symmetric channel, calculate the channel capacity C. **03**

OR

Q5. Consider a channel with noise characteristics given by

$$P(Y|X) = \begin{array}{c} \\ x_0 \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{ccc} y_0 & y_1 & y_2 \end{array} \\ \begin{pmatrix} 0.6 & 0.2 & 0.2 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{pmatrix} \end{array}$$

with $p(x_0) = 1/8$, $p(x_1) = 1/8$, and $p(x_2) = 6/8$

Find (a) Entropy of the source **4x5=20**

(b) Entropy of the receiver

(c) Joint entropy

(d) Conditional entropies

(e) Mutual information