Code: AE2 **DECEMBER 2008** **Subject: DIGITAL COMMUNICATIONS**
Time: 3 Hc **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.**
- **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: (2x10)

a. For an 8-PSK system with information bit rate of 24 kbps the bandwidth efficiency is

(A) 2 bits per second per cycle of bandwidth
(B) 3 bits per second per cycle of bandwidth
(C) 4 bits per second per cycle of bandwidth
(D) 8 bits per second per cycle of bandwidth

b. A signal is sampled at 8 kHz and is quantised using 8 bit uniform quantizer. Assuming SNR_q for a sinusoidal signal, the correct statement for PCM signal with a bit rate of R is

(A) R = 32 kbps, SNR_q = 25.8 dB **(B)** R = 64 kbps, SNR_q = 49.8 dB
(C) R = 64 kbps, SNR_q = 55.8 dB **(D)** R = 32 kbps, SNR_q = 49.8 dB

c. For a bit rate of 8 kbps, the best possible values of the transmitted frequencies in a coherent binary FSK system are

(A) 16 kHz and 20 kHz **(B)** 20 kHz and 32 kHz
(C) 20 kHz and 40 kHz **(D)** 32 kHz and 40 kHz

d. A sinusoidal signal with peak-to-peak amplitude of 1.536 V is quantised into 128 levels using a mid-rise uniform quantizer. The quantization –noise ratio power is

(A) 0.768 V **(B)** $48 \times 10^{-6}\ V^2$
(C) $12 \times 10^{-6}\ V^2$ **(D)** 3.072 V

e. In QAM scheme _____ of the carrier signal is/are varied

(A) both frequency and amplitude **(B)** both amplitude and phase
(C) both phase and frequency **(D)** only amplitude

f. The T1 carrier system used in digital telephony multiplexes 24 voice channels based on 8 bit PCM. Each voice signal is put through a LPF with the cut off frequency of about 3.4 kHz. The filtered voice signal is sampled at 8 kHz. In addition, a single bit is added at the end of the frame for the purpose of synchronization. What is the duration of each bit for this system?

(A) 0.647 μs **(B)** 0.651 μs
(C) 5.208 μs **(D)** 125 μsec

g. Given the signal m(t) = 10 cos 2000πt cos 8000πt, what is the minimum sampling rate (based on the low pass uniform sampling theorem)

(A) 16 kHz **(B)** 8 kHz
(C) 10 kHz **(D)** 2 kHz

h. What is the output SNR (Signal to Noise Ratio) in a DM system for a 1 kHz sinusoid, sampled at 32 kHz, without slope overload and followed by a 4 kHz post construction filter

(A) 49.8 dB **(B)** 3.11 dB
(C) 24.9 dB **(D)** 29.19 dB

i. A PCM system uses a uniform quantizer followed by a 7-bit encoder. The bit rate of the system is 50Mbits/second. What is the message bandwidth for which the system operates satisfactorily?

(A) 3.57 MHz **(B)** 7.14 MHz
(C) 24.99 MHz **(D)** 50 MHz

j. A slow FH/MFSK system has the following parameters:
The number of bits per MFSK symbol = 4
The number of MFSK symbols per hop = 6
What is the processing gain of the system?

(A) 24 **(B)** 1.5
(C) 0.66 **(D)** 12

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

Q.2 a. With a block diagram explain an adaptive delta modulator transmitter and receiver system. **(8)**

b. Explain A-Law and μ-Law compandor. **(4)**

c. Determine the step size 'δ' required to prevent slope overload noise for the input sinusoidal wave. Also discuss it to take care of granular noise. **(4)**

Q.3 a. Determine the expression of transfer function for matched filter? **(8)**

b. Distinguish between coherent and non-coherent FSK demodulation technique with a neat sketch. **(8)**

Q.4 a. Why do binary phase shift keying (BPSK) and quaternary phase shift keying (QPSK) manifest the same bit-error-probability? **(6)**

b. An ideal voice-band telephone line channel has a bandpass frequency-response characteristic spanning the frequency range 600-3000Hz. **(10)**

(i) Design an M = 4 PSK (quadrature PSK or QPSK) system for transmitting data at a rate of 2400 bits/sec and a carrier frequency

f_c = 1800 Hz. For spectral shaping, use a raised cosine frequency-response characteristic. Sketch a block diagram of the system and describe their functional operation.

(ii) Repeat part (i) if the bit rate R = 4800 bits/sec.

Q.5 a. The bit stream 1 0 1 0 1 0 1 1 1 1 0 1 0 1 0 1 0 0 0 0 1 1 1 1 is to be transmitted using DPSK modulation. Show four different differentially encoded sequences that can represent the data sequence above and explain the algorithm that generated each **(10)**

b. Explain how Inter Symbol Interference (ISI) can be minimized by pulse shaping. **(6)**

Q.6 a. A message consists of English text (assume that each word in the message contains six letters). Each letter is encoded using the 7-bit ASCII character code. Thus, each word of text consists of a 42-bit sequence. The message is to be transmitted over a channel having a symbol error probability of 10^{-3}. **(12)**

(i) What is the probability that a word will be received in error?

(ii) If a repetition code is used such that each letter in each word is repeated three times, and at the receiver, majority voting is used to decode the message, what is the probability that a decoded word will be in error?

(iii) If a (126, 42) BCH code with error-correcting capability of t = 14 is used to encode each 42-bit word, what is the probability that a decoded word will be in error?

b. Explain the difference between source coding and channel coding with example. **(4)**

Q.7 a. List advantages and disadvantages of Spread Spectrum Communication systems. **(4)**

b. Compare the processing gain of DS-SS with FH-SS? **(4)**

c. A m = 10 maximum-length shift register is used to generate the pseudorandom sequence in a DS spread-spectrum system. The chip duration is T_c=1 μsec and the bit duration is T_b=LT_c, where L is the length (period) of the m-sequence. **(8)**

(i) Determine the processing gain of the system in dB.

(ii) Determine the interference margin if the required $E_b / I_o = 10$ and the interference is a tone interference with an average power I_{av}

Q.8 a. With a neat sketch for illustration, briefly explain a rate 1/2 convolutional encoder. **(8)**

b. Write short note on 'Golay Codes'. **(8)**

Q.9 a. Distinguish between Linear block codes and convolutional codes with one example of each. **(4)**

b. Define the following with reference to CDMA technique
(i) DS-SS CDMA Capacity
(ii) PN Sequences **(4)**

c. Explain briefly the BPSK receiver that employs coherent detection, using a block schematic showing the carrier recovery section and the bit timing recovery. **(8)**