Q.2 a. Explain the following terms:
(ii) Random Event
(iii) Mutually Exclusive Event
(iv) Marginal Probability

Answer: 3.2 of Text Book

b. Binary data are transmitted over a noisy communication channel in blocks of 16 binary digits. The probability that received binary digit is in error due to channel noise is 0.1. Assume that the occurrence of an error in a particular digit does not influence the probability of occurrence of an error in any other digit within the block.

(i) Find the average number of errors per block
(ii) Find the variance of the number of error per block
(iii) Find the probability that the number of errors per block is greater than or equal to 5.

Answer: Solved Example 3.2 of Text Book

Q.3 a. X and Y are two independent random variables, each having a Guassian pdf with a mean of zero and variance of one.

Find $P(|X| > 3)$ **using the value of Q(y) given Q(3) = 0.0013**

Answer: Solved Example 3.3 of Text Book

b. What is a Random Process? X is a Gaussian random variable with $\mu_X = 2$ **and** $\sigma_X^2 = 9$**. Find** $P(-4 < X \leq 5)$**.**

Answer: 3.5 of Text Book

c. Explain: Stationarity, Time Averages & ergodicity

Answer: Page Number 131 of Text Book

Q.4 a. Give an example of a Markoff source. Draw a tree diagram for the same.

Answer: 4.2.4 of Text Book

b. Consider an information source modelled by a discrete ergodic Markoff random process whose graph is shown below in Fig.1.

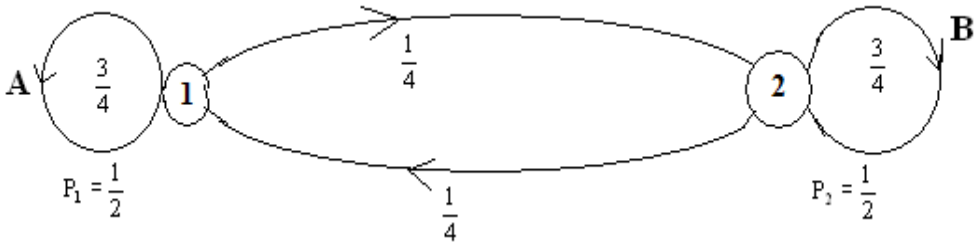

Fig.1

Find the source entropy H and average information content symbol in messages containing one and two symbols i.e. Find G_1 and G_2

Answer: Example 4.4 of Text Book

Q.5 a. What do you understand by source Encoding? State source coding theorem and find the relation between efficiency, entropy and average codeword length.

Answer: 2.2 of Text Book

b. Determine the Huffmen code for the following massage with their probabilities given.

M_1	M_2	M_3	M_4	M_5	M_6	M_7
0.05	**0.15**	**0.2**	**0.05**	**0.15**	**0.3**	**0.1**

Find the average length $\bar{L}$ and the efficiency of the code.

Answer:

M6	0.3	0.0	0.3	0.0	0.3	00	0.3	00	0.4	1	0.6
M3	0.2	1.0	0.2	10	0.2	10	0.3	01	0.3	00	0.4
M2	0.15	101	0.15	010	0.2	11	0.2	10	0.3	01	
M5	0.15	011	0.15	011	0.15	010	0.2	11			
M7	0.1	110	0.1	110	0.15	011					
M1	0.05	1110	0.1	111							
M4	0.05	1111									

Message	Code	No. of bits in the code
M1	1110	4
M2	010	3
M3	10	2
M4	1111	4
M5	011	3
M6	00	2
M7	110	3

$$\bar{L} = \sum_{i=1}^{7} niP(ni)$$

= 4 (0.05+0.05) + 3 (0.15+0.15+0.1) + (0.2 + 0.3) = 2.6 bits

Q.6 a. Explain the c Answer: hannel coding theorem. What is its application to Binary Symmetric channels?

Answer: 2.7 of Text Book

b. Calculate the capacity of a lowpass channel with a usable bandwidth of 3000 Hz and $S/N = 10^3$ at the channel output. Assume the channel noise to be Gaussian and white.

Answer: Page Number 178 of Text Book

Q.7 a. The capacity of a channel with bandwidth B and additive Gaussian band limited white noise is

C = B $\log_2\left(1+\frac{S}{N}\right)$ **bits/sec**

Where S and N are average signal power and noise power, respectively at output of channel.
What is this theorem referred as and what are its two important implications to communication systems?

Answer: 4.6.1 of Text Book

b. A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected to the computer through a voice grade telephone line having a usable bandwidth of 3000 Hz and an output SNR of 10 dB. Assume that terminal has 128 characters and data sent from terminal consist of independent sequences of equiprobable characters.
(i) Find the capacity of channel.
(ii) Find the maximum rate (theoretical) at which data can be transmitted from the terminal to computer without errors.

Answer: Example 4.11 of Text book

Q.8 a. A linear block code with a minimum distance d_{min} can correct upto $[(d_{min}-1)/2]$ errors and detect upto d_{min}-1 errors in each codeword, where $[(d_{min}-1)/2]$ denotes the largest integer no greater than $(d_{min}-1)/2$. Give the proof of this theorem.

Answer: 9.2.2 of Text Book

b. Consider a (7, 4) Linear code whose generator matrix is

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

(i) Find all code vectors of this code
(ii) Find the parity check matrix for this code
(iii) Find d_{min}.

Answer: 8.1 of Text Book

Q.9 a. The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^3$. Find all the code words.

Answer: Example 9.6 of Text Book

b. Explain maximum likelihood decoding of convolutional codes.

Answer: Page Number 407 of Text Book

Text book

Systems Programming and Operating Systems, D.M. Dhamdhere, Tata McGraw-Hill, II Revised Edition, 2005