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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree Supplementary Examination May 2023 (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 Define mutual information. Mention the properties of mutual information. (3)

2 State Shannon's source coding theorem. (3)

3 What is differential entropy? Derive the expression for the entropy of a continuous signals. (3)

4 Draw the channel diagram of Binary Erasure Channel. (3)

5 Define Hamming weight, Hamming distance, d_{min} of a linear block code. (3)

6 If C is a valid code word generated by an (n, k) linear block code with parity check matrix 'H', prove that the product of C and the transpose of 'H' is 0. (3)

7 Explain Hamming code. (3)

8 Find the systematic cyclic code for the data D= [1001] where the generator polynomial for the (7,4) single error correcting cyclic code is $1+x+x^3$. (3)

9 What are convolutional codes? How is it different from block codes? (3)

10 Give notes on tanner graph representation with an example. (3)

PART B

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

Module I

11 a) State and prove Kraft's inequality. (7)

b) Show that the entropy is maximum when all the messages are equally likely. Also derive the expression for maximum entropy. (7

OR

12 a) The five symbols S_1, S_2, S_3, S_4 and S_5 of a source have probabilities 0.4, 0.2, 0.2, 0.1 and 0.1 respectively. Obtain the codewords using Huffman algorithm. (7)

b) Explain prefix property and discuss the test for instantaneous property with an example. (7)

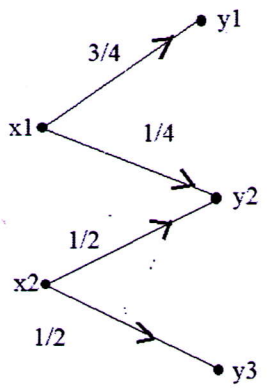
Module II

13 a) Determine the rate of transmission of information through a Binary Erasure Channel? (7)

b) A Gaussian channel has 10MHz bandwidth. If (S/N) ratio is 100, calculate the channel capacity and the maximum information rate. (7)

OR

14 a) Find the mutual information of a channel with channel diagram given below, if $P(x_1) = P(x_2) = ½$. ()



b) Derive the expression for channel capacity of a Gaussian channel with AWGN when bandwidth becomes infinite. (7)

Module III

15 a) For a systematic (6,3) linear block code, the parity matrix P is given by, (7)

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

Find all possible code vectors and draw the encoder circuit.

b) Draw the general syndrome calculation circuit for (n, k) linear block code and explain its operation. (7)

OR

16 a) Consider a (7,4) linear block code whose parity matrix is given by (7)

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

i) Find all code vectors.

ii) Draw the encoder circuit.

b) Draw the complete decoding circuit for the (7,4) linear block code where the syndrome bits are $S=[s_1\ s_2\ s_3]=[(r_1+r_2+r_3+r_5),(r_1+r_2+r_4+r_6),(r_1+r_3+r_4+r_7)]$. (7)

Module IV

17 The generator polynomial of a (15,7) cyclic code is $g(x)=1+x^4+x^6+x^7+x^8$. Find the codeword in systematic form for the message (0101010) using encoder circuit listing the states of registers in each step of code computation. Verify the answer by direct hand calculation. (14)

OR

18 For a (7,4) cyclic code, the received vector Z(x) is 0100101 and the generator polynomial is $g(x)=1+x+x^3$. Draw the syndrome calculation circuit and correct the single error in the received vector. (14)

Module V

19 For a (2,1,3) convolutional encoder, the generator sequences are given as, $g^{(1)} = (1011)$ and $g^{(2)} = (1111)$. (14)

i) Draw the encoder circuit and obtain the state diagram.

ii) Find the output sequence for a message sequence 1101 using Time domain approach.

OR

20 Draw the trellis diagram of (2,1,3) convolutional encoder with impulse response $g^{(1)}=(1011)$ and $g^{(2)}=(1101)$. Also decode the sequence, Y = 110111000110 using Viterbi algorithm. (14)

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