F 3334 (Pages : 4) Reg. No.................................

Name.................................

B.TECH. DEGREE EXAMINATION, NOVEMBER 2014

Seventh Semester

Branch : Electronics and Communication Engineering

EC 010 702—INFORMATION THEORY AND CODING

(New Scheme—2010 admission onwards)

[Regular/Supplementary]

Time : Three Hours Maximum : 100 Marks

Part A

Answer **all** *questions.*
Each question carries 3 marks.

1. Define self information and mutual information.
2. What is ZIP coding ? Give an example.
3. Express the entropy of a binary symmetric channel and sketch its diagram.
4. Define dual or null of a given matrix.
5. What is an interleaver ? Give *two* examples.

(5 × 3 = 15 marks)

Part B

Answer **all** *questions.*
Each question carries 5 marks.

6. Define joint and conditional entropies and give the relationship between the two.
7. State and explain Kraft's inequality.
8. Give the expression relating bandwidth and signal to noise ratio. Explain the trade-off between the two for a Gaussian noise channel.
9. Construct a Galois field GF (2^3) using the primitive polynomial $P(X) = 1 + X + X^3$. Give the 3-tuple representation also.
10. List the characteristics of a BCH code. Also write down the format of its G and H matrices.

(5 × 5 = 25 marks)

Turn over

Part C

Answer **all** *questions.*
Each question carries 12 *marks.*

11. (a) (i) Derive the maximal property of entropy of a discrete memoryless source. (6 marks)

(ii) Show that, mutual information :

$$I(X, Y) = H(X) + H(Y) - H(X,Y).$$

(6 marks)

Or

(b) Consider two sources S_1 and S_2 emits messages x_1, x_2, x_3 and y_1, y_2, y_3 with joint probability P (X, Y) as given below. Find H (X), H (Y), H (X | Y), H (Y | X) and I (X ; Y) and verify the relationship between them.

$P(X,Y)$ (X \ Y)			
	$3/40$	$1/40$	$1/40$
	$1/20$	$3/20$	$1/20$
	$1/8$	$1/8$	$3/8$

(12 marks)

12. (a) An information source produces sequences of independent symbols A, B, C, D, E, F, G with corresponding probabilities $\frac{1}{3}, \frac{1}{27}, \frac{1}{3}, \frac{1}{9}, \frac{1}{9}, \frac{1}{27}$ and $\frac{1}{27}$. Construct a binary code and determine its efficiency and redundancy using :

(i) Shannon Fano coding procedure.

(ii) Huffman coding algorithm.

(12 marks)

Or

(b) (i) Explain algorithm used for arithmetic coding. (6 marks)

(ii) Using the above algorithm, encode the text 'COMMUNICATION'. Sketch the splitting stage diagrams, and draw the encoding table.

(6 marks)

13. (a) (i) Define channel capacity. Derive it for a binary symmetric channel. (8 marks)

(ii) Calculate capacity of a low-pass channel with a suitable bandwidth of 3 kHz and $S/N = 10^3$, at the channel output. Assume channel noise to be white Gaussian.

(4 marks)

Or

(b) (i) A Gaussian channel has 10 MHz bandwidth. If S/N ratio is 100, find channel capacity and maximum information rate.

(6 marks)

(ii) A voice-grade channel of a telephone network has a bandwidth of 3.4 kHz. Calculate the channel capacity of the channel for S/N ratio of 30 dB. Find the minimum S/N ratio required to support information transmission through the telephone channel at the rate of 4800 bits/sec.

(6 marks)

14. (a) The generator matrix G of *a* (7, 3) linear block code is given below :

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

(i) Write H-matrix.

(ii) Write all possible code words in systematic format and its d_{min}.

(iii) Sketch the encoder logic diagram.

(iv) Explain the decoding method of a received code 0011011.

(12 marks)

Or

(b) Define the following :

(i) Irreducible polynomial.

(ii) Primitive polynomial.

(iii) Minimal polynomial.

(iv) Check whether $P(X) = 1 + X + X^3$ is a primitive polynomial.

(12 marks)

15. (a) (i) Explain the method of generating the generator polynomial of (n, k) cyclic code. Hence find it for (7, 4) cyclic code.

(4 marks)

(ii) Using $g(X) = 1 + X^2 + X^3$, find the output code word for the message vector 0111 in systematic and non-systematic format, for a (7, 4) cyclic encoder.

(4 marks)

(iii) Explain syndrome decoding and sketch the logical diagram, to decode the above code word. Take the second bit of $r(X)$ is in error.

(4 marks)

Or

(b) Sketch a (2, 1, 4) convolution encoder with rate $\frac{1}{2}$ and constraint length 4. Given that $g^{(1)} = 1011$ and $g^{(2)} = 1111$.

(i) Find the output for the message sequence 11011.

(ii) Describe the Viterbi decoding for the above encoder, using the Trellis diagram.

(12 marks)

[5 × 12 = 60 marks]