Code: A-21 **Subject: DIGITAL COMMUNICATIONS**
ime: 3 Hours **June 2006** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. A must be written in the space provided for it in the answer book supplied and nowhere else.**
- **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 A Choose the correct or best alternative in the following: (2x10)

a. Aliasing occurs, when the Nyquist rate is

(A) 2 f_m **(B)** 3 f_m
(C) 2.5 f_m **(D)** 1.2 f_m

b. If the absolute value of the two representation levels in a one-bit quantizer used in the delta modulation is denoted as 'δ', then the step size of the quantiser will be related to 'δ' by

(A) $\Delta = \delta$ **(B)** $\Delta = \delta^2$
(C) $\Delta = 2\delta$ **(D)** $\Delta = 2.5\delta$

c. For cellular telephones, the telephone industry benchmark for the size of the antenna is

(A) λ **(B)** $\lambda/2$
(C) $\lambda/4$ **(D)** $\lambda/8$

d. The general analytic expression

$$s_i(t) = \sqrt{\frac{2E_i(t)}{T}} \cos[\omega_o t + \phi_i(t)] \quad o \le t \le T \quad i = 1,2,.....M$$

represents

(A) an ASK signalling **(B)** a FSK signalling
(C) a PSK signalling **(D)** an APK signalling

e. For a general case of an M-ary PSK, the relationship between symbol rate R_s and the baseband bit rate R_b is

(A) $R_s = R_b \cdot \log_2 M$ bauds **(B)** $\frac{R_b}{2} \cdot \log_2 M$ bauds

(C) $\frac{Rb}{\log_2 M}$ bauds **(D)** $\frac{\log_2 M}{R_b}$ bauds

f. The redundancy of an (n, k) code is defined as

(A) n/k **(B)** k/n

(C) $\left(\frac{n-k}{n}\right)$ **(D)** $\left(\frac{n-k}{k}\right)$

B State which of the statement is true and which are false.

g. One of the most important metrics of performance in digital communication systems is a plot of frequency versus S/No

h. For two waveforms $s_1(t)$ and $s_2(t)$ to be orthogonal the condition to be satisfied is $\frac{1}{T}\int_{-T}^{+T} s_1(t)\, s_2(t) \cdot dt = 0$.

i. In the study of eye pattern, the sampling time that corresponds to the maximum eye opening yields the smallest protection against noise.

j. Hamming weight of a code word is equal to its hamming distance from the all-ones vector.

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

Q.2 a. Can analog information be character encoded as in the case of textual data for processing with a digital communication system? Comment on your answer. What is sampling process? What is the output of the sampling process called? Justify your answer. What do you mean by 'Nyquist rate'? **(7)**

b. Discuss briefly the sampling theorem using the frequency shifting property of the Fourier transform. **(6)**

c. A 100-Hz sinusoid x (t) is sampled at 240 Hz. Has aliasing occurred? How many full periods of x (t) are required to obtain one period of the sampled signal? **(3)**

Q.3 a. What is the name given to the class of baseband signals obtained by encoding each quantised PAM sample into a digital word? With a sketch for illustration discuss its essential features. **(10)**

b. Consider an audio signal with spectral components limited to the frequency band 300 to 3300 Hz. Assume that a sampling rate of 8000 samples per second will be used to generate a PCM signal. Assume that the ratio of peak signal power to average quantisation noise power at the output needs to be 30 dB.
(i) What is the minimum number of uniform quantisation levels needed? And what is the minimum number of bits per sample needed?
(ii) Compute the bit duration. **(6)**

Q.4 a. When the received waveforms in the case of baseband signalling are already in a pulse-like form, why then is a demodulator required to recover the pulse waveforms? What do you mean by white noise? Whenever a communication channel is designated as an AWGN channel, what is it that you are informed? **(7)**

b. With a neat schematic, describe briefly the typical demodulation and detection functions of a digital receiver. **(9)**

Q.5 a. Distinguish between 'baseband modulation' and 'bandpass modulation'. List the basic coherent bandpass signalling schemes used in digital communication system. **(7)**

b. Illustrate the features of the PSK modulation format and briefly describe the coherent detection of BPSK. **(6)**

c. Show that in a QPSK system, the symbol rate is equal to half the baseband bit rate. **(3)**

Q.6 a. What do you mean by 'probability of symbol error'? Deduce the expression for the probability of bit error for coherently detected BPSK. **(10)**

b. Calculate the bit error probability for a BPSK system with a bit rate of one megabit per second. The received waveforms are coherently detected with a matched filter. Suppose that the single-sided noise power spectral density is 10^{-11} W / Hz and that signal power and energy per bit are normalised relative to a one-ohm load. The signal amplitude is 10 mV. **(6)**

Q.7 a. Mention the two study areas into which channel coding can be partitioned and define each area of study. What does a block code represent? When do you say that a block code is linear? Define a generator matrix for a linear block code. **(9)**

b. Construct the standard array for a (6, 3) block code. **(7)**

Q.8 a. Define the following:

(i) The Hamming weight. (ii) The Hamming distance.

Establish the relations between the Hamming distance between code words and the Hamming weight. **(5)**

b. Write a short note on BCH codes. **(5)**

c. Illustrate a (2,1) convolutional encoder with constraint length of three by the connection pictorial representation and briefly explain. What are the other methods used for representing a convolutional encoder? **(6)**

Q.9 a. What do you mean by spread spectrum technique? What is the use of Low Probability Of Detection (LPD) communication systems? What is the objective in the design of LPD systems? What is a radiometer? **(6)**

b. How does a pseudorandom signal differ from a random one? Why the name 'pseudonoise' is used in spread spectrum technique? What is "direct sequence" as used in SS technique? **(5)**

c. In the figure shown below a bit stream containing traffic data at a rate of R_b converted to have levels of +1 and –1 V corresponding to the logical states '1' and '0' is to be multiplied by a PN sequence also with +1 and –1 V. If the spreading code sequence is 1110100,

i. What is the spreading sequence interms of voltage levels

ii. What is the chip rate and what is the length of the transmitted sequence that results for each data bit?

iii. Illustrate the outgoing spread bit stream interms of voltage levels. **(5)**