Fifth Semester B.E. Degree Examination, June/July 2019
Information Theory and Coding

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define information content, entropy and information rate. **(03 Marks)**

b. A card is selected at random from a deck of playing cards. If you are told that it is in red colour, how much information is conveyed? How much additional information is needed to completely specify a card? **(05 Marks)**

c. Prove the maximal property of entropy. **(08 Marks)**

OR

2 a. A DMS has an alphabet X = $\{x_1, x_2, x_3, x_4\}$ with probability statistics $\left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}\right\}$ show that $H(X^2) = 2.H(x)$. **(06 Marks)**

b. For the Markov source shown in Fig.Q.2(b). Find state probability, state entropy and source entropy. Also, write tree diagram to generate message of length 2. **(10 Marks)**

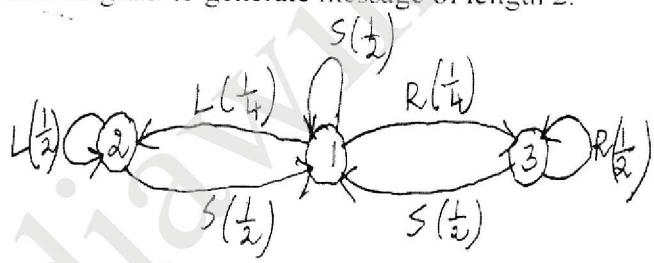

Fig.Q.2(b)

Module-2

3 a. Apply Shannon encoding algorithm and generation codes for the set of symbols $S = \{s_1, s_2, s_3, s_4, s_5, s_6\}$ with probability P = {0.3, 0.25, 0.20, 0.12, 0.08, 0.05}. Find code efficiency and variance. **(08 Marks)**

b. Using Shannon Fano algorithm, encode the following set of symbols and find the P(0) and P(1) {Probability of Zeros and ones}. **(05 Marks)**

Symbol	a	b	c	d	e	f	g
P	0.5	0.25	0.125	0.0625	0.03125	0.015625	0.015625

c. Write the decision tree for the following set of codes and check for KMI property:

S_1	1
S_2	01
S_3	001
S_4	0001
S_5	00001

(03 Marks)

OR

4 a. A DMS has an alphabet of seven symbols with probability statistics as given below:

$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$

$$P = \left\{\frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}\right\}$$

Compute Huffman code for these set of symbols by moving the combined symbols as high as possible. Explain why the efficiency of the coding is 100%. **(08 Marks)**

b. Write a note on Lempel – Ziv Algorithm. **(04 Marks)**

c. Design compact Huffman code by taking the code alphabet X = {0, 1, 2} for the set of symbols $S = \{s_1, s_2, s_3, s_4, s_5, s_6\}$, $P = \left\{\frac{1}{3}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{12}, \frac{1}{12}\right\}$. Find efficiency. **(04 Marks)**

Module-3

5 a. The TPM of a channel is given below. Compute H(x), H(y), H(x/y) and H(y/x)

$$P(xy) = \begin{bmatrix} 0.48 & 0.12 \\ 0.08 & 0.32 \end{bmatrix}$$

(05 Marks)

b. A binary symmetric channel has the following noise matrix. Compute mutual information, data transmission rate and channel capacity if $r_s = 10$ sym/sec

$$P(y/x) = \begin{bmatrix} 1/4 & 3/4 \\ 3/4 & 1/4 \end{bmatrix}$$

$$P(x) = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} \end{bmatrix}$$

(06 Marks)

c. Derive an expression for the data transmission rate of binary Erasure channel. **(05 Marks)**

OR

6 a. An engineer says that he can design a system for transmitting computer output to a line printer operating at a speed of 30 lines/minute over a cabel having bandwidth of 3.5 kHz and $\frac{S}{N} = 30\text{dB}$. Assume that the printer needs 8 bits of data/character and prints out 80 characters/line. Would you believe the engineer? **(06 Marks)**

b. Write a note on differential entropy. **(05 Marks)**

c. Consider a binary symmetric channel whose channel matrix is given by $P(y/x) = \begin{bmatrix} 0.8 & 0.2 \\ 0.4 & 0.6 \end{bmatrix}$. Find channel capacity. **(05 Marks)**

Module-4

7 a. State error detecting and correcting capability of block codes. **(02 Marks)**

b. Consider a linear block code (6, 3). The check bits of this code are derived using the following relations:

$c_4 = d_1 + d_2$

$c_5 = d_1 + d_2 + d_3$

$c_6 = d_2 + d_3$

i) find generator matrix G

ii) find all code words of linear block code

iii) compute error detecting and correcting ability

iv) also find H and H^T. **(07 Marks)**

c. For a linear block code, the syndrome is given by:
$S_1 = r_1 + r_2 + r_3 + r_5$ $S_2 = r_1 + r_2 + r_4 + r_6$ $S_3 = r_1 + r_3 + r_4 + r_7$
i) Find H matrix ii) Draw syndrome calculator circuit iii) Draw encoder circuit. **(07 Marks)**

OR

8 a. A (7, 3) Hamming code is generated using $g(x) = 1 + x + x^2 + x^4$. Design a suitable encoder to generate systematic cyclic codes. Verify the circuit operation for D = [110]. Also, generate the code using mathematical computation. **(08 Marks)**

b. Design a syndrome calculator circuit for (7, 4) cyclic code having the generator polynomial $g(x) = 1 + x + x^3$. Verify the circuit operation using R = [1101001]. Also, perform the relevant mathematical computations. **(08 Marks)**

Module-5

9 a. Write an explanatory note on BCH codes. **(05 Marks)**

b. Consider the (3, 1, 2) convolutional encoder with $g^{(1)} = (110)$ $g^{(2)} = (101)$, $g^{(3)} = (111)$
- i) Find constraint length
- ii) Find rate efficiency
- iii) Draw encoder diagram
- iv) Find the generator matrix
- v) Find the code for the message sequence (11101) using matrix and frequency domain approach. **(11 Marks)**

OR

10 a. For (2, 1, 3) convolutional encoder with $g^{(1)} = (1101)$, $g^{(2)} = (1011)$.
- i) Write state transition table
- ii) State diagram
- iii) Draw the code tree
- iv) Draw the trellis diagram
- v) Find the encoded output for the message (11101) by traversing the code tree. **(10 Marks)**

b. Explain Viterbi decoding. **(06 Marks)**