Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: EC401

Course Name: INFORMATION THEORY & CODING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Find the self information of two messages with respective probabilities 0.1 and 0.9. Comment on the results. (3)

b) Prove that mutual information of a channel is symmetric and always non-negative. (5)

c) Joint probability matrix of a discrete channel is given below: (7)

$$P(X,Y)=\begin{bmatrix}0.3 & 0.2 & 0.1\\ 0.1 & 0.1 & 0.2\end{bmatrix}$$

Determine the different entropies and verify their relationships.

2 a) State and prove noiseless coding theorem. (5)

b) An analog signal is band limited to 3.4 kHz and is sampled at Nyquist rate. The samples are quantized into 4 levels. The quantization levels are assumed to be independent and occur with probabilities $p_1 = 1/2; p_2 = 1/4; p_3 = p_4 = 1/8$. Find the information rate of the source. (4)

c) Find binary Huffman code for random variable S = {s_1, s_2, s_3, s_4, s_5, s_6, s_7, s_8} with probabilities (0.4, 0.25, 0.15, 0.06, 0.05, 0.04, 0.03, 0.02}. Move the combined symbol as high as possible. Find average code word length and efficiency. (6)

3 a) Consider a message ensemble S = {s_1, s_2, s_3, s_4, s_5, s_6} with probabilities P = {1/3, 1/4, 1/8, 1/8, 1/12, 1/12}. Construct a binary code and determine its efficiency using Shannon – Fano coding procedure. (5)

b) Explain binary symmetric and binary erasure channels. Derive the expression for their channel capacities. (10)

PART B

Answer any two full questions, each carries 15 marks.

4 a) What are the properties to be satisfied by a linear block code? Illustrate with an example. (5)

b) What is the capacity of a channel of infinite bandwidth? (5)

c) Define the terms Hamming weight, Hamming distance and minimum Hamming distance with suitable example. (5)

5 a) Explain band width – SNR trade off in a Gaussian channel. (5)

b) For a systematic (7,4) linear block code, the parity matrix P is given by (10)

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

(i) Find all possible valid code vectors. (ii) Draw the encoder circuit. (iii) Draw the syndrome calculation circuit.

6 a) If V is a valid code vector, prove that $VH^T = 0$, where H is parity check matrix. (5)

b) State and prove Shannon – Hartley theorem. (10)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Draw a (2,1,3) encoder with impulse sequences $g^{(1)} = 1011$ and $g^{(2)} = 1111$. Find the generator matrix for the given encoder. Also find the code vector for the message 11010 by time and frequency domain approaches. (12)

b) What is a BCH code? Find the generator polynomial for single, double and triple error correcting BCH code of block length, $n = 15$. (8)

8 a) What are the properties to be satisfied by a cyclic code? (5)

b) For a non-systematic rate ½ code given by $g^{(1)} = 111$ and $g^{(2)} = 101$. Draw the graph, trellis and state diagram. (10)

c) What are the features of Reed-Solomon codes? (5)

9 a) Explain how systematic encoding is achieved in cyclic codes. For a systematic (7, 4) cyclic code, find the code vector corresponding to message $u(x) = 1 + x^3$, generated by $g(x) = 1 + x + x^3$. (10)

b) For a convolutional encoder with generator sequences $g^{(1)} = 100$ and $g^{(2)} = 101$, if the received code word is 00100000010000, find the transmitted code word using Viterbi algorithm. (10)

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