Code: A-21 **Subject: DIGITAL COMMUNICATIONS**

December 2005

Time: 3 Hours

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. The first essential signal processing step is

(A) Source coding. **(B)** Formatting.
(C) Modulation. **(D)** Channel encoding.

b. The outcome of the sampling process is called

(A) PPM **(B)** PWM
(C) PAM **(D)** QAM

c. When pulse modulation is applied to a binary encoder, the resulting binary waveform is called

(A) an ASK waveform **(B)** an AM waveform
(C) a PCM waveform **(D)** a PAM waveform

d. In telephony applications, the PCM waveforms are called

(A) M-ary pulse modulation waveforms
(B) Line codes
(C) DPCM waveforms
(D) ADPCM waveforms

e. For a generator polynomial $g(X) = 1 + X + X^2$ and a message vector 1011, the systematic cyclic codeword generated from the (7, 4) codeword set is

(A) 1011011 **(B)** 1001011
(C) 0111011 **(D)** 1111011

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

f. The filtering at the transmitter and the channel typically do not cause the received pulse sequence to suffer form ISI.

g. A detector that maximises the error probability is known as a maximum likelihood detector.

h. When the receiver exploits knowledge of the carrier's phase to detect the incoming signal, the process is called noncoherent detection

i. BPSK and QPSK signalling have different bit error probability

j. A figure of merit that provides a measure of how vulnerable a system is to interference is the ratio of the noise power spectral density due to the Jammer to the received signal power.

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

Q.2 a. State uniform sampling theorem in two ways. Define the term 'Nyquist rate'. With illustrations, explain the factors that govern the choice of the sampling rate. **(8)**

b. A waveform, $x(t) = 10\cos\left(1000\,t + \pi/3\right) + 20\cos\left(2000\,t + \pi/6\right)$ is to be uniformly sampled for digital transmission

(i) What is the maximum allowable time interval between sample values that will ensure perfect signal reproduction?

(ii) If we want to reproduce one hour of this waveform, how many sample values need to be stored? **(8)**

Q.3 a. Distinguish between PCM and DPCM. With a neat block diagram, explain the operation of a N-tap predictive differential pulse code modulator. **(12)**

b. A signal with correlation coefficient $C_x(1)$ equal to 0.8 is to be quantised with a one-tap LPC filter. Determine the prediction gain when the prediction coefficient is

(i) Optimised with respect to the minimum prediction error.

(ii) Set to unity. **(4)**

Q.4 a. What is a matched filter? Consider that a known signal s (t) plus AWGN n (t) as the input to a linear time-invariant (receiving) filter followed by a sampler. At time t = T, the sampler output Z

(T) consists of a signal component 'a_i' and a noise components 'n_o'. The variance of the output noise is denoted by 'σ_0^2'. Derive the equation for maximum value of the ratio of the instantaneous signal power-to-average noise power at time t = T at the output of the sampler in terms of the input signal energy 'E'. **(12)**

b. Assume that in a binary digital communication system, the signal component out of the correlator receiver is $a_i(T) = +1$v or –1v with equal probability. If the Gaussian noise at the correlator output has unit variance, find the probability of bit error. **(4)**

Q.5 a. What is digital modulation? What will be the type of modulated waveform in the case of

(i) Baseband modulation? (ii) Bandpass modulation?
Define PSK. Write the general analytical expression for PSK. How do you modify the above expression for the binary PSK case? **(8)**

b. Explain the features of a binary correlator receiver for binary detection which uses two correlators. If a system's main performance criterion is bit error probability, which of the following two modulation schemes would be selected for an AWGN channel? Show computations.

(i) Binary noncoherent orthogonal FSK with $\frac{E_b}{N_o} = 13$ dB

(ii)Binary coherent PSK with $\frac{E_b}{N_o} = 8$ dB **(8)**

Q.6 a. Distinguish between coherent detection and noncoherent detection. With a neat schematic, **(8)**

b. In a fast-FH spread spectrum system, the information is transmitted via FSK with non-coherent detection. Suppose N=3 hops/bit, with hard decision decoding of the signal in each hop. Determine the probability of error for this system in an AWGN channel with power spectral density $\frac{N_0}{2}$ and SNR = 13 dB. **(8)**

Q.7 a. What does 'channel coding' refer to? What are linear block codes? Briefly explain the following:
(i) Vector spaces (ii) Vector subspaces. **(10)**

b. The minimum Hamming distance for a particular linear block code is 11. Find the maximum error-correcting capability, the maximum error-detecting capability, and the maximum erasure-correcting capability in a block length. **(6)**

Q.8 a. Explain briefly the following:

(i) Hamming codes. (ii) Extended Golay code. **(8)**

b. Design a feedback shift register encoder for an (8, 5) cyclic code with a generator $g(X) = 1 + X + X^2 + X^3$. Use the encoder to find the codeword for the message 10101 in systematic form. **(8)**

Q.9 a. What are the requirements to be fulfilled by a system to be defined as a spread spectrum system? Briefly, describe the idea behind a spread spectrum 'anti-jam' system. **(9)**

b. What are the goals of a Jammer and a Communicator? What are the assumptions of the communicator in achieving his goals? **(7)**