Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2013

Subject code: 710402N **Date: 26-12-2013**

Subject Name: Information Theory & Coding

Time: 10.30 am – 01.00 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)** Prove McMillan's theorem. Is the following code uniquely decodable? Justify your answer. **07**

A….	1010	D….	0001
B….	001	E….	1101
C….	101	F….	1011

(b) Answer the following questions: **07**

1 Construct a binary 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	K	L
Length	2	4	7	7	3	4	7	7	3	4	7	7

2 Discuss Shannon's fundamental theorem for channel capacity.

Q.2 **(a)** A zero-memory source consists of symbols A and B. If A appears nine times more often than B, find the optimum (Huffman) binary code for this source as well as for its third-order extension. Determine the code efficiency in each case. **07**

(b) Prove following statements: **07**

1 Entropy for a discrete source is a maximum when the output symbols are equally probable.

2 Every binary instantaneous code of a source S has the average length larger or equal to the entropy of S.

OR

(b) Describe the steps to find the capacity of discrete memoriless channel with an arbitrary number of inputs and determine the capacity of a binary symmetric channel of error probability p. **07**

Q.3 **(a)** Discuss the properties of Hamming codes. Find a generator matrix G for a (15,11) single error correcting linear block code. **07**

(b) What are the properties of linear codes? For a (7,4) linear block code, the generator matrix G is given by **07**

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{bmatrix}$$

1 Construct the code table generated by this matrix.

2 Write the parity check matrix for the code and prepare a decoding table (use syndrome decoding method).

OR

Q.3 **(a)** Write down properties of BCH codes and describe (15, 7) BCH code. **07**

(b) 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 $g(x)=1+x^2+x^3$ and draw a systemic encoder for the Hamming code. **07**

Q.4 **(a)** What are the advantages of cyclic codes? Explain decoding of cyclic codes. **07**

(b) Find ternary (three code symbols) Huffman code for the source shown below: **07**

Symbol	A	B	C	D	E	F	G	H
Prob.	0.1	0.2	0.1	0.3	0.05	0.1	0.05	0.1

Find the smallest number of code symbols necessary to construct an instantaneous code of average length $L \leq 1.5$ for the source.

OR

Q.4 **(a)** Explain Shannon-Fano code with a suitable example. **07**

(b) Write short note on Reed-Solomon codes. **07**

Q.5 **(a)** What is meant by maximum–likelihood decoding? Explain Viterbi's algorithm for decoding Convolutional codes. **07**

(b) Answer the following questions: **07**

1 What are the advantages of Wozencraft's sequential decoding algorithm over Viterbi's decoding algorithm for convolutional codes?

2 Make a distinction between secret-key encryption and public key encryption.

OR

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

(b) Explain the principles of public key cryptography and explain any one public-key cryptosystem. **07**

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