Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (OLD) EXAMINATION – WINTER 2016

Subject Code: 710402N **Date:18/11/2016**

Subject Name: Information Theory and Coding

Time:10:30 Am to 1:00 Pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Is the following code uniquely decodable? Is it instantaneous? Can you decide unique decodability of the code by using Kraft's inequality? **07**

A….	01	D….	1000
B….	011	E….	1100
C….	10	F….	0111

Justify the statement with proof "For every uniquely decodable code there exists an instantaneous code with the same lengths of codewords.

(b) Find binary Huffman codes for the source consisting of two symbols A and B, if A appears four times as often as B. Also find Huffman code for its second order extension and explain how extension of source affects the entropy of the source and efficiency of the code. **07**

Q.2 **(a)** Derive expression for mutual information to find the capacity of discrete memory-less channel. What is the channel capacity of binary symmetric channel with error probability p=0.01? **07**

(b) Answer the following questions: (4+3 Marks) **07**

1 Construct a ternary instantaneous code for the following source alphabet with the prescribed lengths of code words:

Symbol	A	B	C	D	E	F	G	H	I	J
Length	1	3	3	3	3	3	2	2	2	2

Is it possible to add a new source symbol and extend the given code to an instantaneous code (with the same code alphabet)? Justify.

2 What is difference between information and data? For an M-ary source, what distribution of probabilities maximizes the information content of source? Also prove it.

OR

(b) Answer the following questions: (4+3 Marks) **07**

1 Prove that for each information source, the average length $L_{min}(S)$ of a binary Huffman code is related to the entropy H(S) by

$$H(S) \leq L_{min}(S) \leq H(S) + 1$$

2 Discuss Shannon's fundamental theorem for channel capacity.

Q.3 **(a)** For a (7,4) systematic linear block code, the three parity-check digits p_5, p_6, and p_7 are **07**

$$p_5 = d_1 + d_2 + d_3$$
$$p_6 = d_1 + d_2 + d_4$$
$$p_7 = d_1 + d_3 + d_4$$

1 Construct the appropriate generator matrix for this code.

2 Construct the code generated by this matrix.

3 Prepare a decoding table (use syndrome decoding method).

(b) What are the properties of linear codes? Write note on standard array and error detection and correction of the linear block codes. **07**

OR

Q.3 **(a)** Verify that the binary cyclic code of length 7 with the generator polynomial $g(x)=1+x^2+x^3$ is a Hamming code. Construct a systematic (7, 4) cyclic code using the generator polynomial $g(x)=1+x^2+x^3$ **07**

(b) State properties of cyclic codes. What are the advantages of cyclic codes over linear block codes? Explain decoding of cyclic codes with suitable example. **07**

Q.4 **(a)** Find the generator polynomial g(x) for a binary BCH code of blocklength 31. Use the primitive polynomial $p(x)=x^5+x^2+1$ to construct GF(32). **07**

(b) Answer the following questions: (4+3 Marks) **07**

1 Give differences between public key and private key encryption.

2 Explain any one method for Burst-error correction.

OR

Q.4 **(a)** Explain why Reed-Solomon codes do so well in a bursty-noise environment. Construct a single-error correcting Reed-Solomon code with blocklength 7. **07**

(b) Answer the following questions: (4+3 Marks) **07**

1 Draw a code tree for the convolutional coder having:
Constraint length = 3, $v_1 = s_1+s_2+s_3$ & $v_2 = s_1+s_3$.
Where s_i = i^{th} stage of shift register and v_i = i^{th} modulo-2 adder output.

2 Write properties of Hamming codes and extended Hamming codes. Find Hamming code for parity check bits m=5.

Q.5 **(a)** What is limitation of Viterbi algorithm for decoding Convolutional codes? Explain Wozencraft decoding method for convolutional codes. **07**

(b) What is Knapsack problem? Explain any one public-key cryptosystem. **07**

OR

Q.5 **(a)** Explain the JPEG standard for lossless image compression. **07**

(b) Explain Arithmetic Coding with a suitable example. **07**

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