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^3, α^5 are field elements of GF (2^3), determine their order and check whether or not they are primitive elements.

   (c) What are the advantages of Turbo code? Discuss how it is implemented?

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

9. Write short notes on (*Any Three*). **(3 × 4) = 12**
   (i) Hamming Code
   (ii) Trellis diagram
   (iii) Shannon-Fano code
   (iv) BCH Code
   (v) Source coding.

CODING & 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) Purpose of the source coding is to
   (a) Increase the information transmission rate
   (b) Decrease the information transmission rate
   (c) Decrease the S/N ratio
   (d) Decrease the probability of error.

   (ii) Code rate r, k information bits and n as total bits, is defined as
   (a) r = k/n (b) k = n/r (c) r = k * n (d) n = r * k.

   (iii) For a (7,4) cyclic code generated by $g(x)= x^3+x+1$. The syndrome for the error pattern $e(x)=x^5$ is
   (a) 101 (b) 111 (c) 110 (d) 011.

   (iv) In discrete memoryless source, the current letter produced by a source is statistically independent of ____ .
   (a) past output (b) future output
   (c) both a and b (d) none of the above

   (v) If m = 3, then length (n) of the BCH code
   (a) 6 (b) 5 (c) 7 (d) none of these.

   (vi) An encoder for a (4,3,5) convolution code has input order of
   (a) 4 (b) 2 (c) 3 (d) 5.

   (vii) Which among the following represents the code in which codeword consists of message bits and parity bits separately?
   (a) Block Codes (b) Systematic Codes
   (c) Code Rate (d) Hamming Distance.

(viii) The generator polynomial of a (7,3) cyclic code has a degree of
(a) 2 (b) 3 (c) 4 (d) 5.

(ix) Basically, Galois field consists of _____ number of elements.
(a) finite (b) infinite
(c) both a and b (d) none of the above.

(x) What is the Hamming distance between 11011 & 11001?
(a) 2 (b) 3 (c) 1 (d) 5?

Group – B

2. (a) Define mutual information, channel capacity.

(b) Show that H(X, Y) = H(X/Y) + H(Y). where symbols have their usual meanings.

(c) An analog signal band limited to 5 kHz is quantized in 8 levels of a PCM system with probabilities 1/4, 1/5, 1/5, 1/10, 1/10, 1/20, 1/20, 1/20 respectively. Calculate entropy and the rate of information.

(2 + 2) + 3 + (3 + 2) = 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) Define uniquely decodable codes.

(5 + 2 + 2 + 2) + 1 = 12

Group – C

4. (a) An error control has the following parity check matrix.

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

(i) Determine the generator matrix G
(ii) Decode the received code word 110110.

(b) For a symmetric linear block code, the three parity check digits, c_4, c_5 and C_6 are given by
$C_4 = m_1 \oplus m_2 \oplus m_3$
$C_5 = m_1 \oplus m_2$
$C_6 = m_1 \oplus m_3$
(i) Construct generator matrix.
(ii) Construct code that begins with 001, generated by this matrix.

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

5. (a) For a linear block code derive that $C.H^T = 0$, where, symbols have their usual meaning.

(b) What is an equivalent code?

(c) Define minimum distance of a code-set. Minimum distance of a code is 5, determine the error-detection and error- correction capability of the code.

(d) Parity check matrix of a linear block code is

$$H = \left[\begin{array}{ccc:ccc}1&0&1&1&0&0\\1&1&0&0&1&0\\0&1&1&0&0&1\end{array}\right]$$

(i) Determine the generator matrix.
(ii) Assuming that a vector [101111] is received, find the correct data.

3 + 2 + (1 + 1 + 1) + (2 + 2) = 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) Determine systematic and nonsystematic code words for i = (1101) for the (7,4) code with $g(x) = x^3+x+1$.

6 + 6 = 12

7. (a) For a (2, 1, 2) convolution code, g^0 = (101) and g^1 = (110). Draw the encoder. Find the state diagram, for this convolution code.

(b) What is constraint length in convolution code? Compute the same for the above mentioned code.

3 + 7 + 2 = 12