BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : VII**
BRANCH: ECE **SESSION : MO/18**

SUBJECT: MEC1125 INFORMATION THEORY & CODING

TIME: 3 HRS. **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Consider a DMS with source probabilities {0.30, 0.25, 0.20, 0.15, 0.10}. Find the source entropy, H(X). [2]

Q.1(b) Prove that the entropy for a discrete source is a maximum when the output symbols are equally probable. [4]

Q.1(c) Define mutual information and prove the following equation for chain rule for mutual information [6]

$$I(X_1,X_2,\ldots..X_n;\ Y) = \sum I(X_i;Y|X_{i-1},X_{i-2},\ldots\ldots X_1);\ \text{where } i=1 \text{ to } n.$$

Q.2(a) Define prefix coding with an example. [2]

Q.2(b) Determine the minimum information rate necessary to represent the output of a discrete time, continuous memoryless Gaussian source with known variance considering a mean square-error distortion measure per symbol. [4]

Q.2(c) Consider Lempel Ziv encoding for quaternary data (symbols: 0, 1, 2, 3). Encode the following quaternary data: 1 3 3 0 0 2 0 2 1 1 1 3 0 0 0 0 2 2 1 2 2 2 3 3. What is the compression ratio obtained? [6]

Q.3(a) Define Binary Erasure Channel. [2]

Q.3(b) Find the overall channel capacity of three cascaded BSC channels with transition probabilities 0.0, 0.2 and 0.3 respectively. [4]

Q.3(c) Discuss the channel capacity for MIMO system. [6]

Q.4(a) Explain Hamming code. [2]

Q.4(b) Provide the basic conditions for a perfect code and a maximum distance separable code. Consider the polynomials $\mathbf{f(x)=2+x+x^2+2x^4}$ and $\mathbf{g(x)=1+2x^2+2x^4+x^5}$ over GF(3). Then determine **f(x) + g(x).** [4]

Q.4(c) What is the order of Galois extension field $\mathbf{GF(2^4)}$? In the same field compute $\alpha^{17} \times \alpha^{15}$ in terms of their field elements. Prepare table for multiplicative inverse and additive inverse of $\mathbf{GF(2^2)}$ with irreducible polynomial $\mathbf{x^2 + x + 1}$. [6]

Q.5(a) Briefly explain BCH code. [2]

Q.5(b) For nonsystematic coding in (7, 3) cyclic code (under GF (2)) with generator polynomial $g(x) = (1+x)(x^3+x+1)$ Generate all possible codewords and determine parity check matrix, H. [4]

Q.5(c) For (7, 3) code the generator polynomial of a systematic coding is given as: $\mathbf{g(x)=x^4+x^3+x^2+1}$. Let the message vector is, m = (1, 0, 1) then determine the code vector. Also design the corresponding encoder. [6]

Q.6(a) Define constraint length of a convolutional encoder. [2]

Q.6(b) Describe Viterbi decoding of convolutional codes with its advantages. [4]

Q.6(c) For the rational systematic encoder with matrix transfer function [6]

$$G(x) = \begin{bmatrix} 1 & 0 & \dfrac{1+x}{1+x^3} \\ 0 & 1 & \dfrac{x^2}{1+x^3} \end{bmatrix}$$

Determine the code rate and draw the systematic convolutional encoder along with its state diagram.

Q.7(a) Elaborate Caesar cipher with an example. [2]

Q.7(b) What is the difference between a message authentication code (MAC) and one-way hash function. [4]

Q.7(c) Explain public key cryptography with a suitable example. [6]

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