9. (a) Explain Trellis Coded Modulation highlighting its salient features.

   (b) Explain the concept of mapping by set partitioning in TCM.

6 + 6 = 12

ERROR CONTROL AND CODING
(ECEN 5202)

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) The expected information contained in a message is called
   (a) entropy (b) efficiency
   (c) coded signal (d) none of the above.

   (ii) The entropy of a binary memoryless source is maximum when any of the symbols has a probability p equal to
   (a) zero (b) 0.2
   (c) 0.5 (d) 0.7.

   (iii) If linear block code is an error correcting code then it must atleast
   (a) satisfy the hamming bound
   (b) over satisfy the hamming bound
   (c) dissatisfy the hamming bound
   (d) none of these.

   (iv) 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}.

   (v) 1 decit equals
   (a) 1 bit (b) 3.32 bits
   (c) 10 bits (d) none of these.

   (vi) Channel capacity of a channel with bandwidth B is given by
   (a) $C = B\log_2(1+S/N)$ (b) $C = B\log_{10}(1+S/N)$
   (c) $C = 2B\log_2(1+S/N)$ (d) $C = B\log_2(S/N)$.

(vii) Viterbi algorithm is used for decoding of
(a) cyclic code (b) hamming code
(c) convolution code (d)) Huffman code.

(viii) A "t" error correcting cyclic code with least degree polynomial g(x)which has roots from elements of GF(2^m) gives rise to
(a) binary BCH code (b) convolution code
(c) Reed Solomon code (d) Hadamard code.

(ix) Modulo-2 addition of two polynomials $C_1(X) = 1 + X + X^2$ and $C_2(X) = 1 + X$ is
(a) X^2 (b) 1+X (c) 1 (d) X.

(x) (7,4) Hamming code is a
(a) single error correcting code
(b) double error correcting code
(c) triple error correcting code
(d) zero error correcting code

Group - B

2. (a) Why is Huffman code called an optimum code?

(b) A DMS has five symbols x_1, x_2, x_3, x_4 and x_5 with $P(x_1) = 0.4$, $P(x_2) = 0.19$, $P(x_3) = 0.16$, $P(x_4) = 0.15$ and $P(x_5) = 0.1$. Construct a Shanon Fano code and calculate the code efficiency.

3 + 4 + 3 = 12

3. (a) Explain the terms and their significance: Entropy, Mutual information, Self-information and Channel capacity.

(b) An analog signal is bandlimited to fm Hz and sampled at Nyquist rate. The samples are quantized into 4 levels. Each level represent one symbols. Thus there are 4 symbols. The probability of occurrence of these 4 levels (symbols) are P(x1) = P(x4) = 1/8 and P(x2) = P(x3) = 3/8. Obtain the information rate of the source.

8 + 4 = 12

Group - C

4. (a) For the (7,4) Hamming code the parity-check matrix H is given by

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

(i) Construct the Generator matrix
(ii) The code word that begins with 1010
(iii) If the received codeword is Y = 0111100, decode the received codeword.

(b) Prove that a block code, with minimum distance of d_{min}, can correct up to $t = ½(d_{min} - 1)$ number of errors. For a block code with minimum distance of 5, find it's error correction and detection capability.

6 + 6 = 12

5. (a) The polynomial $p(x) = 1 + x + x^4$ is a primitive polynomial over GF(2). Find the elements of GF(2^4).

(b) Explain the term minimal polynomial. What is meant by distinct conjugate roots?

8 + (3 + 1) = 12

Group - D

6. (a) Explain clearly the difference between convolution code and block code. Mention the advantage of convolution code over block code. What are the type of errors that can be corrected by convolution code.

(b) Define the following terms:
(i) Constraint length
(ii) Tree Code
(iii) Block Length
(iv) (n,k) convolution code

(2 + 1 + 1) + 8 = 12

7. (a) Construct a single error correcting Reed-Solomon code with blocklength 7.Consider a (7, 5) Reed –Solomon code with generator polynomial $g(x) = x^2 + \alpha^4 x + \alpha^3$ and construct the systematic codeword for the information word i = (10, α, α^5, α^2).

(b) Write a short note on Barlekamp algorithm.

6 + 6 = 12

Group - E

8. (a) Describe in details the LDPC code.

(b) How many types of LDPC codes are there? Mention briefly the steps required for construction of Regular LDPC code.

6 + (2 + 4) = 12