Q. Code: 890102

Reg. No. | | | | | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATIONS, MAY 2023

Sixth Semester

EC18014 – INFORMATION THEORY

(Regulation 2018)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	To understand the principles of Information theory	**2**
CO 2	To study the different data compression techniques	**2**
CO 3	To learn the channel classification and capacity.	**2**
CO 4	To gain knowledge on differential entropy and Gaussian channel capacity.	**1**
CO 5	To understand the characterization of Rate Distortion and Gaussian channel	**2**

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	A discrete data source produces messages from the set { S_1,S_2,S_3,S_4} with probabilities $P_1 = ¼$, $P_3 = 1/8$ and $P_4 = 1/8$. Find the entropy.	**1**	**3**
2.	Define mutual Information I(X ;Y).	**1**	**1**
3.	Determine whether the code {0,10,11} is uniquely decodable or not.	**2**	**3**
4.	What are the upper and lower bounds of average code word length?	**2**	**1**
5.	What is Shannon's Channel coding theorem?	**3**	**2**
6.	Write the properties of channel capacity.	**3**	**2**
7.	Write the scaling property of differential entropy.	**4**	**2**
8.	Find the differential entropy of a random variable uniformly distributed from 0 to a.	**4**	**2**
9.	Compare the lossy and lossless compression techniques.	**5**	**4**
10.	Define Rate distortion function.	**5**	**1**

PART- B (5 x 14 = 70 Marks)

			Marks	CO	RBT LEVEL
11. (a)	**(i)**	What are concave and convex functions? Derive the Jensen's inequality for both cases.	**(7)**	**1**	**3**
	(ii)	Find the maximum value of entropy for a random variable X = $\begin{cases} 1 & \text{with probability } p \\ 0 & \text{with probability } 1-p \end{cases}$	**(7)**	**1**	**3**
		(OR)			
	(b)	Consider the table shown where the entry s_i,r_j denotes joint probability $P(X=s_i,Y=r_j)$. Find H(X), H(Y), H(Y/X), H(X/Y) and H(X,Y)	**(14)**	**1**	**3**

	r_0	r_1	r_2
s_0	1/16	3/8	1/16
s_1	1/16	3/16	0
s_2	0	3/16	1/16

12. (a) A discrete memoryless source has an alphabet of seven symbols with probabilities of occurrence as shown below: **(14) 2 3**

Symbol	S_0	S_1	S_2	S_3	S_4	S_5	S_6
Probability	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Obtain the Shannon -Fano code and the Huffman code for this source and compare efficiency of the two coding schemes.

(OR)

(b) **(i)** State and establish Kraft's inequality. **(7) 7 3**

(ii) The code words chosen for a set of symbols S_0,S_1,S_2,S_3 are 1,01,001,000 respectively. Draw the binary tree representation of the code words and check whether it is prefix free or not. **(7) 7 3**

13. (a) Discuss binary symmetric and binary erasure channel. Draw the channel diagrams and derive the expressions for their channel capacities. **(14) 3 3**

(OR)

(b) **(i)** 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) 3 3**

(ii) Discuss the generation and properties of Hamming codes. **(4) 3 3**

14. (a) **(i)** Derive the capacity of a bandlimited Gaussian channel with noise spectral density $\frac{N_0}{2}$ watts/Hz and power P watts. **(14) 4 3**

(OR)

(b) **(i)** Consider a voice graded telephone channel with bandwidth of 3.4 KHz, and output signal power to noise power ratio of 20 dB. The input to the channel has 128 symbols assumed to occur with equal probability and successive transmissions are statistically independent. Calculate the channel capacity and maximum symbol rate for which error free transmission over channel is possible. **(10) 4 3**

(ii) Write the properties of differential entropy. **(4) 4 3**

15. (a) **(i)** How to measure distortion? Explain with two examples. **(4) 5 2**

(ii) Explain the calculation of Rate distortion function for binary source. **(10) 5 2**

(OR)

(b) Explain the calculation of channel capacity and rate distortion function. **(14) 5 2**

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	**CO**	**RBT LEVEL**
16.	Explain the noiseless binary channel with a diagram and transition matrix and find the capacity.	**(10)**	**3**	**2**

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