Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S7 (S) Examination Sept 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)	Explain the necessary and sufficient conditions for a code to be instantaneous. Give examples.	(3)
	b)	A zero memory source has a source alphabet, $S = \{s_1, s_2, s_3\}$ with $P = \{0.5, 0.3, 0.2\}$. Find the entropy of the source. Find the entropy of its second extension and verify.	(5)
	c)	Explain the properties of mutual information.	(7)
2	a)	Prove that the entropy of a discrete memory less source S is upper bounded by average code word length L for any distortion less source encoding scheme.	(5)
	b)	Given a binary source with two symbols x_1 and x_2. Given x_2 is twice as long as x_1 and half as probable. The duration of x_1 is 0.3 seconds. Calculate the information rate of the source.	(4)
	c)	Consider a source with 8 alphabets, ***a*** to ***h*** with respective probabilities 0.2, 0.2, 0.18, 0.15, 0.12, 0.08, 0.05 and 0.02. Construct a minimum redundancy code and determine the code efficiency.	(6)
3	a)	Consider a message ensemble $S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\}$ with probabilities $P = \{0.45, 0.15, 0.12, 0.08, 0.08, 0.08, 0.04\}$. Construct a binary code and determine its efficiency using Shannon – Fano coding procedure.	(5)
	b)	Given a binary symmetric channel with $P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$ and $P(x_1) = 2/3; P(x_2) = 1/3$. Calculate the mutual information and channel capacity.	(10)

PART B

Answer any two full questions, each carries 15 marks.

4	a)	Explain the significance of Shannon-Hartley's theorem.	(5)
	b)	Define standard array. How is it used in syndrome decoding? Explain with an example.	(10)

5 a) What are the properties to be satisfied by a linear block code? (2)

b) The parity matrix for a (6,3) systematic linear block code is given by (8)

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

(i) Find all code words. (ii) Find generator and parity check matrix. (iii) Draw encoding circuit. (iv) Draw syndrome circuit.

c) A communication system employs a continuous source. The channel noise is white and Gaussian. The bandwidth of the source output is 10 MHz and signal to noise power ratio at the receiver is 100. (5)

(i) Determine the channel capacity.

(ii) If the signal to noise ratio drops to 10, how much bandwidth is needed to achieve the same channel capacity as in (i).

(iii) If the bandwidth is decreased to 1 MHz, what S/N ratio is required to maintain the same channel capacity as in (i).

6 a) Define the minimum distance of a code. How is it important in error detection and correction? (5)

b) Derive Shannon Limit. (5)

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

PART C

Answer any two full questions, each carries 20 marks.

7 a) What is a perfect code? Explain the features of (7,4) Hamming code. (5)

b) Consider the (7, 4) cyclic code generated by $g(x) = 1 + x + x^3$. Suppose the message $\boldsymbol{u}$ = 1111 is to be encoded. Compute the code word in systematic form. Draw the encoder circuit. (7)

c) Draw a (2, 1, 3) encoder, if the generator sequences are (1 0 0 0) and (1 1 0 1) respectively. Also find the code vector for the input $\boldsymbol{u}$ = 1101 using transform domain approach. (8)

8 a) Draw a convolutional encoder with generator sequences $g^{(1)} = 100$ and $g^{(2)} = 101$. Draw state and Trellis diagrams. (10)

b) Write H matrix for (15, 11) cyclic code using $g(x) = 1 + x + x^4$. Calculate the code polynomial for a message polynomial $d(x) = 1 + x^3 + x^7 + x^{10}$. (10)

9 a) Explain maximum likelihood decoding of convolutional codes. (6)

b) What is free distance of a convolutional code? (6)

c) Explain decoder for cyclic code with the help of a block diagram. (8)

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