

# CBCS SCHEME

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15EC54

## Fifth Semester B.E. Degree Examination, June/July 2018 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

- With neat sketch, explain the block diagram of an information system. (04 Marks)
  - Define entropy. State various properties of the entropy. (04 Marks)
  - A code is composed of dots and dashes. Assuming a dash is 3 times as long as a dot and has one-third the probability of occurrence. Calculate:
    - The information in a dot and a dash.
    - The entropy of dot-dash code.
    - The average rate of information if a dot lasts for 10mili seconds and the same time is allowed between symbols. (08 Marks)

OR

- Derive an expression for the entropy of  $n^{\text{th}}$  extension of a zero memory source. (06 Marks)
  - The first order Markoff model shown in Fig.Q.2(b). Find the state probabilities, entropy of each state and entropy of the source. (10 Marks)

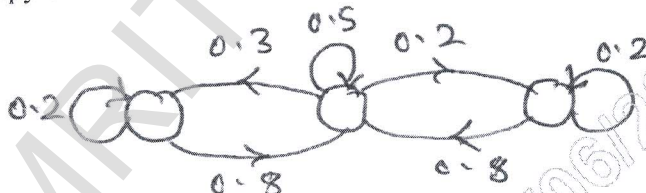


Fig.Q.2(b)

### Module-2

- Apply Shannon's binary encoding algorithm to the following set of symbols given in table below. Also obtain code efficiency. (08 Marks)

Symbols	A	B	C	D	E
P	1/8	1/16	3/16	1/4	3/8

- Consider a source  $S = \{s_1, s_2\}$  with probabilities  $3/4$  and  $1/4$  respectively. Obtain Shannon-Fano code for source  $S$  and its  $2^{\text{nd}}$  extension. Calculate efficiencies for each case. Comment on the result. (08 Marks)

OR

- Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05 and 0.02. Construct Huffman's code and determine its efficiency. (10 Marks)
  - With an illustrative example, explain arithmetic coding technique. (06 Marks)

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- 5 a. Define: i) Input entropy ii) Output entropy iii) Equivocation iv) Joint entropy and v) Mutual information with the aid of respective equations. (04 Marks)
- b. In a communication system, a transmitter has 3 input symbols  $A = \{a_1, a_2, a_3\}$  and receiver also has 3 output symbols  $B = \{b_1, b_2, b_3\}$ . The matrix given below shows JPM. (08 Marks)

$a_i \backslash b_j$	$b_1$	$b_2$	$b_3$
$a_1$	$\frac{1}{12}$	*	$\frac{5}{36}$
$a_2$	$\frac{5}{36}$	$\frac{1}{9}$	$\frac{5}{36}$
$a_3$	*	$\frac{1}{6}$	*
$P(b_j)$	$\frac{1}{3}$	$\frac{14}{36}$	*

- i) Find missing probabilities (\*) in the table.
- ii) Find  $P\left(\frac{b_3}{a_1}\right)$  and  $P\left(\frac{a_1}{b_3}\right)$ .
- c. A transmitter has 5 symbols with probabilities 0.2, 0.3, 0.2, 0.1 and 0.2. Given the channel matrix  $P(B/A)$  as shown below, calculate  $H(B)$  and  $H(A, B)$ . (04 Marks)

$$P(B/A) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1/4 & 3/4 & 0 & 0 \\ 0 & 1/3 & 2/3 & 0 \\ 0 & 0 & 1/3 & 2/3 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

Fig.Q.5(c)

OR

- 6 a. A Gaussian channel has a 10MHz bandwidth. If (S/N) ratio is 100, calculate the channel capacity and the maximum information rate. (04 Marks)
- b. A binary symmetric channel has channel matrix  $P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$  with source probabilities of  $P(X_1) = \frac{2}{3}$  and  $P(X_2) = \frac{1}{3}$ .

- i) Determine  $H(X)$ ,  $H(Y)$ ,  $H(Y/X)$  and  $H(X, Y)$ . (06 Marks)
- ii) Find the channel capacity. (06 Marks)
- c. Find the channel capacity of the channel shown in Fig.Q.6(c) using Muroga's method. (06 Marks)

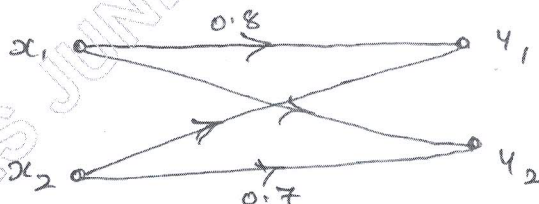


Fig.Q.6(c)

**Module-4**

- 7 a. Distinguish between “block codes” and “convolution codes”. (02 Marks)
- b. For a systematic (6, 3) linear block code, the parity matrix is  $P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ . Find all possible code vectors. (08 Marks)
- c. The parity check bits of a (8, 4) block code are generated by  $c_5 = d_1 + d_2 + d_4$ ,  $c_6 = d_1 + d_2 + d_3$ ,  $c_7 = d_1 + d_3 + d_4$  and  $c_8 = d_2 + d_3 + d_4$  where  $d_1, d_2, d_3$  and  $d_4$  are message bits. Find the generator matrix and parity check matrix for this code. (06 Marks)

**OR**

- 8 a. A (7, 4) cyclic code has the generator polynomial  $g(x) = 1 + x + x^3$ . Find the code vectors both in systematic and nonsystematic form for the message bits (1001) and (1101). (12 Marks)
- b. Consider a (15, 11) cyclic code generated by  $g(x) = 1 + x + x^4$ . Device a feed back shift register encoder circuit. (04 Marks)

**Module-5**

- 9 a. Write a note on BCH codes. (06 Marks)
- b. Consider the (3, 1, 2) convolutional encoder with  $g^{(1)} = (110)$ ,  $g^{(2)} = (101)$  and  $g^{(3)} = (111)$ .
- i) Draw the encoder diagram.
- ii) Find the generator matrix.
- iii) Find the code word for the message sequence (11101). (10 Marks)

**OR**

- 10 a. For a (2, 1, 3) convolutional encoder with  $g^{(1)} = (1101)$ ,  $g^{(2)} = (1011)$ , draw the encoder diagram and code tree. Find the encoded output for the message (11101) by traversing the code tree. (10 Marks)
- b. Describe the Viterbi decoding algorithm. (06 Marks)

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