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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Examination June 2022 (2019 Scheme)

Course Code: ECT306

Course Name: INFORMATION THEORY AND CODING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1 A source transmits two independent messages with probabilities p and (1-p) respectively. Prove that the entropy is maximum when both the messages are equally likely and plot the graph for Entropy H. (3)

2 Define (3)

i. Entropy

ii. Information rate

3 State Shannon's second theorem on channel capacity. Give the Positive and Negative statements. (3)

4 Illustrate channel diagram for a Discrete memoryless channel with an example. (3)

5 Differentiate (3)

i. Systematic and non-systematic codes

ii. Linear and non-linear codes

6 For a (7,4) linear block code, the Parity Check matrix is (3)

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

Obtain the Generator matrix

7 The generator polynomial of a (15,7) Cyclic code is, (3)

$G(p) = p^8 + p^7 + p^6 + p^4 + 1$

Find the code vector in Systematic form for the message vector 1101100

8 Explain the various parameters of RS codes? (3)

9 Draw the encoder circuit of a (2, 1, 3) convolutional encoder, if the generator sequences are $g^{(1)}$=(1 0 0 1) and $g^{(2)}$ = (1 1 0 1) respectively. (3)

10 Explain the concept of Tanner graph in LDPC Code? (3)

PART B

Answer one full question from each module, each carries 14 marks.

Module I

11 a) A discrete source emits one of six symbols once in every milliseconds. The source probabilities are $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$ and $\frac{1}{32}$ .Find the source entropy and Information rate. (7)

b) State and prove Kraft's inequality. (7)

OR

12 a) A DMS has 6 codes with probabilities as $p(x_1)=0.25$, $p(x_2)=0.3$, $p(x_3)=0.12$, $p(x_4)=0.2$, $p(x_5)=0.08$ and $p(x_6)=0.05$.Obtain the Huffman codes and find the code efficiency and redundancy. (7)

b) Calculate the information rate of a telegraphy system which uses a dash and dot as symbols. Assume that the dash is twice as long as dot and half as probable. The data last for 0.2 milliseconds and the same interval exists for the pause between the symbols. (7)

Module II

13 a) For the Channel matrix given below, find H(X), H(Y) and H(X,Y). Assume all input symbols are equally likely. (7)

$$P(Y/X) = \begin{bmatrix} \frac{1}{6} & 0 & \frac{2}{3} & \frac{1}{6} \\ 0 & \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & 0 & \frac{2}{3} & \frac{1}{3} \\ \frac{1}{4} & \frac{1}{4} & 0 & \frac{1}{2} \end{bmatrix}$$

b) Explain the relation between differential entropy and entropy. (7)

OR

14 a) Given an AWGN channel with 5 K Hz bandwidth and the noise power spectral density $\eta/2 = 10^{-9}$ W/Hz. The signal power required at the receiver is 0.2 mW. Calculate the capacity of this channel. (7)

b) Derive the capacity of a Binary Symmetric Channel. (7)

Module III

15 a) For a systematic linear block code, the three parity check bits, c_4, c_5 and c_6 are given by: (7)

$c_4 = d_1 \oplus d_2 \oplus d_3$

$c_5 = d_1 \oplus d_2$

$c_6 = d_1 \oplus d_3$

i. Construct the Generator matrix

ii. Decode the received code word 101100.

b) For a (7,4) linear block code, the Generator matrix is (7)

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

i. Find all the codewords.

ii. Comment on the error detection and correction capability.

iii. Draw the encoder circuit

OR

16 a) Write notes on (7)

i. Rings

ii. Finite fields.

b) The Parity check matrix of a (7,4) linear block code is given as (7)

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

Construct the code words and show that this is a Hamming code.

Module IV

17 a) The generator polynomial of a (7,4) Cyclic code is $G(p) = p^3 + p + 1$. Find the code vectors corresponding to the message vectors 1011 and 1101 in Non-Systematic form. (7)

b) Draw the encoder circuit for a (7,4) Cyclic code with $G(p) = p^3 + p + 1$ and obtain the codeword for the message sequence 1001. (7)

OR

18 a) Obtain the generator matrix of a (7,4) Cyclic code for the generator polynomial (7)

$G(p) = p^3 + p^2 + 1$ in Non-systematic form and using that find the codeword for the message vector 1100 and 1111.

b) For a (7,4) Cyclic code, the received vector Y is 1110101 and the generator polynomial is p^3+p+1. Draw the syndrome calculation circuit and correct the single error in the received vector. (7)

Module V

19 a) For a Convolutional encoder, the generator sequences are given as, $g^{(1)} = (1,1,0)$ and $g^{(2)} = (1,0,1)$.Obtain the (7)

a. Code Tree for the message sequence 1011

b. State diagram

b) Explain the Message-passing decoding scheme for LDPC codes. (7)

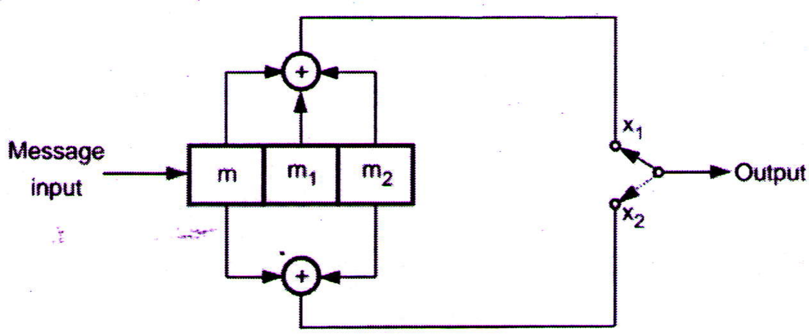
OR

20 a) For a Convolutional encoder, the generator sequences are given as, $g^{(1)} = (1,0,1)$ and $g^{(2)} = (0,1,1)$. (7)

a. Draw the encoder circuit.

b. Output sequence for a message sequence 1011 using Time domain approach.

b) For the convolutional encoder shown in figure , decode the sequence , Y= 11 01 11 00 01 10 using Viterbi algorithm. (7)



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