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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Supplementary Examination August 2021

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) Explain Source Coding theorem and Kraft's inequality. (5)

b) A DMS X having five symbols x_1, x_2, x_3, x_4, and x_5 with respective probabilities 0.4, 0.19, 0.16, 0.15, 0.1. Construct Shannon-Fano code and calculate the efficiency and redundancy. (5)

c) Find the capacity of a binary erasure channel. (5)

2 a) Given the messages S_1,S_2,S_3,S_4,S_5 and S_6 with respective probabilities 0.3,0.2,0.15,0.1,0.15 and 0.1.Construct a binary code by applying Huffman coding procedure. Determine the efficiency, redundancy and variance of the code. (8)

b) Write the channel matrix and draw channel diagrams of a binary symmetric channel (BSC) and binary erasure channel (BEC). Find capacities. (7)

3 a) Discuss the conditions that are to be satisfied for a code to be instantaneous. Cite examples. (5)

b) If X and Y are discrete random sources and P(X,Y) is their joint probability distribution and is given as (10)

P(X,Y)=	0.08	0.05	0.02	0.05
	0.15	0.13	0.01	0.09
	0.10	0.05	0.02	0.05
	0.01	0.12	0.01	0.06

Calculate H(X), H(Y), H(X/Y), H(Y/X) and H(X,Y). Verify the formula H(X,Y)=H(X)+H(Y/X).

PART B

Answer any two full questions, each carries 15 marks.

4 a) Discuss the error detecting and correcting capability of block codes. (3)

b) An analog signal has a bandwidth of 4 kHz. The signal is sampled at 2.5 times the (12)

Nyquist rate and each sample quantized into 256 equally likely levels. Assume that successive samples are statistically independent.

(i) Find the information rate of the source.

(ii) Can the output of this source be transmitted without errors over a Gaussian channel of bandwidth 50 kHz and S/N ratio of 20 dB.

(iii) If the output of this source is to be transmitted without errors over an analog channel of S/N ratio 10dB, compute the bandwidth requirement of the channel.

5 a) Explain the trade-off between signal to noise ratio and bandwidth for a continuous 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 the code vectors corresponding to the message vectors [0010], [1100], [1010].

(ii) Draw the encoder circuit.

(iii) A single error has occurred in each of the following received vectors. Detect and correct those received vectors.

(a) R_A = [0111110]

(b) R_B = [1011100]

6 a) Given a (7,4) linear block code whose generator matrix is given by (7)

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

(a) Find the parity check matrix

(b) Find all possible code words

(c) Find d_{min}

b) State Shannon-Hartley Theorem. Discuss its implications. Explain Shannon's Limit. (8)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Explain the encoding procedure for a (n, k) systematic cyclic code using shift registers with relevant diagrams. (7)

b) For a systematic (7,4) cyclic code with generator polynomial $g(X) = X^3+X^2+1$. (8)

Determine the correct codeword transmitted for the following received vectors using syndrome decoding technique (i) 1101101 (ii) 0101000 (iii) 0001100

c) Give the properties of syndrome for cyclic code (5)

8 a) Draw a (3,2,1) convolutional encoder with impulse responses given as $g_1^{(1)}=[1,1]$, $g_1^{(2)}=[1,0]$, $g_1^{(3)}=[1,0]$, $g_2^{(1)}=[0,1]$, $g_2^{(2)}=[1,1]$, $g_2^{(3)}=[0,0]$. Find output for input sequence [1 0 1 0 0 1]. Find the equivalent generator matrix. (15)

b) Discuss perfect codes. (5)

9 a) Generate a (7,4) systematic cyclic code for message words {1000, 1100, 1101, 1111}. Assume a suitable generator polynomial. (8)

b) A convolutional code is described by $g^1 = [100]$, $g^2=[101]$, $g^3=[111]$. (12)

(a) Draw the encoder for the corresponding to this code

(b) Draw state diagram

(c) Decode the transmitted sequence 101001011110111

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