Code: A-21 **Subject: DIGITAL COMMUNICATIONS**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x8)

a. The signal to quantizing noise ratio of an 7-bit PCM is

(A) 31.8 dB. **(B)** 37.8 dB.
(C) 43.8 dB. **(D)** 49.8 dB.

b. Hamming Code is one form of

(A) Source coding. **(B)** Cyclic code.
(C) Block code. **(D)** Trellis code.

c. Costas loop is used for

(A) carrier synchronization. **(B)** frame synchronization.
(C) bit synchronization. **(D)** word synchronization.

d. Impulse response of matched filter is

(A) $h(t) = K\,x(T-t)$. **(B)** $h(t) = K\,x(T/t)$.
(C) $h(t) = K\,x(T)$. **(D)** $h(t) = K\,x(t)$.

e. Signaling rate in PCM is

(A) $r = n/f_s$. **(B)** $r = n f_s$.
(C) $r = B_T/f_s$. **(D)** $r = f_s/B_T$.

f. spread spectrum signals are used to achieve

(A) message privacy.
(B) good communication.

(C) good correlation between the signals.
(D) an error free transmission.

g. Frequency Hopping Spread spectrum is usually employed with

(A) ASK. **(B)** SSB.
(C) DM. **(D)** FSK.

h. Adaptive delta modulation is used to remove

(A) attenuation in the transmission. **(B)** granular noise.
(C) quantization noise. **(D)** inter symbol interference.

PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. What are the similarities and differences between the 'Channel coding' and "source coding"? **(8)**

b. Twenty four voice signals are sampled uniformly and then time division multiplexed. The sampling operation uses flat top samples with $1\mu s$ duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of sufficient amplitude and also $1\mu s$ duration. The highest frequency component of each voice signal is 3.4 KHz.

(i) Assuming a sampling rate of 8 KHz, calculate the spacing between successive pulses of multiplexed signal.
(ii) Repeat your calculation assuming the use of Nyquist rate sampling. **(6)**

Q.3 a. The term matched filter is often used synonymously with Correlator. Describe how is that possible when their mathematical operations are different? **(8)**

b. A binary PAM wave is to be transmitted over a baseband channel with an absolute maximum bandwidth of 75 KHz. The bit duration is 10 μs. Find the raised cosine spectrum that satisfy these requirements. **(6)**

Q.4 a. Digital modulation schemes fall into one of the two classes with opposite behaviour characteristics: orthogonal signaling and phase/amplitude signaling. Describe the behaviour of each class. **(8)**

b. Binary data are transmitted over a microwave link at the rate of 10^6 bps and the power spectral density of the noise at the receiver input is 10^{-10} W/Hz. Find the average carrier power required to maintain an average probability of error $P_e \leq 10^{-4}$ for (i) coherent binary PSK and (ii) DPSK. **(6)**

Q.5 a. Describe four types of trade-offs that can be accomplished by using an error correcting code. **(8)**

b. Consider the rate $r = 1/2$, construct length K=2, convolutaional encoder of Fig.1 The code is systematic. Find the encoder output produced by the message sequence 10111. **(6)**

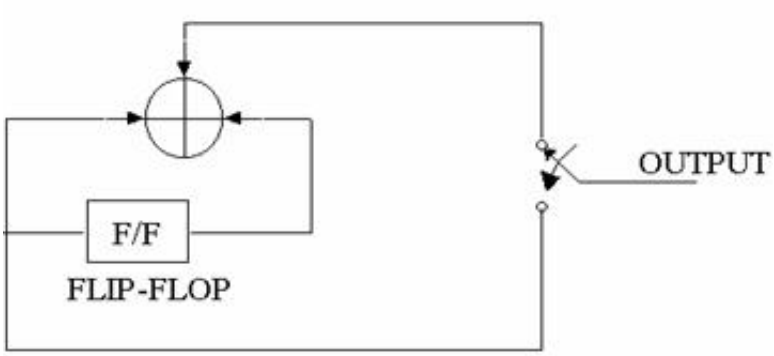

Fig.1

Q.6 a. Explain how spread spectrum systems can reliably receive signals that are "buried in noise". **(8)**

b. A pseudo noise (PN) sequence is generated using a feedback shift register of length m = 6. The chip rate is 10^7 chips/sec. Find the following parameters

(i) PN sequence length.
(ii) Chip duration of the PN sequence.
(iii) PN sequence period. **(6)**

PART II
Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. With a suitable example, discuss the salient features of natural sampling and flat top sampling. **(8)**

b. The binary data stream 001101001 is applied to the input of a duobinary system.

(i) Construct the duobinary coder output and corresponding receiver output, without a precoder.
(ii) Suppose that owing to error during transmission, the level at the receiver input produced by the second digit is reduced to zero. Construct the new receiver output. **(6)**

Q.8 a. Describe the difference between equalizers that use a zero forcing solution and those that use a minimum mean square error solution. **(8)**

b. It is required to transmit telephone messages for a distance of 3000 Km run. The signal level is not to be allowed to drop below 1 mV before amplification and the signal is not to be allowed to be larger than 15 volts in order to avoid amplifier overload. Assuming that repeaters are to be located with equal spacings. How many repeaters will be required, assuming attenuation in the cable 1dB/Km. **(6)**

Q.9 a. With the help of a suitable example, explain the basic concept of DPSK technique of digital transmission. **(8)**

b. Find out the bandwidth required by QPSK signal. **(6)**

Q.10 a. Consider the (5, 1) repetition code with $G = [11111:1]$ and $H = \begin{bmatrix} 1 & 0 & 0 & 0 & : & 1 \\ 0 & 1 & 0 & 0 & : & 1 \\ 0 & 0 & 1 & 0 & : & 1 \\ 0 & 0 & 0 & 1 & : & 1 \end{bmatrix}$. Evaluate the

(i) All five possible single error patterns.
(ii) All 10 possible double error patterns. **(8)**

b. Consider a rate – ½ constraint length –7 convolutional code with free distance $d_{free} = 10$. Calculate the asymptotic coding gain for the following two channels.
(i) Binary symmetric channel.
(ii) Binary input AWGN channel. **(6)**

Q.11 a. How does processing gain parameter differ for direct sequence systems as compared to frequency Hopping systems? **(8)**

b. Describe three randomness properties the make Pseudorandom signals appear to be random. **(6)**