M.E. Electronics & Telecommunication Engineering Examination-2024
1st Year 2nd Semester
Coding Theory

Time: Three hours | Full Marks: 100

Answer any seven questions from Part-I and any three questions from Part-II
Answer all the parts of a question in the same place

Part – I

1. a) For a linear block code, show that the minimum Hamming distance (d_{min}) required to correct t-error is equal to 2t+1.
   b) What do you mean by repetition code? Write its advantage.
   c) A (7, 1) repetition code used to encode information sent through a channel with a bit error probability of 0·01. Find the probability that an information bit will be received erroneously after decoding.

(4+2+4)

2. a) What do you mean by primitive element?
   b) If A = (a_3 a_2 a_1 a_0) and B = (1 1 0 0) are the 4-tuple representation two elements of GF(2^4) then derive a simplified expression of AB for a given reduction polynomial $r(x) = x^4 + x^3 + 1$
   c) Simplify following two expressions
   i) $\alpha^7 + \alpha^3 + \alpha$ ii) $(x + \alpha^3)^5(x + \alpha^{10})$
   where α is a primitive element over GF(2^4), such that $\alpha^4 + \alpha^3 + 1 = 0$.

(2+4+4)

3. a) Show that the syndrome polynomial in a cyclic code solely depends on error polynomial.
   b) What do you mean by maximum distance separable code?
   c) Derive the relationship between syndromes and error location numbers of a t-error correcting RS Codes. Briefly explain the working principle of Chien search algorithm.

(2+2+6)

4. a) Consider (7, 4) cyclic code with generator polynomial $g(x) = 1+x+x^3$. Find the code-words for the messages 1010 and 1100 using corresponding generator matrix.
   b) A (15, 5) linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$. Find the nonsystematic codeword polynomial for the message polynomial $d(x) = 1 + x^2 + x^4$.

(6+4)

5. a) If the generator matrix G of a (7, 4) Hamming code is given by

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

then construct corresponding generator matrix of a (8, 4) Hamming code. Also determine the outcome of the decoder when the received codeword is $v = (0\ 0\ 1\ 0\ 1\ 0\ 1\ 0)$.

b) For an (n, k) block code derive the expression for Hamming bound.

((2+4) + 4)

6. a) What is minimal polynomial? Find the minimal polynomial of α^7, where α is a primitive element over GF(2^4), such that $\alpha^4+\alpha+1=0$.

b) If the minimal polynomials of α, α^3 and α^5 are $\phi_1(x) = x^4+x+1$, $\phi_3(x) = x^4+x^3+x^2+x+1$, and $\phi_5(x) = x^2+x+1$ respectively, then determine the generator polynomial of a BCH code of $d_{min} \geq 7$. (5+5)

7. a) What types of codes are used for correcting both random as well as burst errors? Explain the basic principle of interleaved codes.

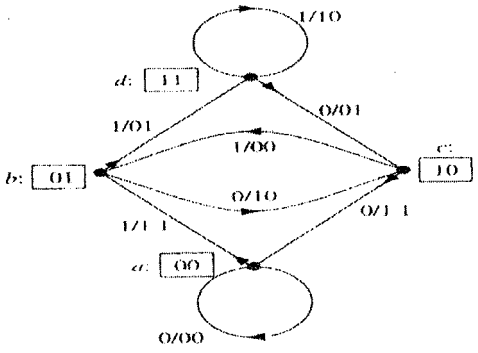
b) Draw the basic block diagram of Turbo encoder and explain its operation briefly.

c) Write the advantages of Trellis diagram over tree and state diagrams.

(4+4+2)

8. a) Explain the concept of Maximum Likelihood decoding.

b) For the state transition diagram of a convolutional encoder shown below suppose the first eight received bits are 01101100. Explain the process of decoding using Viterbi's algorithm.



(2+8)

Part - II

9. Derive the expression of the Generating Function of a maximal length sequence (m-sequence) generator as a ratio of two polynomials. Hence, discuss the significance of these polynomials.

(7+3)

10. Consider a sequence given as 110001001101011. Does it represent a maximal length sequence? Justify your answer.

(10)

11. Discuss, how will you generate $2^{n/2}$ numbers of Small Set Kasami binary sequences staring from an m-sequence using decimation, where n is an even number. Compare the performance of this sequence with the m-sequence of comparable length.

(8+2)

12. What is the necessity of generating orthogonal codes of variable length in W-CDMA system? Draw a code tree structure to generate variable length orthogonal codes. Hence, discuss the special features of this code tree.

(1+6+3)