P.B. SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, Vijayawada – 520 010
Reaccredited at 'A+' level by NAAC
Autonomous&ISO 9001:2015 Certified

Title of the Course: ALGEBRAIC CODING THEORY
Semester : II

Course Code	22MA2D1	Course Delivery Method	Blended Mode
Credits	4	CIA Marks	30
No. of Lecture Hours / Week	4	Semester End Exam Marks	70
Total Number of Lecture Hours	60	Total Marks	100
Year of Introduction : 2020-21	Year of offering : 2022-23	Year of Revision: ---	Percentage of Revision : ---

Course Objective : To acquire knowledge on basic concepts of linear codes, parity-check matrices, Gilbert bound, Hamming bound, Singleton bound, Cyclic Linear Codes, Perfectcodes.

CO-NO	COURSE OUTCOME	BTL	PO	PSO
CO1	Understand the basic knowledge of coding theory and encoding and decoding using MLD	**K2**	**1**	**1**
CO2	calculate a basis for linear codes and its dual.	**K3**	**7**	**2**
CO3	Calculate generator matrix, parity check matrix for linear codes and its dual using algorithms and decoding using CMLD and IMLD.	**K3**	**1**	**2**
CO4	Understand perfect codes, Hamming codes and Reed-Muller codes.	**K3**	**7**	**1**
CO5	understand cyclic linear codes, dual cyclic codes and construct cyclic linear codes of a given length.	**K3**	**1**	**2**

.

Mapping of Course Outcomes:

CO-PO-PSO MATRIX										
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**
22MA2D1	**CO1**	**2**							**2**	
	CO2							**3**		**3**
	CO3	**2**								**3**
	CO4							**3**	**2**	
	CO5	**3**								**3**

UNIT – I

Introduction to Coding Theory: Introduction, Basic assumptions, Correcting and Detecting error patterns, Information Rate, The Effects of error Correction and Detection, Finding the most likely codeword transmitted, Some basic algebra, Weight and Distance, Maximum likelihood decoding, Reliability of MLD.
(Section 1.1 to 1.10 of chapter 1 of prescribed book [1])

UNIT – II

Introduction to Coding Theory : Error- Detecting Codes, Error – Correcting Codes.

Linear Codes : Linear Codes, Two important subspaces , Independence, Basis, Dimension, Matrices, Bases for C= <S> and $C^{\perp}$.
(Sections 1.11, 1.12 of chapter 1 & Section 2.1 to 2.5 of chapter 2 of prescribed book [1]).

UNIT - III

Linear Codes : Generating Matrices and Encoding , Parity – Check Matrices, Equivalent Codes, Distance of a Linear Code, Cosets, MLD for Linear Codes, Reliability of IMLD for Linear Codes.(section 2.6 to 2.12 of chapter 2 of prescribed book [1])

UNIT – IV

Perfect and Related Codes: Some bounds for Code, Perfect Codes, Hamming Codes , Extended Codes, The extended Golay Code, Decoding the extended Golay Code, The Golay code, Reed – Muller Codes, Fast decoding for RM (1,m).(Chapter 3 of prescribed book [1])

UNIT – V

Cyclic Linear Codes : Polynomials and Words, Introduction to Cyclic codes, Polynomials encoding and decoding, Finding Cyclic Codes, Dual Cyclic Codes.
(Chapter 4 of prescribed book [1])

PRESCRIBED BOOK:

1. Hoffman D.G, Lanonard D.A, Lindner C.C, Phelps K.T, Rodger C.A, Wall J.R, Coding Theory- The Essentials, Marcel Dekker (1991).

REFERENCE BOOK: Van Lint J.H., Introduction to coding Theory, SpringerVerlag (2013).

Course has Focus on : Foundation (Elective Paper)

Websites of Interest :1. www. nptel.ac.in

2. www.epgp.inflibnet.ac.in

3. www.ocw.mit.edu

P B SIDDHARTHA COLLEGE OF ARTS AND SCIENCE::VIJAYAWADA

(An autonomous college in the jurisdiction of Krishna University)

M. Sc. Mathematics

Second Semester

ALGEBRAIC CODING THEORY– 22MA2D1

Time: 3 Hours **Max. Marks : 70**

SECTION- A

Answer all questions. **(5 X 4=20)**

1 (a) Define Binary code, length of a code, reliability of a channel, Information rate. (CO1, L1)

(OR)

(b) Show that (i) wt (v+w) $\leq$ wt (v) +wt (w) and (ii) d(v, w) $\leq$ d(v, u) + d(u, w) (CO1, L1)

2 (a) Define a linear code. Verify whether the code C={000, 100, 101, 001} is linear. (CO2, L2)

(OR)

(b) Prove that the set {1000, 0100, 0010, 0001} is linearly independent. (CO2, L2)

3 (a) Define a generating matrix and a parity check matrix. Prove that G is a generating matrix for a linear code C □ the rows of G are linearly independent. (CO3, L2)

(OR)

(b) Find the cosets for the code C = {0000, 1010, 0101, 1111} (CO3, L2)

4 (a) State and prove singleton bound theorem. (CO4, L2)

(OR)

(b) Define Reed-Muller code and a perfect code. (CO4, L2)

5 (a) Define a linear cyclic code. Verify whether the code C= { 000, 100, 110, 101} is cyclic. (CO5, L3)

(OR)

(b) Define dual code of a cyclic code. Find a generator matrix and a basis for the code C= {000, 101, 010, 111} (CO5, L3)

SECTION- B

Answer all questions. All questions carry equal marks. **(5X10=50)**

6. (a) Define CMLD, IMLD. Construct IMLD table for the code

   C = {0000,1001,0110,1111}

   (b) Suppose p=0.90 , $|M|$=3, n=4, and C ={0000,1010,0111}. For each v in C, calculate

   θ_p (C, v). (CO1, L2)

(OR)

   (c) Suppose we have a BSC with ½ < p < 1. Let v_1 and v_2 be code words, w a word , each of length n and v_1, w disagree in d_1 positions and v_2, w disagree in d_2 positions. Then show that $\varphi_p(v_1, w) \le \varphi_p(v_2, w)$ if and only if $d_1 \ge d_2$

   (d) Find the error patterns that corrected by C ={000,111} (CO1, L2)

7 (a) Show that a code C of distance d will at least detect all non zero error patterns of weight less than or equal to (d-1) and there is at least one error pattern of weight d which C will not detect.

   (b) Find the largest linearly independent set from the following set

   S = { 1101, 0111, 1100, 0011} (CO2, L3)

(OR)

   (c) For each of the following sets S, find a basis B for the code C =<S> and a basis for the dual code where S ={111000,000111,101010,010101} (CO2, L3)

8 (a) Find a generator matrix and a parity check matrix for the code

   C={000000,010101,101010,111111} (CO3, L3)

(OR)

   (b) If H is a parity –check matrix for a linear code C then show that C has distance d if and only if any set of (d-1) rows of H are linearly independent and at least one set of d rows of H is linearly dependent. (CO3, L3)

9. (a) Construct an SDA for a Hamming code of length 7 and use it to decode the word 1101011. (CO4, L4)

(OR)

(b) Using the IMLD for C_{24} decode the following word

w= 001001001101,101000101000. (CO4, L4)

10 (a) Show that g(x) is a generator polynomial for a linear cyclic code C of length n if and only if g(x) divides $(1+x^n)$. (CO5, L3)

(OR)

(b) Find the generator polynomial for all linear cyclic codes of length n=4. (CO5, L3)

***