

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M.Tech (ECE)/SEM-1/MCE-102/2012-13**

**2012**

**ADVANCED DIGITAL COMMUNICATION**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

Answer Question No. 1 and any *four* from the rest.

1. Answer any *seven* of the following :  $7 \times 2 = 14$
- a) Define central limit theorem. What is its significance ?
  - b) Calculate the minimum sampling rate of the signal  $x(t) = 10 \cos(200\pi t) + 5 \cos(400\pi t)$  in order to avoid aliasing.
  - c) Draw the Manchester coding and PNRZ coding for binary data "110001".
  - d) State Parseval's theorem for power signal.
  - e) What do you mean by random variable and random process ?
  - f) What are the desirable properties of line codes ?
  - g) What is white noise ? Draw its power spectral density and autocorrelation function.
  - h) What are the properties of maximal-length PN sequences ?



- i) What do you mean by symbol error rate and bit error rate ?
  - j) What is the difference between convolution and correlation function ?
2. Answer any *four* of the following : 4 × 14 = 56
- a) Describe the operation of direct sequence spread spectrum with BPSK modulation. 5
  - b) Derive the bit error probability of a single tone interference with direct sequence spread spectrum. 5
  - c) A spread spectrum system has the following parameters :  
 Message bit rate ( $f_b$ ) = 3 kbps  
 PN sequence chip rate ( $f_c$ ) = 3072 kbps  
 If error probability ( $p_e$ )  $\leq 10^{-5}$ , find out processing gain and jamming margin.  
 Given,  $x = 10$  if  $\text{erfc } \sqrt{x} = 2 \times 10^{-5}$  2 + 2
3.
  - a) Derive the Nyquist criterion for zero inter symbol interference ? 5
  - b) What are the limitations of above criterion ? 2
  - c) A binary digital with PNRZ signalling is passed through a communication system with raised cosine filter characteristic  $\alpha = 0.25$ . If bit rate is 64 kbps then find the transmission bandwidth. 2
  - d) The binary data 0010110 are applied to the input of a duobinary system. Construct the duobinary coder output and corresponding receiver output without precoding. Consider the first bit to be a startup digit, not a part of data. 3 + 2



4. a) Deduce the impulse response of a matched filter. 5
- b) Consider a rectangular pulse  $x(t)$  of amplitude  $A$  and duration  $T$  sec. Show that the maximum signal to noise ratio for matched filter is  $2E/\eta$ . Where  $E$  is the signal energy and  $\eta/2$  is the white noise power spectral density. 4
- c) In a binary transmission, a rectangular pulse is represented by

$$x(t) = \begin{cases} A & \text{for } 0 < t < T \\ 0 & \text{for otherwise} \end{cases}$$

Sketch the impulse response and output of the matched filter. 3 + 2

5. a) A BPSK signal is represented by  $S(t) = b(t) \sqrt{2P} \cos(2\pi f_c t + \theta)$  where  $b(t)$  is a rectangular pulse of amplitude  $\pm A$  and of duration  $T_b$ . Deduce the PSD function of modulating signal and modulated signal and corresponding spectrum. Draw the signal space diagram and estimate the bandwidth of BPSK signal.

3 + 2 + 1 + 1 + 1 + 1

- b) For a BFSK signal find bit error rate.

Given, the power spectral density of white noise  $\frac{\eta}{2} = 10^{-10}$  watt/Hz, amplitude of carrier = 1mV at receiver input and frequency of baseband NRZ signal  $f_b = 1$  KHz.

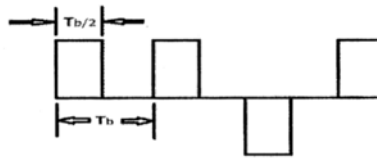
5

6. a) Prove that power spectral density function of a signal and its autocorrelation forms a Fourier transform pair.

5



- b) A random binary pulse train is shown below. A binary 1 is transmitted by a positive pulse and a binary 0 is transmitted by the negative pulse. Assume that two symbols are equally likely and occur randomly. Determine the autocorrelation function and power spectral density of the signal. 2 + 2



- c) A fair coin is tossed four times in succession. If a random variable  $X$  is defined as the number of heads appear in a trial, determine cumulative distribution function  $F_X(x)$  and probability density function  $f_X(x)$  of the random variable  $X$ . 3 + 2
7. a) What do you mean by stationary random process and wide sense stationary random process ? 3
- b) Explain the Gram-Schmidt procedure to represent an arbitrary function into an orthonormal set of functions. 6
- c) Two functions  $x_1(t)$  and  $x_2(t)$  are shown below. Express the functions in terms of orthonormal components using Gram-Schmidt procedure. 5

