GURU NANAK INSTITUTE OF TECHNOLOGY

An Autonomous Institute under MAKAUT

2022-2023

ADVANCED INFORMATION THEORY

MCE103C

TIME ALLOTTED: 3 HOURS **FULL MARKS: 70**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable

GROUP – A
(Multiple Choice Type Questions)

Answer any *ten* from the following, choosing the correct alternative of each question: 10×1=10

		Marks	CO No
1.(i)	The number of undetectable errors for a (n,k) linear code is a) 2^{n-k} b) 2^n c) 2^n-2^k d) 2^k	1	CO2
(ii)	The generator polynomial of a (7,4) cyclic code has the degree of a) 2 b) 3 c) 4 d) 5	1	CO4
(iii)	A code is with d_{min} =5. How many errors can it correct? a) 3 b) 2 c) 4 d) 1	1	CO2
(iv)	For GF (2^3) the elements in the set are a) {1 2 3 4 5 6 7} b) {0 1 2 3 4 5 6} c) {0 1 2 3} d) {0 1 2 3 4 5 6 7}	1	CO3
(v)	Relation between syndrome vector (S) and error vector (E) is a) $S=H^TE$ b) $S=EH^T$ c) none of these d) both (a) and (b)	1	CO4
(vi)	For a standard array the first element of the row is called a) Coset b) Coset leader c) Always all zero code d) Minimum weight code	1	CO4

(vii) In any linear feed forward path of a (4, 3, 2) convolution encoder, we need maximum shift Registers — 1 — CO3
a) 4
b) 3
c) 2
d) none of these

(viii) Reed-Solemon code is — 1 — CO2
a) Non binary BCH code
b) Binary BCH code
c) Binary multiple error correcting code
d) All the above

(ix) For a linear block code related to its property, the correct one is — 1 — CO2
a) All zero code word is a valid code word
b) Modulo sum of any two code is a valid code word
c) Minimum weight is equal to minimum distance
d) All of the above

(x) The generator polynomial of cyclic code of block length n is a factor of — 1 — CO4
a) $1+x^n$
b) $1+x^{n+1}$
c) $1+x^{n+2}$
d) $1+x^{n-1}$

(xi) If C is code word and H is a parity check matrix , then for a valid and correctly received code word — 1 — CO3
a) $CH=0$
b) $C^TH=0$
c) $C^TH^T=0$
d) $CH^T=0$

(xii) For m=4, what is the block length of the BCH code? — 1 — CO4
a) 16
b) 15
c) 16
d) None of these

GROUP – B
(Short Answer Type Questions)

(Answer any *three* of the following) — **3 x 5 = 15**

		Marks	CO No
2.	Explain Hamming code and its error correcting and detecting properties.	5	CO2
3.	Define sets, groups and fields related to Error Control Coding. Construct the Modulo2 addition and multiplication table.	5	CO3
4.	What do you mean by Primitive Field and its Elements?	5	CO2

5. One parity check code has parity check matrix as : 5 CO4

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

Determine generator matrix

6. Write short notes on BCH codes 5 CO2

GROUP – C
(Long Answer Type Questions)

(Answer any *three* of the following) **3 x 15 = 45**

Marks CO No

7. a) The generator matrix for a (6,3) block code is given below. Find all the code vectors of this code. 8 CO2

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

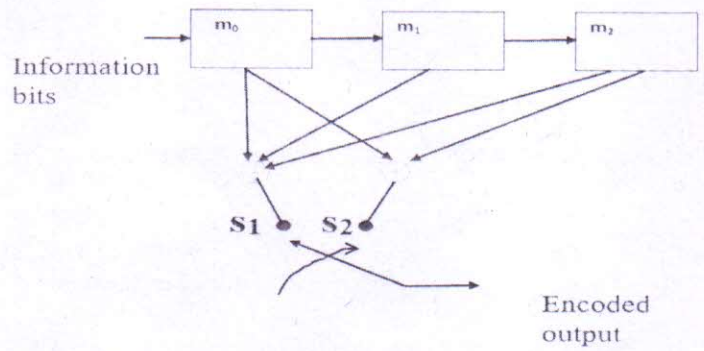
b) What is minimum distance d_m? 3 CO2

c) Discuss the concept of Syndrome decoding. 4 CO3

8.a) For a systematic (7, 4) cyclic code determine the generator matrix and parity check matrix if 9 CO4
$G(p) = p^3 + p + 1$

b) Find the code word for message 1001 and 1000. 6 CO4

9. Consider a (2, 1, 2) encoder shown in figure below.



Find the followings using the above encoder

a) State Diagram. 5 CO3

b) Trellis Diagram 5 CO3

c) Draw the *trellis diagram* for the input sequence u=(110100) 5 CO3

10.a)	A convolution encoder with code rate 1/3 having three outputs as c_1, c_2, c_3, with the generator vectors as g1=[111] g2=[011] g3=[101] Draw the encoder circuits	5	CO4
b)	Find the output sequence for an input sequence of 101001 using Delay Transform Domain Approach for the above encoder.	10	CO4
11.	Answer any three questions	3x5=15	
a)	Explain the Perfect Code	5	CO4
b)	Write the procedural steps of construction of Standard Array.	5	CO4
c)	Explain with example the Veterbi Algorithms.	5	CO4
d)	For a Hamming distance of 5, how many errors can be detected? How many errors can be corrected?	5	CO2