Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER– II(Old course) • EXAMINATION (Remedial) – WINTER- 2015**

**Subject Code: 1722202** **Date: 10/12/2015**

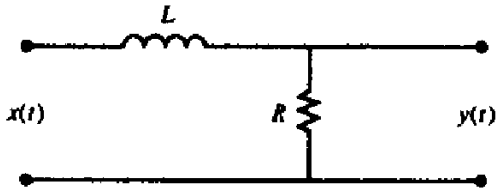
**Subject Name: Advanced Digital Communication**

**Time:2:30 pm to 5:00 pm** **Total Marks: 70**

**Instructions:**

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

**Q.1** **(a)** Suppose low pass filter illustrated in figure is excited by a stochastic process $x(t)$ having a power density spectrum, $\Phi_{xx}(f)=No/2$, For all $f$. Determine the power density spectrum of the output process. **07**



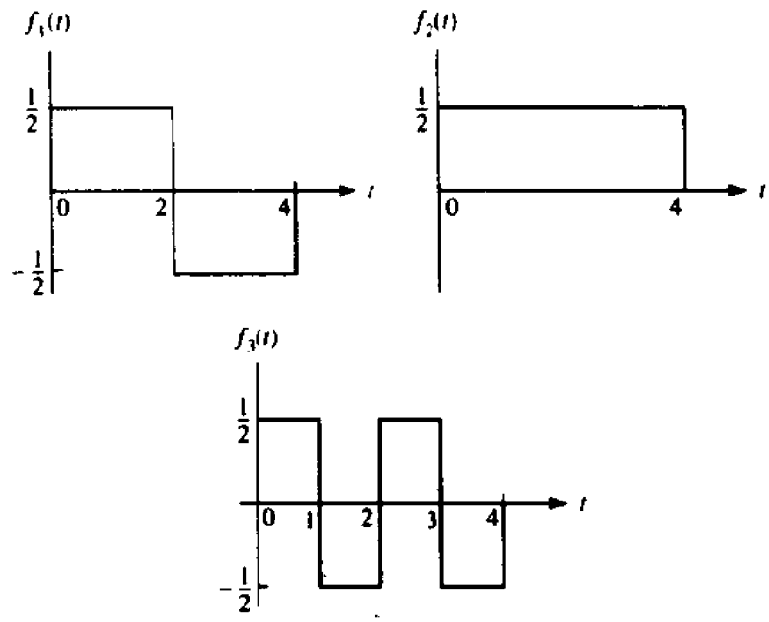

**(b)** Explain following in brief. 1) Stationary stochastic processes 2) Wide sense stationary stochastic processes 3) Power density spectrum. **07**

**Q.2** **(a)** The autocorrelation sequence of a discrete ï time stochastic process is $\varphi(k) = (\frac{1}{2})^{|k|}$. Determine its power spectral density. **07**

**(b)** Consider the three waveforms $f_n(t)$ shown in Figure. Show that these waveforms are orthonormal. Express waveform $x(t)$ as a weighted linear combination of $f_n(t)$ , $n=1,2,3$ *if* **07**

$$x(t)= \begin{cases} -1 & (0 \le t < 1) \\ 1 & (1 \le t < 3) \\ -1 & (3 \le t < 4) \end{cases}$$

And determine the weighting coefficients.



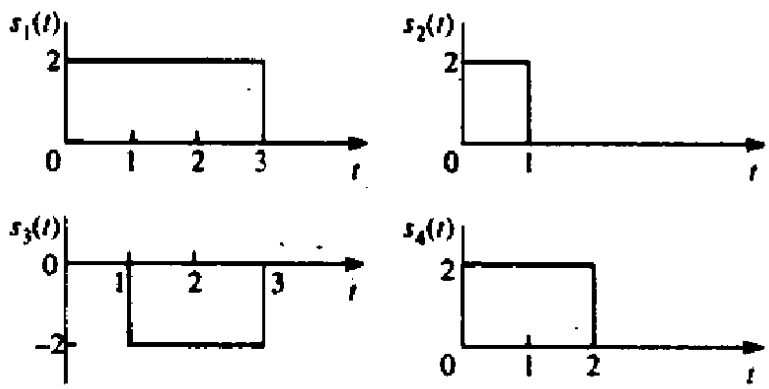

**OR**

**(b)** Consider the four waveform shown in figure below. **07**

a) Determine the dimensionality of the waveforms and a set of basis functions.

b) Use the basis functions to represent the four waveforms by vectors $s_1$, $s_2$, $s_3$, and $s_4$.

c) Determine the minimum distance between any pair of vectors.




**Q.3** **(a)** Define symbol synchronization and carrier recovery. Explain with proper diagram that how Synchronization is achieved with Phase locked loop. **07**

**(b)** With proper block diagram explain how in phase carrier recovery is done using Costas loop method **07**

**OR**

**Q.3** **(a)** Explain the following in brief **07**

i) Multipath intensity profile

ii) Coherence bandwidth

iii) Frequency selective channel

iv) Doppler power spectrum

Also derive the relationship between $\varphi c(\Delta t)$ and $\varphi c(\tau)$

**(b)** Explain the effect of inter symbol interference on eye opening and prove Nyquist condition for zero ISI. **07**

**Q.4** **(a)** What do you mean by Regenerative repeater? **07**

In digital communication use of repeater will increases the end to end error probability, In analogue repeater error probability is given as

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

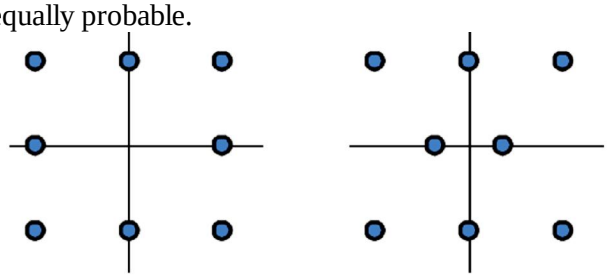
Where $E_b$ is bit energy and $N_o$ is AWGN noise and $K$ is number of repeaters. In case of regenerative digital repeater error probability is given as,

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

A binary digital communication system transmits data over a wire line 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)** 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. **07**



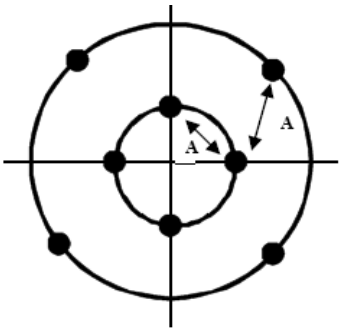
Constellation A Constellation B

**OR**

**Q.4** **(a)** i)What is simplex signal and bi-orthogonal signal? List out all properties of simplex and bi-orthogonal signals. **02**

ii) A speech signal is sampled at a rate of 8 kHz, logarithmically compressed and encoded into a PCM format using 8 bits per sample. The PCM data is transmitted through an AWGN base band channel via M-level PAM. Determine the bandwidth required for transmission when M=8 and M=16 **05**

**Q.4** **(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. **07**




**Q.5** **(a)** i) Explain the significance of Parallel transmission under fading channel. Give block diagram to generate Orthogonal Frequency Division Multiplexing (OFDM) signal. **04**

ii) Describe a discrete-time model for a channel with ISI with an example. **03**

**(b)** Explain an FFT-based multi-carrier communication system in brief. What is the major problem with multi-carrier modulation? Describe the various methods investigated to solve it **07**

**OR**

**Q.5** **(a)** Explain significance of design of band limited signal in digital communication system. Explain design process of band limited signals with controlled ISI- partial response signals. **07**

**(b)** Suppose a digital communication system employs Gaussian ï shaped pulses of the form **07**

$$x(t)= exp(-\pi a^2 t^2)$$

To reduce the level of inter symbol interference to a relatively small amount, we impose the condition that $x(T) =0.01$, where $T$ is the symbol interval. The bandwidth $W$ of the pulse $x(t)$ is defined as the value of $W$ for which $X(W)/X(0) =0.01$, where $X(f)$ is Fourier transform of $x(t)$. Determine the value of W and compare this value to that of raised cosine spectrum with 100 percent roll off.

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