Time: 3 Hours **December 2016** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. A TV remote control works on the principle of

(A) pulse code modulated ultra violet light

(B) pulse code modulated infrared light

(C) demodulation

(D) either **(A)** or **(B)**

b. The PSD and the power of a signal $g(t)$ are respectively $S_g(\omega)$ and P_g, the PSD and the power of signal $a.g(t)$ are respectively

(A) $aS^2_g(\omega)$ and a^2P_g **(B)** $aS_g{}^2(\omega)$ and aP_g

(C) $aS_g(\omega)$ and a^2P_g **(D)** $aS_g(\omega)$ and aP_g

c. Which of the following modulation schemes provides 4 bits per symbol?

(A) QPSK **(B)** 8-PSK

(C) 16-QAM **(D)** 64-QAM

d. Three analog signals having bandwidths 1200 Hz, 600 Hz, and 600 Hz are sampled at their respective Nyquist rates, encoded with 12 bit words and time division multiplexed. The bit rate for the multiplexed signal is:

(A) 115.2 kbps **(B)** 28.8 kbps

(C) 57.6 kbps **(D)** 38.4 kbps

e. In PCM system with uniform quantization, increasing the number of bits from 8 to 9 will reduce the quantization noise power by a factor of:

(A) 9 **(B)** 4

(C) 8 **(D)** 2

f. If $f_h(t)$ is the Hilbert transform of $f(t)$, and $f(t)$ is a real valued signal, the pre-envelope of $f(t)$ is

(A) $f(t) - jf_h(t)$ **(B)** $f(t) + jf_h(t)$

(C) $f_h(t) + jf(t)$ **(D)** $f_h(t) - jf(t)$

g. A communication channel with additive white Gaussian noise has a bandwidth of 4 kHz and SNR of 1.5. Its channel capacity is:

(A) 1.6 kbps **(B)** 16 kbps

(C) 32 kbps **(D)** 256 kbps

h. A source produces 26 symbols with equal probability. What is the average information produced by this source?

(A) < 4 bits/symbol **(B)** 6 bits/symbol
(C) 8 bits/symbol **(D)** between 4 and 6 bits/symbol

i. During power measurement, the output power measured was -90 dBm. What is the measured power in W?

(A) 1mW **(B)** 1pW

(C) 10W **(D)** 1W

j. The number of signalling bits per channel per frame in T1 multiplexer as per CCITT hierarchy is:

(A) 64000 **(B)** 128

(C) 4 **(D)** 400

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Draw the block diagram of a digital communication system and explain the function of each block. Also discuss transmission characteristics of commonly used communication channels. **(8)**

b. (i) Prove that mutual information of a channel is (i) symmetric and (ii) always nonnegative. **(4)**

(ii) The five source symbols of the alphabet of a discrete memoryless source and their probabilities are given in the table below. Obtain the Huffman codes for the source symbols and also calculate the average code-word length. **(4)**

Symbol	**Probabilities**
S0	0.4
S1	0.2
S2	0.2
S3	0.1
S4	0.1

Q.3 a. (i) State sampling theorem for band-limited signals of finite energy. **(2)**
(ii) Consider the cosine wave $g(t) = A\cos(2\pi f_o t)$. Plot the spectrum of the discrete time signal $g_\delta(t)$ derived by sampling $g(t)$ at the times $t_n = n/f_s$, where $n = 0, \pm1, \pm2, \pm3$ ..., and f_s= (i) f_o (ii) $2f_o$. **(6)**

b. Explain the process of signal recovery from a sampled signal using sample and hold circuit. **(4)**

c. Draw the block diagram of a time division multiplexing system and explain its working. **(4)**

Q.4 a. With the help of block diagram, discuss the essential operations performed in Pulse Code Modulation systems. **(8)**

b. For a sinusoidal signal, illustrate the process of Delta Modulation (DM) both graphically and mathematically. Also draw the block diagrams of DM transmitter and receiver systems. Discuss the limitations of DM. **(8)**

Q.5 a. (i) Draw the representation of binary data: [1 0 1 0 1 1 1 0 0] using NRZ unipolar, NRZ polar, NRZ-inverted (differential encoding) and Manchester encoding. **(4)**

(ii) Derive the expression for power spectral density of NRZ Unipolar data format. **(4)**

b.Discuss how eye patterns are used to analyze inter-symbol interference in PCM. Give a detailed interpretation of eye pattern. **(4)**

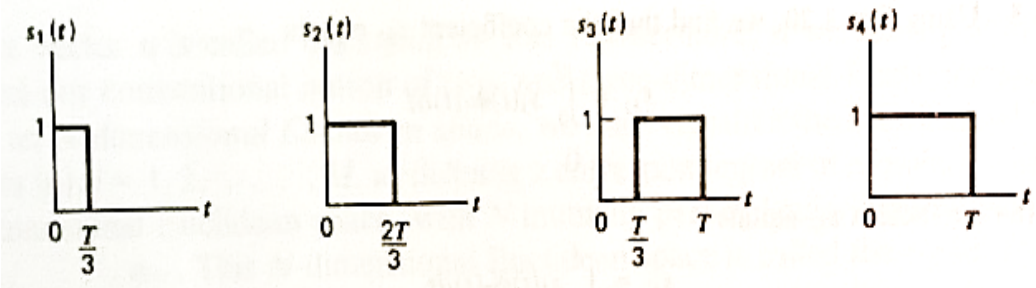
c. Give a block level representation of modified duo binary signalling scheme and plot the frequency response of its conversion filter. **(4)**

Q.6 a. With the help of block diagrams, explain M-ary QAM system. Also derive its probability of symbol error. **(8)**

b. Using signal space diagram, explain coherent QPSK system. Also draw the block diagrams of its transmitters and receivers. **(8)**

Q.7 a. Write a short note on Maximum likelihood detector. **(4)**

b. Consider the signals given in the fig. below. Find the orthonormal basis for this set of signals using Gram-Schmidt Orthogonalization. **(6)**



c. Give some commonly used criteria for estimation of signals. What measures are used to access the quality of an estimate? **(6)**

Q.8 a. What are pseudo-noise sequences? How are these generated using feedback shift register? Discuss various properties of maximal-length sequences. **(8)**

b. Discuss in detail direct sequence spread spectrum with coherent PSK. Give the block level representation of their transmitters and receivers. **(8)**

Q.9 a. Discuss digital radio as an application of digital modulation techniques. **(8)**

b. Explain digital multiplexers as an application of waveform coding. Also give the digital hierarchy of Bell system (T_n system). **(8)**