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**MTECH**  
**(SEM I) THEORY EXAMINATION 2024-25**  
**INFORMATION THEORY**

**TIME: 3 HRS****M.MARKS: 70****Note: 1.** Attempt all Sections. If require any missing data; then choose suitably.**SECTION A****1. Attempt all questions in brief.****2 x 7 = 14**

a.	What is the log-sum inequality?
b.	Define joint entropy and provide an example.
c.	What is the Asymptotic Equipartition Property (AEP)?
d.	What is the significance of the typical set in data transmission?
e.	Define the transition matrix of a Markov chain.
f.	What is the Kraft inequality?
g.	What is the significance of a symmetric channel in communication theory?

**SECTION B****2. Attempt any three of the following:****7 x 3 = 21**

a.	Derive the formula for mutual information and explain its significance.
b.	Analyze how AEP affects error correction in communication systems.
c.	Explain the relationship between information entropy and physical entropy using a real-world example.
d.	Explain the difference between fixed-length codes and variable-length codes in the context of data compression.
e.	Explain how channel capacity is calculated for a Gaussian channel and the role of signal-to-noise ratio (SNR).

**SECTION C****3. Attempt any one part of the following:****7 x 1 = 7**

(a)	Prove Jensen's inequality for a convex function and explain its role in probability theory.
(b)	Illustrate the effect of data-processing inequality in an encryption system

**4. Attempt any one part of the following:****7 x 1 = 7**

(a)	Prove the AEP theorem for an i.i.d. random process using Shannon entropy.
(b)	Show how the typical set concept can be used to improve error detection in noisy channels.

**5. Attempt any one part of the following:****7 x 1 = 7**

(a)	Explain the difference between a discrete-time and continuous-time Markov chain with examples.
(b)	Analyze the significance of entropy rate in network communication and graph-based search algorithms.



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**TIME: 3 HRS****M.MARKS: 70****6. Attempt any *one* part of the following:****7 x 1 = 7**

(a)	Describe the steps involved in generating a Huffman code and illustrate this process with an example.
(b)	Describe the concept of a prefix code and explain why it is important for efficient data compression.

**7. Attempt any *one* part of the following:****7 x 1 = 7**

(a)	Compare and contrast symmetric and asymmetric channels in terms of their capacity and error correction strategies.
(b)	Discuss the impact of noise on the channel capacity of a communication system and describe how capacity is calculated for a noisy channel.

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