SPECIAL SUPPLE B.TECH/ECE/7TH SEM/ECEN 4102/2018

CODING AND INFORMATION THEORY
(ECEN 4102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Entropy is
(a) average information per message
(b) information in a signal
(c) amplitude of signal
(d) all of the above.

(ii) If m = 4, then what will be the length of the BCH code?
(a) 16 (b) 17 (c) 15 (d) None.

(iii) For a GF (q^m), q stands for?
(a) no of field elements
(b) no of element in base field
(c) degree of the polynomial used to construct the field
(d) none of above.

(iv) The rate of a block code is the ratio of
(a) block length to message length
(b) message length to block length
(c) message weight to block length
(d) none.

(v) For GF (2^3) the elements in the set are
(a) { 1,2,3,4,5,6,7,8} (b) { 0,1,2,3,4,5,6,7}
(c) {0,1,2,3,4,5,6 } (d){ 1,2,3,4}.

(vi) In a (7,4) block code the number of valid code words is
(a) 15 (b) 16 (c) 7 (d) 4.

(vii) A code with minimum distance $d_{min} = 5$ can correct — number of bits.
(a) 4 (b) 3 (c) 2 (d) 1.

(viii) The Hamming distance between V = 101011001 & W = 110111010 is
(a) 4 (b) 5 (c) 6 (d) None.

(ix) Information contain (in bit) in an event with probability 0.5 is
(a) 0.5 (b) 1 (c) 0.693 (d) None.

(x) The order of α^3 in GF (2^4) is
(a) 4 (b) 5 (c) 6 (d) None.

Group – B

2. (a) Define Entropy, Mutual information, Noiseless Channel and Information rate.

(b) A discrete source emits one of 5 symbols once every millisecond with probabilities $P(x_1) = 0.4$, $P(x_2) = 0.19$, $P(x_3) = 0.16$, $P(x_4) = 0.15$ and $P(x_5) = 0.1$. Determine the source entropy and information rate.

(4 × 2) + 4 = 12

3. (a) A discrete memoryless source has seven symbols x_1, x_2, x_3, x_4, x_5, x_6 and x_7 with probabilities of occurrence $P(x_1) = 0.05$, $P(x_2) = 0.15$, $P(x_3) = 0.2$, $P(x_4) = 0.05$, $P(x_5) = 0.15$, $P(x_6) = 0.3$ and $P(x_7) = 0.1$.
Construct the Huffman code and determine
(i) Entropy
(ii) Average code length
(iii) Code efficiency.

(b) Repeat the same for Shanon Fano code & compare the results.

6 + (5 + 1) = 12

Group – C

4. (a) For a (7, 4) systematic linear block code, the three parity check bits c_4, c_5 & c_6 are formed following the equations:
$C_4 = d_1 \oplus d_3 \oplus d_4$, $C_5 = d_1 \oplus d_2 \oplus d_3$, $C_6 = d_1 \oplus d_2 \oplus d_4$ [Where C & d have their usual meaning]
(i) Write down the generator matrix.
(ii) Construct code words for $i_1 = [1011]$, $i_2 = [1101]$, $i_3 = [1110]$.

(b) Suppose that the received word is 0101110. Decode this received word by finding the location of the error if any & the transmitted data.

(3 + 3) + 6 = 12

5. (a) Define the terms Code length, Code efficiency and redundancy.

(b) Determine the parity-check matrix of the (6,3) linear code for the generator matrix

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

6 + 6 = 12

Group – D

6. (a) For a systematic (7, 3) cyclic code determine the generator matrix and parity check matrix if $g(x) = x^4 + x^3 + x^2 + 1$.

(b) A code word polynomial c(x) belonging to the (7, 4) cyclic code with $g(x) = 1 + x + x^3$ incurs errors so as to produce recieved polynomial v(x). Find c(x) when
(i) $v(x) = x^5 + x^2 + 1$
(ii) $v(x) = x^6 + x^3 + 1$

6 + 6 = 12

7. (a) What is systematic code & non-systematic code? Write down the properties of cyclic codes.

(b) Determine systematic & non-systematic codes for i_1 =(0111) given the (7,4) code with $g(x) = 1 + x + x^3$.

(c) For a (2, 1, 2) convolution code, g^0 = (101) & g^1 = (111). Draw the encoder.

(3 + 3) + 3 + 3 = 12

Group – E

8. (a) Determine the Galois field elements of GF (2^3) for the corresponding polynomial p(x) = x^3 +x +1.

(b) What do you mean by primitive element? α^2, α^{12} are field elements of GF (2^4), determine their order and check whether or not they are primitive elements.

(c) Find the minimal polynomial of α^3 in GF (2^3).

3 + (1 + 2 + 2) + 4 = 12

9. Write short notes on (Any Three):
   (i) Source Coding
   (ii) Hamming Code
   (iii) State diagram.
   (iv) Viterbi Algorithim.

4 + 4 + 4 = 12