Subject: DIGITAL COMMUNICATIONS

Time: 3 Hours **JUNE 2011** **Max. Marks: 100**

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. The Nyquist sampling rate for the signal $g(t) = 200\cos(200\pi t) + 60\cos(500\pi t)$ is __________

(A) 400 samples/sec **(B)** 1000 samples/sec
(C) 200 samples/sec **(D)** 500 samples/sec

b. The average code word length of a discrete memoryless source is 1.8 bits/ source–symbol and entropy is 1.5 bits/symbol. The efficiency of the source encoder is ________

(A) 12% **(B)** 83%
(C) 18% **(D)**15%

c. A 10 bit binary PCM system uses a uniform quantizer of step size of 0.24 volts. The quantization noise power is ________

(A) 4.8 m Watts **(B)** 24 m Watts
(C) 2.4 m Watts **(D)**10 m Watts

d. A binary data of rate 10 Kbps is transmitted using a base band binary PAM system designed to have a raised cosine spectrum. Transmission band width is 10 KHz. The roll off factor of the spectrum is ________

(A) 0.0 **(B)** 0.5
(C) 1.0 **(D)** 2.0

e. The only one signal waveform that produces zero inter symbol interference (ISI) is _________

(A) sin $(2\pi\ B_o t)$ **(B)** cos $(2\pi\ B_o t)$
(C) sinc $(2\ B_o t)$ **(D)** sin $(B_o t)$

f. In a T-1 carrier system 24 voice signals are multiplexed. Each time frame consists of

(A) 192 bits **(B)** 193 bits
(C) 48 bits **(D)** 24 bits

g. The correlation receiver or optimum receiver of a digital communication system consists of two subsystems. The first subsystem is detector. The second subsystem is _________.

(A) Non coherent Receiver
(B) Vector Receiver
(C) Gaussian Receiver
(D) Scalar Receiver

h. The probability of bit error for a coherent PSK receiver is ________.

(A) $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_o}}\right)$
(B) $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{2E_b}{N_o}}\right)$
(C) $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{2N_o}}\right)$
(D) $P_e = \frac{1}{2}\text{erfc}\left(E_b / N_o\right)$

i. In a spread spectrum communication system the information bit duration $T_b = 20\text{m sec}$ and PN chip duration, $T_c = 0.01\text{m sec}$. The processing gain of the system is _________.

(A) 5000
(B) 1000
(C) 4000
(D) 2000

j. A spread spectrum communication system using coherent binary PSK receiver has the processing gain of 2048 and the bit energy-to-noise ratio of 10. Hence the Jamming margin is _________.

(A) 23.10 dB
(B) 10 dB
(C) 20.48 dB
(D) 48 dB

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

Q.2 a. A source emits one of five possible symbols s_0, s_1, s_2, s_3 and s_4 with probabilities $\frac{1}{3}, \frac{1}{6}, \frac{1}{4}, \frac{1}{8}$ and $\frac{1}{8}$ respectively. The successive symbols emitted by the source are statistically independent. Find the entropy of the source. **(4)**

b. A discrete memoryless source has an alphabet of five symbols with their probabilities for its output as given below:

Symbol	s_1	s_2	s_3	s_4	s_5
Probability	0.4	0.2	0.2	0.1	0.1

Compute the Huffman code for this source. Hence find the average code word length and the variance of the average code word length. **(8)**

c. A voice- grade channel has a bandwidth of 3.4 KHz. Calculate the channel capacity of the channel for a signal-to- noise ratio of 30 dB Also find the minimum SNR required to support information transmission through the channel at the rate of 4800 bits per second. **(4)**

Q.3 a. State low pass sampling theorem.
The spectrum of a message signal, g(t) is given in Fig.1. Sketch the spectrum of the sampled signal if the sampling frequency is (i) $f_s = 300$ Hz (ii) $f_s = 500$ Hz. **(8)**

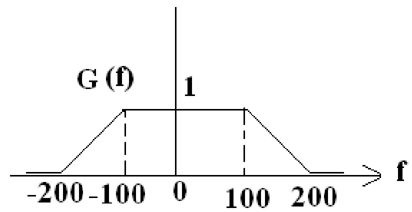

Fig.1

b. Six independent message sources of bandwidths B, B, 2B, 2B, 3B and 3B hertz are to be transmitted on a time- division multiplexed basis using a common communication channel.
(i) Set up a scheme for accomplishing this multiplexing requirement, with each signal being sampled at its Nyquist rate.
(ii) Determine the minimum transmission bandwidth of the channel. **(8)**

Q.4 a. Derive an expression for the quantization noise power of the quantization noise produced by a uniform quantizer in a PCM system. **(6)**

b. Define slope over load error in a delta modulation scheme. Obtain an expression for the no slope over load error condition for the input message signal, $x(t) = A \cos(2\pi f_o t)$. **(6)**

c. A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 56×10^6 bps**.** Find the maximum message bandwidth for which the system operates satisfactorily. **(4)**

Q.5 a. Consider a random binary sequence where bits are statistically independent and equally likely. Determine the power spectral density for the NRZ- polar representation of the sequence. **(8)**

b. The binary data 001101001 is applied to the input of a duobinary system. Construct the duobinary coder output and corresponding receiver output for
(i) Without precoder (ii) With precoder. **(8)**

Q.6 a. In a coherent FSK system, the signals $s_1(t)$ and $s_2(t)$ representing symbols 1 and 0, respectively , are defined by,

$$s_1(t), s_2(t) = A_c \cos\left[2\pi\left(\mathbf{f_c} \pm \frac{\Delta f}{2}\right)t\right],\ 0 \le t \le T_b$$

Assuming fc >> Δ f, show that the correlation coefficient of the signals $s_1(t)$ and $s_2(t)$ is given by, $\rho = \text{sinc}(2\Delta f\, T_b)$. Also find the minimum value of frequency shift Δf for which signal $s_1(t)$ and $s_2(t)$ are orthogonal. **(8)**

b. The binary sequence 1100100110 is applied to a DPSK transmitter. Illustrate the generation of DPSK signal. Sketch the resulting waveform at the transmitter output. During the transmission, due to error this waveform is inverted. Show that the original binary sequence is reconstructed at the receiver output inspite of the inversion. **(8)**

Q.7 a. Consider three signals $s_1(t)$, $s_2(t)$ and $s_3(t)$ shown in the Fig.2. Apply the Gram-schmidt orthogonalization procedure, find a set of orthonormal basis function to represent these signals. Also, express these signals in terms of the set of basis functions. **(8)**

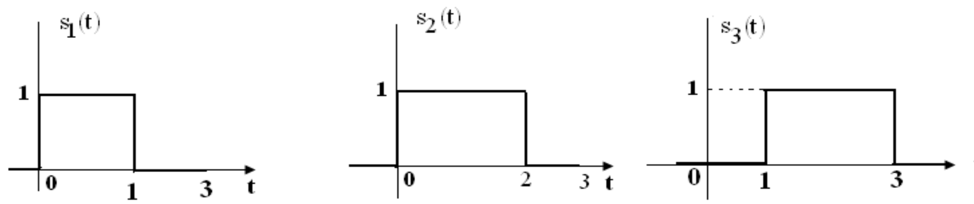

Fig.2

b. Consider the signal s(t) shown in the Fig.3. Determine the impulse response of a filter matched to this signal and sketch it as a function of time. Also, find and plot the matched filter output as a function of time. Choose T = 1 secs. **(8)**

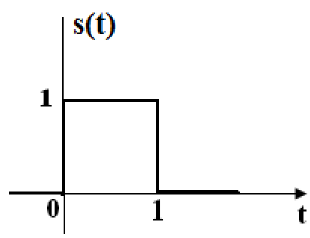

Fig.3

Q.8 a. Explain the properties of maximum-length sequences used in spread spectrum communication. **(6)**

b. Describe the working of a direct-sequence spread binary PSK system with a block diagram of the model of the system. **(6)**

c. What is frequency hop spread spectrum? A slow FH/MFSK system has the following parameters:
Number of bits per MFSK symbol = 4
Number of MFSK symbols per hop = 5
Calculate the processing gain of the system. **(4)**

Q.9 Write explanatory notes on:-

(i) Light wave transmission.
(ii) Diversity techniques in digital radio.
(iii) Advantages of CDMA over TDMA. **(6+6+4)**