Roll No

Total No. of Pages 3

510401

510401

B. Tech. V - Sem. (Main/Back) Exam., (Academic Session 2021- 2022)

Computer Science & Engineering

5CS3 – 01 Information Theory and Coding

Time: 2 Hours

Maximum Marks: 80
Min. Passing Marks:

Instructions to Candidates:

Part – A: *Short answer questions (up to 25 words) 5 × 2 marks = 10 marks. All **five** questions are compulsory.*

Part – B: *Analytical/Problem solving questions 4 × 10 marks = 40 marks. Candidates have to answer **four** questions out of **six**.*

Part – C: *Descriptive/Analytical/Problem Solving questions 2 × 15 marks = 30 marks. Candidates have to answer **two** questions out of **three**.*

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL

2. NIL

PART – A

Q.1 Write in short about entropy and its properties. [2]

Q.2 What is mutual information? [2]

Q.3 Explain Shannon theorem in short. [2]

Q.4 What are the basic properties of Galois fields (GF)? [2]

Q.5 Compare Block code and Convolutional code. [2]

PART – B

Q.1 Prove the following –

(a) $I(X, Y) = H(X) + H(Y) - H(X, Y)$ [5]

(b) $H(X, Y) = H(Y/X) + H(X)$ [5]

Q.2 A discrete memoryless source X has eight symbols with probabilities 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05 and 0.02. Construct a Shannon-Fano code and calculate the efficiency of the code. [10]

Q.3 (a) A black and white TV picture consists of 525 lines of picture information. Assume that each line consists of 525 picture elements (pixel) and that each element can have 256 brightness levels. Pictures are repeated at the rate of 30 frames/sec. Calculate the average rate of information conveyed by the TV set to a viewer. [6]

(b) Prove that the entropy of the n^{th} extended binary source is given as $H(S^n) = nH(S)$. Where H(S) is entropy of binary source. [4]

Q.4 For a (7, 4) Linear Block Code, the generator matrix G is given by –

$$G = \left[\begin{array}{cccc:ccc} 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{array}\right]$$

(a) Find all the possible valid code vectors. [6]

(b) If the single error has been occurred & received code vector is R= [1 0 1 1 1 0 0]. Find the syndrome & correct code word transmitted. [4]

Q.5 Generator polynomial for systematic cyclic code is $g(x) = 1 + x + x^3$ –

(a) Design the corresponding encoder circuit and explain its operation. [4]

(b) Find systematic cyclic code for message vectors (1 0 0 1) and (1 1 1 1). [6]

Q.6 For generator polynomial $g(x) = x^3+x+1$, find the systematic cyclic codes for following messages – [10]

(a) 1011

(b) 1110

PART – C

Q.1 An analog signal has 4 kHz bandwidth. The signal is sampled at 2.5 times Nyquist rate and each sample is quantized into 256 equally likely levels.

(a) Find the information rate of the source. [4]

(b) Can the output of this source be transmitted without error over the AWGN channel having bandwidth of 50 kHz and (S/N) ratio of 20 dB. [5]

(c) If the output of this source is to be transmitted without errors over the channel having (S/N) ratio of 10 dB. Compute the bandwidth requirement of the channel. [6]

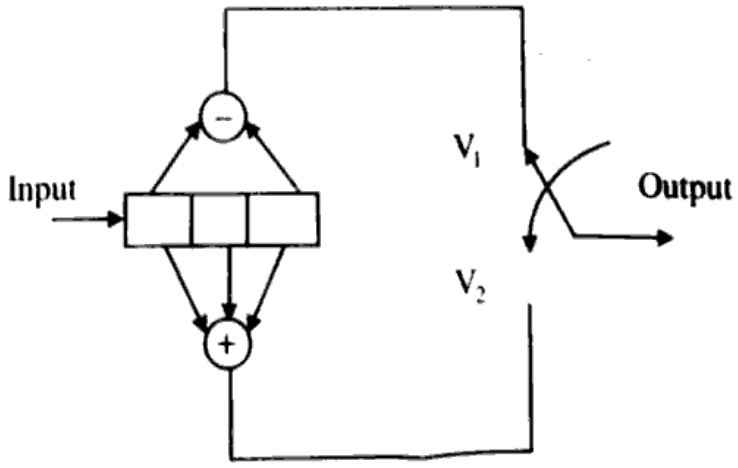
Q.2 A binary symmetric channel has following matrix with source probabilities of $P(x_1) = 2/3$ and $P(x_2) = 1/3$

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

(a) Determine the given entropies H(X), H(Y/X), H(X,Y) and H(Y) [12]

(b) Find mutual information I (X;Y) [3]

Q.3 For the Convolutional encoder given below -



(a) Give the state diagram for it. [5]

(b) Construct the tree diagram. [5]

(c) Give Trellis diagram of coder. [5]
