## Subject: DIGITAL COMMUNICATIONS

**Time: 3 Hours** **Max. Marks: 10**

## DECEMBER 2010

**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 half an hour 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. The minimum sampling rate for the signal, $x(t) = 10\cos(100\pi t)\cdot\cos(250\pi t)$ is

**(A)** 350 samples/sec **(B)** 250 samples/sec
**(C)** 100 samples/sec **(D)** 500 samples/sec

b. In a binary system the symbol-'0' occurs with a probability $p_o$ and the symbol-'1' occurs with a probability $p_1$. The maximum value for entropy occurs when

**(A)** $p_o > p_1$ **(B)** $p_o < p_1$
**(C)** $p_o = p_1$ **(D)** $p_o$ = zero

c. A Gaussian channel has 2 MHz bandwidth and SNR of 30 dB. The channel capacity is

**(A)** 49.9 Mbits/sec **(B)** 3 Mbits/sec
**(C)** 19.9 Mbits/sec **(D)** 9.9 Mbits/sec

d. A PCM system uses a uniform quantizer of midtread type followed by a 8 bit binary encoder. The signal to quantization noise ratio is

**(A)** 46.2 dB **(B)** 40.8 dB
**(C)** 42.8 dB **(D)** 30.2 dB

e. The minimum transmission bandwidth of the T1 system is

**(A)** 1544 kHz **(B)** 772 kHz
**(C)** 2048 kHz **(D)** 1234 kHz

f. The average probability of symbol error for coherent binary PSK equals

**(A)** $P_e = \frac{1}{2}\text{erfc}\left(\frac{E_b}{N_o}\right)$ **(B)** $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{2E_b}{N_o}}\right)$

**(C)** $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{2N_o}}\right)$ **(D)** $P_e = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_o}}\right)$

g. For the input signal s(t), which is zero outside the interval of $0 < t < T$, the impulse response of a matched filter is

**(A)** $h(t) = s(T - t)$ **(B)** $h(t) = s(T + t)$
**(C)** $h(t) = s(t - T)$ **(D)** $h(t) = T \cdot s(t)$

h. In a QPSK system, if $E_b$ is the signal energy per bit, then transmitted signal energy per symbol, E is given by,

**(A)** $E = E_b$ **(B)** $E = 2E_b$
**(C)** $E = 4E_b$ **(D)** $E = 8E_b$

i. A spread spectrum communication system has the processing gain of 2000 and information bit duration of 4 msec. The PN chip duration is

**(A)** $4\mu$sec **(B)** $2\mu$sec
**(C)** 8 secs **(D)** $0.5\mu$sec

j. In a digital radio, for each voice channel the PCM is used with a bit rate of

**(A)** 8 K b/sec **(B)** 32 K b/sec
**(C)** 16 K b/sec **(D)** 64 K b/sec

---

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

---

**Q.2** a. Explain the Huffman encoding algorithm. Using this algorithm compute the Huffman code for a discrete memoryless source. The source has an alphabet of five symbols with their probabilities given below:

| Symbol | $s_1$ | $s_2$ | $s_3$ | $s_4$ | $s_5$ |
|---|---|---|---|---|---|
| Probability | 0.55 | 0.15 | 0.15 | 0.1 | 0.05 |

Find the coding efficiency. **(10)**

b. Define channel capacity. Derive an expression for the channel capacity of a binary symmetric channel. **(6)**

**Q.3** a. Explain the Quadrature sampling of band pass signals with the help of block diagram. **(8)**

b. The signal $g(t) = 4\cos 300\pi t + 6\cos 750\pi t$ is sampled at a rate of 500 samples/second. Draw the spectrum of the sampled signal. If the sampled signal is passed through an ideal low pass filter having a cutoff frequency 400 Hz, what frequency components will appear at the filter output? **(8)**

**Q.4** a. With the help of block diagram, explain PCM system and also discuss the functions of each block. **(8)**

b. Derive an expression of the SNR of a delta modulator having no slope overload distortion for an input $x(t) = A\cos(2\pi f_o t)$. Assume that the receiver has a post reconstruction low pass filter of bandwidth 'W' such that $(W \geq f_o)$. **(8)**

**Q.5** a. For the binary sequence 01100110 draw unipolar NRZ, AMI, bipolar NRZ and Manchester line codes. **(4)**

b. Define ISI. Derive the Nyquist criterion for distortionless baseband binary transmission in the absence of noise. **(6)**

c. The binary data 01101001 is applied to the input of a precoded duobinary system. Construct the duobinary coder output, and corresponding receiver output. **(6)**

**Q.6** a. Derive an expression for the probability of symbol error for coherent binary FSK system. **(8)**

b. The binary sequence 11001000110 is applied to a DPSK transmitter. Sketch the resulting waveform at the transmitter and receiver end. **(8)**

**Q.7** a. Using the Gram-Schmidt orthogonalization procedure, find a set of orthonormal basis functions to represent the four signals $s_1(t), s_2(t), s_3(t)$ and $s_4(t)$ shown in the Fig.1. Express each of these signals in terms of the set of basis functions. **(8)**

**use T = 3 sec**

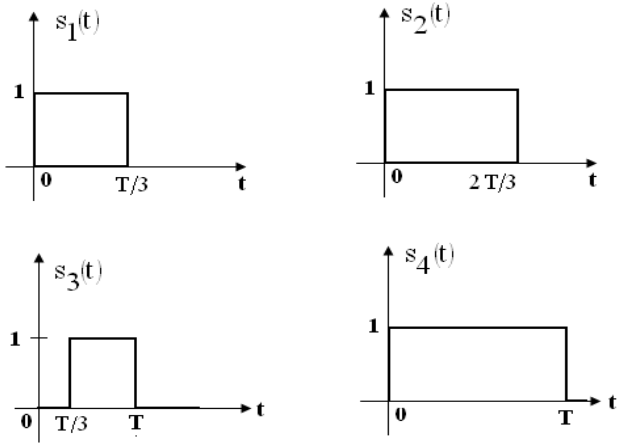


**Fig.1**

b. Ob its properties. **(8)**

**Q.8** a. Define spread Spectrum Modulation Technique. Discuss, how it differs from other digital modulation techniques. Also explain the term Processing Gain and Jamming Margin. **(8)**

b. What is frequency hop spread spectrum? Describe frequency hop spread MFSK system employing slow-frequency hopping technique. **(8)**

**Q.9** Write short notes on:-

(i) The application of waveform coding Techniques.
(ii) CDMA. **(8+8)**