Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Examination July 2010

Subject code: 722202

Subject Name: Advanced Digital Communication

Date: 06 /07 /2010 **Time: 11.00am – 1.30pm**

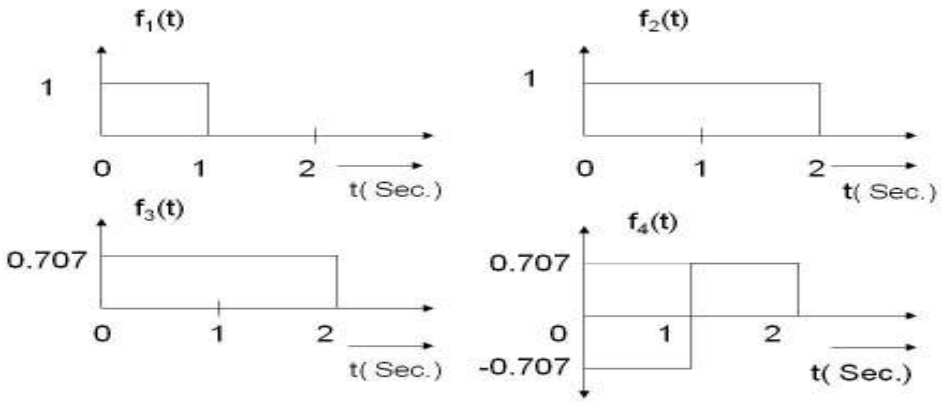
Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms with respect to two signals **06**
(i) Orthogonality, (ii) Ortho- normality (iii) Anti-podality

(b) Using Gram-Schmidt method, find the set of orthonormal bases functions for the four signals as shown below, **06**



Q.2 **(a)** The basis signals of a three dimensional signal space are given by **06**
$\psi_1 = p(t)$, $\psi_2 = p(t-T_o)$ and $\psi_3 = p(t-2T_o)$ where p(t) is given as,
$p(t) = (T_o)^{-0.5}[\ U(t) - U(t-T_o)]$ and U(.) is unit step function

Sketch the signal waveforms in time domain which are represented by (2,-1,1), (3,2,-0.5) and (-0.5,-1,1) coordinates.

(b) The signal X(t) has energy Ex and signal Y(t) has energy Ey. Signal X(t) and Y(t) are orthonormal to each other with same energy. **06**
Find energy of new signals 2X(t) + Y(t) and X(t) – 2Y(t).
Is there any relation between energy of newly defined signal.

OR

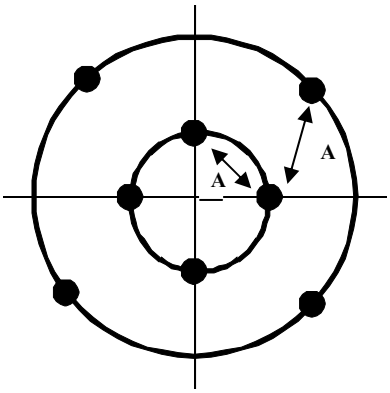
(b) Give answer of following questions **06**

(i) Find arbitrary set of Ortho-normal signals for a five dimensional signal space.

(ii) Explain the transmission of random process through linear filter. Also give equation to find the Power spectral density of output random process.

Q.3 **(a)** What is simplex signal and bi-orthogonal signal? List out all properties of simplex and bi-orthogonal signals. **06**

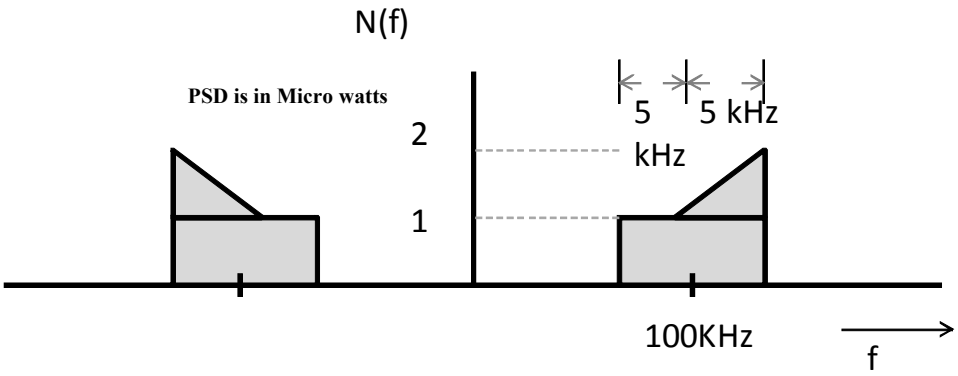
(b) In one digital transmission method the 8 signals are represented using constellation diagram as shown in figure below. A nearer neighbor signal points are separated by distance of A units. Find the total average power transmitted by transmitter under this scheme. **06**



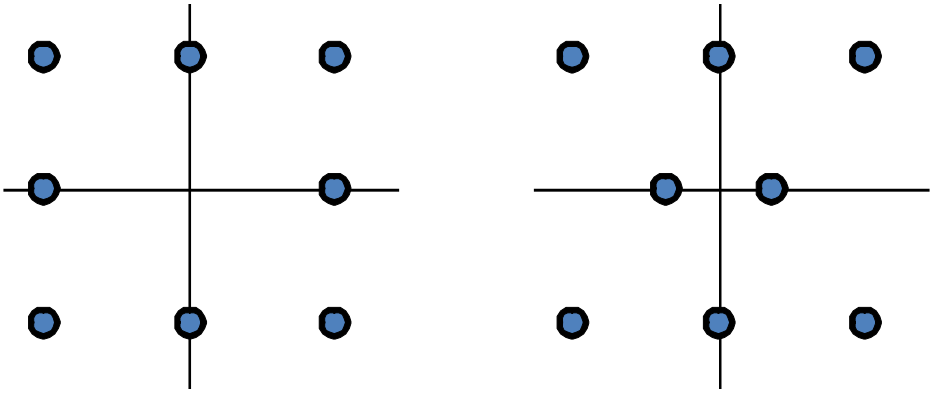
OR

Q.3 **(a)** Explain how Hilbert transform differs from Fourier transform. List out all properties of Hilbert transform. **06**

(b) A Noise Signal (Random signal) is applied to band pass system which generates band pass random signal n(t). Output bandpass signal n(t)'s spectrum is shown in figure below. Find the total power of output random signal n(t). **06**

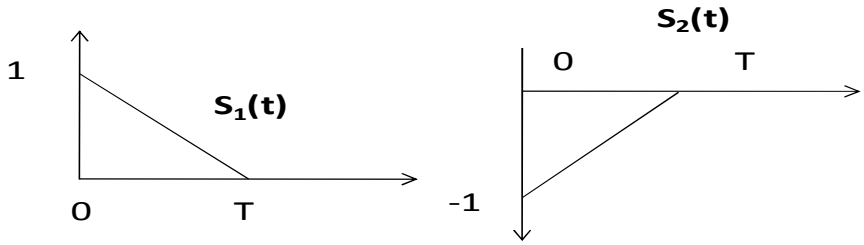


Q.4 **(a)** Consider the two 8 point QAM signal constellation shown in figure below. The maximum distance between adjacent points is 2A. If the efficiency of transmitted QAM signal is considered in term power saving, then which constellation is efficient? Assume that all signal points are equally probable. **06**



Constellation A Constellation B

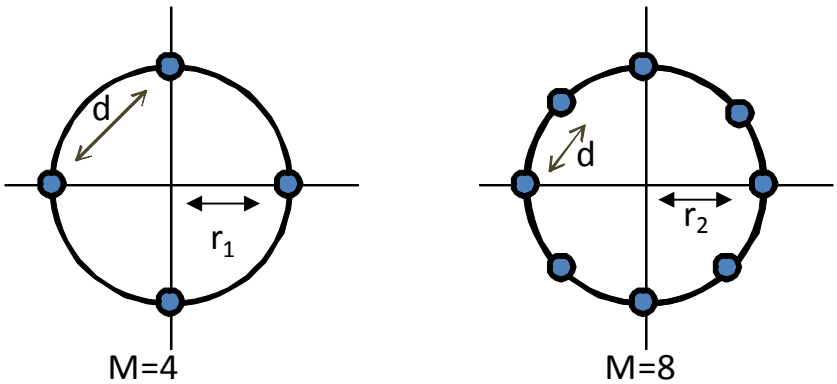
(b) A binary set of signal as shown in figure below used to represent binary digits. A sequence of these signals is received and decoded in the presence of white noise. If the noise has one sided PSD of 10^{-7} V^2/Hz and the bit duration is $T=10^{-7}$ sec, find the minimum probability of error with which they can be decoded. Sketch the matched filter response in both the cases. **06**



[Note: Approximately Error function Q(.) is solved as, $q(x) \approx \frac{1}{x\sqrt{2\pi}} e^{-x^2/2}$]

OR

Q.4 **(a)** Consider the four phase and eight phase signal constellation shown in figure below. Determine the radii r_1 and r_2 of circles such that the distance between two adjacent points in the two constellations is d. Also find additional energy required in 8 PSK to achieve same BER as four phase PSK. **06**



(b) A bipolar binary signal, $S_i(t)$ is a +1 or -1 V pulse during the interval (0,T). Additive white Gaussian noise having two-sided power spectral density of 10^{-3} W/Hz is added to the signal. If the received signal is detected with the matched filter, determine the maximum bit rate that can be sent with a bit error probability of $P_B \leq 10^{-3}$. **06**

[Note: Approximately Error function Q(.) is solved as, $q(x) \approx \frac{1}{x\sqrt{2\pi}} e^{-x^2/2}$]

Q.5 **(a)** In digital communication use of repeater will increases the end to end error probability, **06**

In analogue repeater error probability is given as

$$P_b = Q\left(\sqrt{\frac{2E_b}{KN_o}}\right)$$

where E_b is bit energy and N_o is AWGN noise and k is number of repeaters. In case of regenerative digital repeater error probability is given as,

$$P_b = KQ\left(\sqrt{\frac{2E_b}{N_o}}\right)$$

A binary digital communication system transmits data over a wireline channel of length 1000 Km. Repeater are used at every 10 km to offset the effect of channel attenuation. Determine the E_b/N_o, that is required to achieve a probability of a bit error of 10^{-5} in both the cases of repeaters.

(b) Give answer of following questions. **06**

(i) Explain the significance of continuous phase modulation; With proper equation explain how signal is transmitted in case of Gaussian Minimum shift keying (GMSK).

(ii) Explain the significance of equalizer in wireless communication.

OR

Q.5 **(a)** Give answer of following questions **06**

(i) Explain with proper diagram that how Synchronization is achieved with Phase locked loop.

(ii) With proper block diagram explain how in phase carrier recovery is done using Costas loop method.

(b) Give answer of following questions **06**

(i) A friend of yours says that she can design printer which can print 100 lines per minute and the printer data is transmitted over voice grade telephone line with bandwidth of 10 KHz and SNR of 15 dB. The printer prints maximum 60 characters per line. Would you believe on your friend? Why?

(ii) Explain the significance of Parallel transmission under fading channel. Give block diagram to generate Orthogonal Frequency Division Multiplexing (OFDM) signal.

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