CBCS SCHEME

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15EC54

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Information Theory and Coding

Time: 3 hrs. Max. Marks: 80

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define entropy and list the properties of entropy. **(04 Marks)**

b. Consider a zero memory source emitting three symbols s_1, s_2 and s_3 with respective probabilities 0.5, 0.3 and 0.2. Calculate: i) Entropy of the source ii) All symbols and the corresponding probabilities of the second order extension. Also, find entropy of extended source iii) Show that $H(s^2) = 2H(s)$. **(08 Marks)**

c. Show that 1 Nat = 1.443 bits. **(04 Marks)**

OR

2 a. Define Markoff source. Explain with typical transition state diagram. **(06 Marks)**

b. For the Markoff source shown in Fig.Q.2(b), find
i) State probabilities
ii) State entropies
iii) Source entropy.

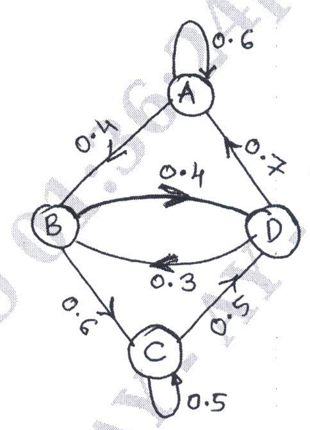

Fig.Q.2(b) **(10 Marks)**

Module-2

3 a. State and prove source coding theorem. **(08 Marks)**

b. Consider a discrete memoryless source with three symbols S = (X, Y, Z) with P = (0.5, 0.35, 0.15)
i) Use Shanon's first encoding technique and find the codewords for the symbols. Also, find the source efficiency and redundancy.
ii) Consider the second order extension of the source. Recompute the codewords, efficiency and redundancy. **(08 Marks)**

OR

4 a. Consider a discrete memoryless source with S = {A, B, C, D} with P = {0.4, 0.3, 0.2, 0.1}. Find the codeword using Huffman coding. Compute efficiency and variance. **(08 Marks)**

b. Write a note on LZ-Algorithm with an example. **(08 Marks)**

Module-3

5 a. Show that **(06 Marks)**

b. For the Joint Probability Matrix (JPM) given, find: i) H(X) ii) H(Y) iii) H(X, Y) iv) H(Y/X) and v) H(X/Y)

$$JPM = P(X, Y) = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \\ x_4 \end{array}\begin{array}{c} \begin{array}{cccc} y_1 & y_2 & y_3 & y_4 \end{array} \\ \begin{bmatrix} 0.2 & 0 & 0 & 0.05 \\ 0 & 0.15 & 0.15 & 0 \\ 0 & 0 & 0.10 & 0.05 \\ 0.10 & 0.10 & 0 & 0.10 \end{bmatrix} \end{array}$$

(10 Marks)

OR

6 a. State and explain Muroga's theorem. **(04 Marks)**

b. Find the capacity of the channel for the channel matrix P(Y/X):

$$P(Y/X) = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array}\begin{array}{c} \begin{array}{ccc} y_1 & y_2 & y_3 \end{array} \\ \begin{bmatrix} 0.2 & 0.5 & 0.3 \\ 0.2 & 0.6 & 0.2 \\ 0.1 & 0.1 & 0.8 \end{bmatrix} \end{array}$$

(08 Marks)

c. Briefly explain Differential Entropy. **(04 Marks)**

Module-4

7 a. Briefly explain the need of parity/redundant bits in the data transmission. Also, explain how errors can be tackled using,
i) FEC (Forward Error Correction) ii) ARQ codes (Automatic Repeat Request Codes). **(06 Marks)**

b. Consider a (6, 3) Linear Block Code (LBC) with generator matrix

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

Find:
i) All codewords
ii) All Hamming weights
iii) Minimum Hamming weight and distance
iv) Parity Check Matrix (PCM)
v) Draw the encoder circuit. **(10 Marks)**

OR

8 a. Explain the syndrome calculation and error detection with the help of neat circuit diagram for cyclic codes. **(06 Marks)**

b. Consider a (15, 7) binary cyclic code with $g(x) = 1 + x^4 + x^6 + x^7 + x^8$
i) Draw the encoder circuit
ii) Obtain the codeword for the input (00111)
iii) Draw the syndrome calculating circuit. **(10 Marks)**

Module-5

9 a. Briefly explain: i) Golay codes ii) BCH codes. (06 Marks)

b. Consider the convolution encoder shown in Fig.Q.9(b).

i) Write the impulse response of the encoder.

ii) Find the output for the message (10011) using time-domain approach.

iii) Find the output for the message (10011) using transform domain approach.

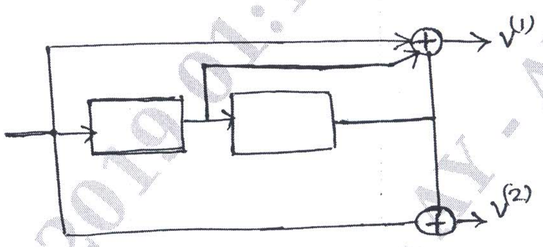

Fig.Q.9(b) (10 Marks)

OR

10 a. Explain various ways to represent convolution codes. (06 Marks)

b. For the convolution encoder $g^{(1)} = 110$, $g^{(2)} = 101$, $g^{(3)} = 111$

i) Draw the encoder block diagram for (3, 1, 2) convolution code

ii) Find generator matrix

iii) Find codewords corresponding to information sequence 11101 using time domain and transform domain approach. (10 Marks)

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