Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2710502 Date:19/05/2016

Subject Name: Information Theory and Coding

Time:02:30 pm to 05:00 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)** State and prove *Kraft's inequality* and *McMillan's Theorems.* **07**

(b) Assign two different binary instantaneous codes to the five symbols s1, s2, s3, s4 and s5. Draw the decoding trees for the same. Which one is a better assignment? Justify your answer. **07**

Q.2 **(a)** A zero memory source emits messages m1 and m2 with probabilities 0.8 and 0.2 respectively. Find the optimum (Huffman) binary code for this source as well as for its second and third order extensions (that is for N=2 and 3). Determine the average length (L_{avg}) in each case. **07**

(b) A source emits seven symbols with probabilities 1/2, 1/4, 1/8, 1/16, 1/32, 1/64 and 1/64 respectively. Find the entropy of the source. Design the Shannon-Fano and Huffman codes for the source. Find the average length, efficiency and redundancy of both the codes. **07**

---------- OR ----------

(b) Encode the message sequence *"ECDGCE"* using Arithmetic coding for the symbols with following probabilities: **07**

Symbol	A	B	C	D	E	F	G
Length	0.1	0.2	0.1	0.3	0.05	0.1	0.15

Q.3 **(a)** Define *entropy* of an information source. Enlist and explain, briefly, some important properties of entropy. Discuss the conditions for *maximum* and *minimum* entropy. **07**

(b) Which (n, k) Hamming code will be designed for m = 4? Assign the codewords to messages 01010101010 and 00110011001. **07**

---------- OR ----------

Q.3 **(a)** Define the terms: *reliability, repetition code.* Let a binary symmetric channel which corrupts one symbol in a thousand (i. e. *p = 0.001* and *q = 0.999)*. Find the error probability (P_{err}) for binary repetition codes K_3 and K_5. **07**

(b) For a binary symmetric channel (BSC), find H(X), H(Y), H(X|Y), H(Y|X) and I(X, Y). Let $P(y_1|x_1) = 2/3$, $P(y_2|x_1) = 1/3$, $P(y_1|x_2) = 1/10$, $P(y_2|x_2) = 9/10$, $P(x_1) = 1/3$ and $P(x_2) = 2/3$. **07**

Q.4 **(a)** Consider the linear block code with the codeword defined by: **07**

U = m1 + m2 + m4 + m5, m1 + m3 + m4 + m5, m1 + m2 + m3 + m5, m1 + m2 + m3 + m4, m1, m2, m3, m4, m5.

i. Find the Generator and parity check matrices.

ii. Prepare the syndrome look-up table for this code.

iii. Are received codevectors 011110101 and 100011001 correct? If incorrect, locate the error positions.

(b) Draw the diagram of an encoder for systematic cyclic code and explain cyclic code generation in detail. Also explain the decoding procedure. **07**

---------- OR ----------

Q.4 **(a)** Design two different feedback shift register circuits for a cyclic code having an 8-bit codeword length. Encode the messages 110 and 11010 using these circuits. **07**

Q.4 **(b)** Compare the Viterbi and Sequential decoding algorithms for a Convolutional code stating their advantages and limitations. **07**

Q.5 **(a)** For a rate ½ Convolutional encoder with constraint length, K = 3, the connection vectors are given as: g1 = 1 0 1 and g2 = 0 1 1. Find the (i) impulse response of the encoder and (ii) draw the state diagram, tree diagram and trellis diagram for the same. **07**

(b) Describe the decoding procedure for the BCH codes. **07**

---------- OR ----------

Q.5 **(a)** Describe the data encryption standard *(DES) encryption* procedure. **07**

(b) Explain the Reed-Solomon (RS) encoding and decoding procedure. **07**

****