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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2016

Electronics and Communication Engineering

(Telecommunication Engineering)

01EC6518 Information Theory

Max. Marks : 60 Duration: 3 Hours

(Answer **ANY TWO** questions from each Part)

Part A

1. a) Derive the chain rules for mutual information and relative entropy. (4)
   b) What do you mean by relative entropy? Write the formula for the relative entropy between two probability mass functions p(x) and q(x). (3)
   c) Prove that the relative entropy between two probability density functions is zero if both are the same. (2)

2. a) State and prove Jensen's inequality. (5)
   b) Prove : i) $H(X, Y/Z) \geq H(X/Z)$

   ii) $I(X, Y; Z) \geq I(X; Z)$

   iii) Under what condition the equality holds. (4)

3. a) State and prove Krafts Inequality. (3)
   b) Briefly explain the codes i) Non-singular ii) Uniquely decodable iii) Instantaneous, with an example. (2)
   c) Consider the random variable:

X =

x1	x2	x3	x4	x5	x6	x7
.49	.26	.12	.04	.04	.03	.02

   i) Find a binary Huffman code for X.

   ii) Find the expected code length for X.

   iii) Find a ternary Huffman code for X. (4)

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Part B

4. a) Briefly explain i) typical set ii) high probability sets (2)

   b) State the Asymptotic Equipartition theorem and hence prove it. (3)

   c) State and prove any two properties of typical sets. (2)

   d) Discuss the consequence of AEP. (2)

5. a) State and prove Shannon's channel coding theorem. (6)

   b) Derive the capacity of binary symmetric channel. (3)

6. a) State and prove the source-channel theorem. (6)

   b) Find the capacity and the maximising probability distribution of the channel whose transition matrix is given below: (The input and outputs are binary)

$$Q = \begin{bmatrix} 1 & 0 \\ 0.5 & 0.5 \end{bmatrix}$$ (3)

Part C

7. a) Evaluate the differential entropy for the exponential density, $f(x) = \lambda.e^{-\lambda x}$, $x \geq 0$. (3)

   b) Derive the differential entropy of a normal distribution. (3)

   c) Derive the chain rule for differential entropy. (3)

   d) Prove that $h(aX) = h(X) + \log |a|$ where $h(X)$ represents the differential entropy. (3)

8. a) State and prove the converse to the rate distortion theorem. (7)

   b) Evaluate the rate distortion function for a binary source. (5)

9. a) Briefly explain Shannon limit. A telephone channel which is bandlimited from 300 Hz to 3600 Hz, has a SNR = 33 dB, calculate the capacity of the telephone channel in bits per second. (4)

   b) Explain the water filling in Parallel Gaussian channels. (8)

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