Code: AE21 **Subject: DIGITAL COMMUNICATIO**
Time: 3 Hours **Max. Marks: 10**

JUNE 2011

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. Which of the following give the maximum probability of error

(A) ASK **(B)** PSK
(C) FSK **(D)** DPSK

b. In PCM quantization noise depends on

(A) Sampling rate **(B)** Number of quantization level
(C) Signal power **(D)** None of the above

c. For a given data rate, the bandwidth required with M-array transmission is smaller than for binary transmission by

(A) $\log_2 M$ **(B)** $\log_2 M/M$
(C) $2/\log_2 M$ **(D)** $\log_2 M/2$

d. Companding is used in PCM to

(A) Reduce bandwidth **(B)** Reduce power
(C) Increase SNR **(D)** Get almost uniform SNR

e. In a digital communication system employing FSK, the 0 and 1 bit are represented by sine waves of 10 kHz and 25 kHz respectively. These waveforms will be orthogonal over a bit interval of

(A) 45 μsec **(B)** 200 μsec
(C) 50 μsec **(D)** 250 μsec

f. Hamming codes can correct

(A) Single error only. **(B)** Two errors only
(C) More than three errors **(D)** Not correct any error

g. ___________ is/are the generator polynomial of (7,4) cyclic codes.

(A) $1+x+x^3$ | **(B)** $1+x^2+x^3$
(C) Both **(A)** and **(B)** | **(D)** None of them

h. A hoping bandwidth of W_{SS} of 400 MHz and a frequency step size of 100 Hz are specified. What is the minimum number of PN chips that are required for each frequency word?

(A) 11 chips | **(B)** 22 chips
(C) 9 chips | **(D)** 1 chip

i. A maximal length n stage linear feedback shift register can produce a sequence with a period number greater than a

(A) 2^n | **(B)** 2^{n-1}
(C) 2^n-1 | **(D)** n

j. PSD of Gaussian noise is

(A) Impulsive | **(B)** Rectangular
(C) Unit step | **(D)** Gaussian

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

Q.2 a. Derive an expression for SNR of a PCM system for a sinusoidal input. A PCM system uses a uniform quantizer followed by a 7 bit binary encoder. The bit rate of the system is 50 Mbps. What is the maximum message bandwidth for which the system operates satisfactorily? What is the SNR for a full load sinusoidal signal? **(8)**

b. Explain DM system. Also discuss the slope overload distortion and granular noise present in it. Find the signal amplitude for the maximum slope overload error in a DM system. If the step size is 1V with a repetition period of 1msec. the information signal frequency of 100 Hz. **(8)**

Q.3 a. We wish to transmit the data sequence 1 1 0 1 0 0 0 1 0 1 1 0 by a binary DPSK. Let $s(t)= A\cos(2\pi f_c t+\theta)$ represent the transmitted signal in any signalling interval of duration T. Give the phase of transmitted signal for the data sequence. Begin with $\theta=0$ for the phase of the first bit to be transmitted. If the data sequence is uncorrelated, determine and sketch the power spectrum density of the signal transmitted by DPSK. **(8)**

b. Compare the coherent and non-coherent modulation schemes. Draw the spectrum, constellation diagram and derive the expression of d_{min} and probability of error for an orthogonal BFSK modulation scheme. **(8)**

Q.4 a. Consider the (31, 15) Reed Solomon code.
(i) How many bits are there in a symbol of the code?
(ii) What is the block length in bits?
(iii) What is the minimum distance of the code?
(iv) How many symbols in the error can the code correct? **(8)**

b. Show that, for any value of β, the raised cosine spectrum given by

$$x(t) = \text{sinc}\,(t/T)\frac{\cos(\pi\beta t/T)}{1-4\beta^2 t^2/T^2}$$

satisfies the Nyquist criterion. **(8)**

Q.5 The generator matrix for a linear binary code is

$$G=\begin{bmatrix} 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

(i) Express G in systematic $[I|P]$ form.
(ii) Determine the parity check matrix H for the code.
(iii) Construct the table of syndromes for the code.
(iv) Determine the minimum distance of the code.
(v) Demonstrate that the code word corresponding to the information sequence 101 is orthogonal to H. **(16)**

Q.6 Write a short note on the following:
(i) ISI
(ii) Duo-binary encoding and modified duo-binary encoding.
(iii) Viterbi algorithm
(iv) Turbo codes. **(16)**

Q.7 a. A matched filter has the frequency response $H(f) = \dfrac{1-e^{-j2\pi fT}}{j2\pi f}$

(i) Determine the impulse response h(t) corresponding to H(f)
(ii) Determine the signal waveform to which the filter characteristic is matched. **(8)**

b. A speech signal is sampled at a rate of 8 kHz, logarithmically compressed and encoded into a PCM format using 8 bit/sample. The PCM data is transmitted through an AWGN baseband channel via M-level PAM. Determine the bandwidth required for transmission when
(i) M=4, (ii) M=8, and (iii) M=16. **(8)**

Q.8 a. Often times, providing more E_b/N_o will not mitigate the degradation due to ISI. Explain why this is the case. **(8)**

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

Q.9 a. Fig.1 shows a four stage feedback shift register. The initial state of register is 1000. Find the output sequence of shift register. Also, verify the run and balance property of PN sequence. **(8)**

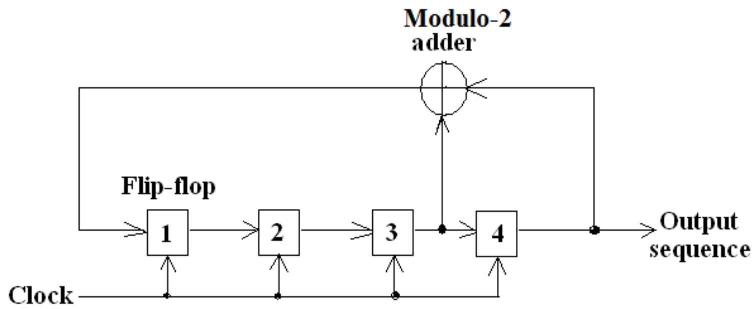

Fig.1

b. A CDMA system consist of 15 equal power users that transmits information at a rate of 10,000 bps, each using a DS spread spectrum signal operating at a chip rate of 1 MHz the modulation is BPSK.

(i) Determine the E_b/N_o, where N_o is the spectral density of the combined interference.
(ii) What is the processing gain?
(iii) How much should the processing gain be increased to allow for doubling the number of users without affecting the output SNR? **(8)**