ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY
(Unit of Alva's Education Foundation (R), Moodbidri)
Shobhavana Campus, MIJAR-574225, Moodbidri, Karnataka
Affiliated to VTU,Belagavi & Approved by AICTE New Delhi
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Academic Year 2023-24

Subject Name: Digital Communication **Subject Code:** 21EC51 **Semester:** 5^{th} 'A'

Subject Seminar GroupWise Topics

#	Group Number	USN	Student Name	Seminar Topic
1	Group-1	4AL21EC001	A. S. Pavithra	Kraft–McMillan inequality
2		4AL21EC002	ABHISHEK S	
3		4AL21EC003	AKASH A H	
4		4AL21EC005	Akshay Kumar h	
5	Group-2	4AL21EC006	Amaresha M	Binary Erasure Channel, Muroga's Theorem.
6		4AL21EC007	Anchita	
7		4AL21EC008	Anush S Amargol	
8		4AL21EC009	B.VENNELA	
9	Group-3	4AL21EC010	Basangouda patil	Convolution Codes
10		4AL21EC011	Basavakiran	
11		4AL21EC013	Bharath N	
12		4AL21EC014	Bhaskar T	
13	Group-4	4AL21EC015	Bhavana.B	Noisy Channel Coding Theorem
14		4AL21EC016	Chakravarty Jaipal T	
15		4AL21EC018	CHARAN RAJ RV	
16		4AL21EC019	Chetan M	
17	Group-5	4AL21EC020	Chethan K.M	Gaussian Channel and Information Capacity Theorem
18		4AL21EC021	Chiranjeevi U B	
19		4AL21EC022	Chithra L	
20		4AL21EC023	Darshan T S	

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#	Group Number	USN	Student Name	Seminar Topic
21	Group-6	4AL21EC024	Darshana Basavaraj B	Generator Matrix and Parity Check Matrix
22		4AL21EC025	Deeksha S	
23		4AL21EC026	Deekshith D Shetty	
24		4AL21EC027	Diya	
25	Group-7	4AL21EC028	Gagan H S	Systematic Codes, Error Detections and Correction
26		4AL21EC029	Gowthama M A	
27		4AL21EC030	Harshitha B.S	
28		4AL21EC031	Hemanth R	
29	Group-8	4AL21EC032	Hemashri H N	Fire Code, Golay Code, CRC Codes and Circuit Implementation of Cyclic Codes
30		4AL21EC033	Huriya Sanadi	
31		4AL21EC034	Inchara S Shetty	
32		4AL21EC035	Jeevan K G	
33	Group-9	4AL21EC036	Jeevan V	Reed Solomon (RS) Codes
34		4AL21EC037	Kalmesh G G	
35		4AL21EC038	Kaluva Chandrashekar	
36		4AL21EC039	Keerthan S	
37	Group-10	4AL21EC040	Kiran Kashyap M	Hamming and Hadamard Codes
38		4AL21EC041	Kishor U	
39		4AL21EC042	Lakshan	
40		4AL21EC043	Lakshmi Keerthana B	
41	Group-11	4AL21EC044	Lekhan T	Probability Rules and Baye's Theorem
42		4AL21EC045	Madugonde Sandeep	
43		4AL21EC046	Mahantesh Shidaray T	
44		4AL21EC047	Mailaragouda N P	

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#	Group Number	USN	Student Name	Seminar Topic
45	Group-12 ✓	4AL21EC049	Manupriya Y	Information theory in Cryptography and Cryptanalysis
46		4AL21EC050	Meghana L	
47		4AL21EC051	Mohammed Iqbal	
48		4AL21EC052	Muhammad Razi	
49	Group-13 ✓	4AL21EC053	Nagabhushan H K	Optimum Quantizer, Practical Application of Source Coding: JPEG Compression
50		4AL21EC054	Naveen Kumar H S	
51		4AL21EC062	Prajwal s das	
52		4AL21EC068	Ramya .R	
53	Group-14 ✓	4AL21EC104	Vaishnavi S	Noisy Channel Coding Theorem
54		4AL22EC402	G Chethan Kumar G	
55		4AL22EC408	Veeresh S V	
56		4AL22EC406	Shamshuddin	
57	Group-15 ✓	4AL22EC400	Abhishek P Tatuskar	Markov statistical model of information sources
58		4AL22EC401	Chetana A Burud	
59		4AL22EC403	Lakshmi B	
60		4AL22EC405	Pallavi A B	
61		4AL22EC407	Suhani R Jadhav	

Faculty Incharge

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Academic Year 2023-24

Subject Name: Digital Communication **Subject Code:** 21EC51 **Semester:** 5th 'B'

Subject Seminar Groupwise Topics

#	Group Number	USN	Student Name	Seminar Topic
1	Group-1	4AL21EC056	Nivedita T Patil	Kraft–McMillan inequality
2		4AL21EC057	Prajyot Rajgonda Patil	
3		4AL21EC058	Pavan	
4		4AL21EC059	Pooja Venkatesh Naik	
5	Group-2	4AL21EC060	Prajwal L R	Binary Erasure Channel, Muroga's Theorem.
6		4AL21EC061	Prajwal Malabagi	
7		4AL21EC063	Prakruthi K P	
8		4AL21EC064	Prasanna kumar B I	
9	Group-3	4AL21EC065	Rakesh	Convolution Codes
10		4AL21EC066	Raksha	
11		4AL21EC067	Rakshith	
12		4AL21EC069	Ravi Kovi	
13	Group-4	4AL21EC070	sahana	Noisy Channel Coding Theorem
14		4AL21EC071	Saikumar	
15		4AL21EC073	sanjana shrikant H	
16		4AL21EC074	Santhosha S	
17	Group-5	4AL21EC076	Shashank C S	Gaussian Channel and Information Capacity Theorem
18		4AL21EC077	Shashank Swami	
19		4AL21EC078	Shashank V Shetti	
20		4AL21EC079	Shivakumar K V	

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#	Group Number	USN	Student Name	Seminar Topic
21	Group-6	4AL21EC080	Shravya shetty	Generator Matrix and Parity Check Matrix
22		4AL21EC081	Shreya C Shetty	
23		4AL21EC082	Shreya K R	
24		4AL21EC083	Shreyas S Naik	
25	Group-7	4AL21EC084	Shruthi	Systematic Codes, Error Detections and Correction
26		4AL21EC085	Siddharoodh B D	
27		4AL21EC086	Sinchana C K	
28		4AL21EC087	sinchana R	
29	Group-8	4AL21EC088	Sinchana RD	Fire Code, Golay Code, CRC Codes and Circuit Implementation of Cyclic Codes
30		4AL21EC089	Sinchana.S.D	
31		4AL21EC090	Sindhu KS	
32		4AL21EC091	Sindhu S Patil	
33	Group-9	4AL21EC092	Sonali	Reed Solomon (RS) Codes
34		4AL21EC093	Srishti S Shetty	
35		4AL21EC094	Suma K G	
36		4AL21EC095	Sumith N	
37	Group-10	4AL21EC096	Sushrutha N	Hamming and Hadamard Codes
38		4AL21EC097	Tanishka	
39		4AL21EC098	Tej Ashok	
40		4AL21EC099	Thejas J Kotian	
41	Group-11	4AL21EC100	Thejashwi P Acharya	Probability Rules and Baye's Theorem
42		4AL21EC101	Thrisha P Hegde	
43		4AL21EC102	Usha Rani.N	
44		4AL21EC103	V Venkta Sainihith M	

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#	Group Number	USN	Student Name	Seminar Topic
45	Group-12	4AL21EC105	Vaishnavi Vithal Naik	Information theory in Cryptography and Cryptanalysis
46		4AL21EC106	Varshini Shetty	
47		4AL21EC107	Varun Kumar R	
48		4AL21EC108	Varun Devaramani	
49	Group-13	4AL21EC109	Veena Basavaraj R	Optimum Quantizer, Practical Application of Source Coding: JPEG Compression
50		4AL21EC110	Videesh D Shetty	
51		4AL21EC111	Vishal	
52		4AL21EC112	Vishwanath HB	
53	Group-14	4AL21EC113	Yashaswini T R	Noisy Channel Coding Theorem
54		4AL21EC114	Yashwanth GT	
55		4AL21EC115	Yogeshwar M	
56		4AL20EC009	C.Navajeevan	
57		4AL22EC404	Navaneeth	

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G-6(B)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SEMINAR REPORT

on

Generator Matrix and Parity Check Matrix

ACADEMIC YEAR: 2023-2024
SUBJECT CODE : 21EC51
SUBJECT : Digital communication
CLASS : 3rd Year
SEMESTER : 5th Semester
SECTION : 'B' Section

SUBMITTED BY:

Sl.no	USN	NAME
1	4AL21EC080	Shravya Shetty
2	4AL21EC081	Shreya C Shetty
3	4AL21EC082	Shreya K R
4	4AL21EC083	Shreya S Naik

CERTIFICATE OF EVALUATION

College Name	Alva's Institute of Engineering & Technology	
Degree	B. E.	
Branch	Electronics and Communication Engineering	
Semester	5^{th} Semester	
Section	B	
USN & Name of theStudents	4AL21EC080	Shravya Shetty
	4AL21EC081	Shreya C Shetty
	4AL21EC082	Shreya K R
	4AL21EC083	Shreya S Naik
Subject & Subject Code	Digital Communication (21EC51)	
Faculty Name	Mrs. Bhagyashree K	
Designation	Assistant Professor	
Date of Submission	25-01-2024	
Total Marks	10	
Marks Scored	10	

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Faculty Incharge

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Table of Contents

Generator Matrix and Parity Check Matrix

Introduction:

1.Generator Matrix:

Generator Matrix and Parity Check Matrix are fundamental concepts in the field of coding theory, a branch of information theory that deals with the transmission and storage of information in a reliable and efficient manner. These matrices play a crucial role in the design and implementation of error-correcting codes, which are essential for ensuring accurate data transmission in communication systems and data storage devices.

Generator matrix of a non-systematic (n,k) cyclic codes

- The generator matrix will be in this form:

$$G=\begin{bmatrix} g_0 & g_1 & \cdots & g_{n-k-1} & g_{n-k} & 0 & 0 & \cdots & 0 \\ 0 & g_0 & g_1 & \cdots & g_{n-k-1} & g_{n-k} & 0 & \cdots & 0 \\ 0 & 0 & g_0 & g_1 & \cdots & g_{n-k-1} & g_{n-k} & 0 & 0 \\ & \vdots & & & & & & & \\ 0 & 0 & 0 & \cdots & 0 & g_0 & \cdots & g_{n-k-1} & g_{n-k} \end{bmatrix}_{r\times n}$$

notice that the row are merely cyclic shifts of the basis vector $\bar{g}=[g_0 g_1 \cdots g_{n-k-1} g_{n-k} 00\ldots0]$

- A Generator Matrix is a matrix used to generate codewords in a systematic linear block code.
- Linear block codes are a type of error-correcting code where each codeword is a linear combination of the original message vectors.
- The primary purpose of the Generator Matrix is to facilitate the systematic encoding of information for transmission or storage.
- It defines the linear transformation that converts an input message vector into a corresponding codeword.
- In a systematic linear block code, a portion of the codeword directly represents the original message, making it easy to identify and extract the message at the receiver's end.
- If G is the Generator Matrix and m is a message vector, then the codeword c is obtained by multiplying the message vector by the generator matrix: c=m×G.

- The Generator Matrix allows for the creation of systematic codes, where a part of the codeword remains unchanged and represents the original message, making the decoding process more straightforward.
- If G is an $k \times n$ matrix (where k is the dimension of the message vector and n is the length of the codeword), it defines a linear mapping from the k-dimensional message space to the n-dimensional codeword space.

2. Parity Check Matrix:

A Parity Check Matrix is a fundamental concept in coding theory, a field of study within information theory that focuses on the design and analysis of error-detecting and error-correcting codes. Parity Check Matrices are particularly important in the context of linear block codes, providing a mechanism for detecting and sometimes correcting errors that may occur during the transmission or storage of data. In coding theory, a parity-check matrix of a linear block code C is a matrix which describes the linear relations that the components of a codeword must satisfy. It can be used to decide whether a particular vector is a codeword and is also used in decoding algorithms. Formally, a parity check matrix H of a linear code C is a generator matrix of the dual code, $C^{\perp}$. This means that a codeword $\mathbf{c}$ is in C if and only if the matrix-vector product $H\mathbf{c}^{\top} = \mathbf{0}$ (some authors[1] would write this in an equivalent form, $\mathbf{c}H^{\top} = \mathbf{0}$.)

The rows of a parity check matrix are the coefficients of the parity check equations. That is, they show how linear combinations of certain digits (components) of each codeword equal zero. For example, the parity check matrix

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

compactly represents the parity check equations,

$$c_3 + c_4 = 0$$
$$c_1 + c_2 = 0,$$

that must be satisfied for the vector (c_1, c_2, c_3, c_4) to be a codeword of C

From the definition of the parity-check matrix it directly follows the minimum distance of the code is the minimum number d such that every $d - 1$ columns of a parity-check matrix H are linearly independent while there exist d columns of H that are linearly dependent.

Creating a parity check matrix

The parity check matrix for a given code can be derived from its generator matrix (and vice versa). If the generator matrix for an $[n,k]$-code is in standard form

$$G = [I_k | P],$$

then the parity check matrix is given by

$$H = [-P^{\top}|I_{n-k}].$$

Because

$$GH^{\top} = P - P = 0.$$

Negation is performed in the finite field F_q. Note that if the characteristic of the underlying field is 2 (i.e., $1 + 1 = 0$ in that field), as in binary codes, then $-P = P$, so the negation is unnecessary.

For example, if a binary code has the generator matrix

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

then its parity check matrix is

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

It can be verified that G is a k x n matrix, while H is a (n-k) matrix.

- A Parity Check Matrix is a mathematical construct used to perform error checking in linear block codes.
- Linear block codes are a type of error-correcting code where codewords are generated through linear combinations of message vectors.
- The primary purpose of a Parity Check Matrix is to check the validity of received codewords.
- If H is the Parity Check Matrix and c is a received codeword, the product c×HT (where HT is the transpose of H) results in a vector known as the syndrome.
- The syndrome is a crucial indicator of errors in the received codeword.
- A non-zero syndrome signals the presence of errors, and the specific pattern of the syndrome helps identify the location and nature of these errors.
- If H is an (n−k)×n matrix (where n is the length of the codeword and k is the dimension of the message vector), it defines linear relationships among the elements of a codeword.
- The Parity Check Matrix H is carefully designed to ensure that any valid codeword satisfies certain parity-check equations, making it a powerful tool for error detection.
- While Parity Check Matrices are primarily used for error detection, they can also be employed in certain cases for error correction, especially in codes that support error correction.

Types of Generator Matrix:

In coding theory, Generator Matrices play a crucial role in defining linear block codes. The types of Generator Matrices depend on specific properties and structures. Here are a few types along with brief explanations:

1.Systematic Generator Matrix:

A systematic generator matrix is designed to create systematic linear block codes. In a systematic code, a part of the codeword directly represents the original message, making the encoding and decoding processes more straightforward. The leftmost submatrix of a systematic generator matrix is typically an identity matrix.

2.Non-Systematic Generator Matrix:

Unlike a systematic generator matrix, a non-systematic generator matrix does not guarantee that a portion of the codeword corresponds directly to the message. While it is still valid for encoding, the absence of a systematic structure may complicate decoding.

3.Standard Form Generator Matrix:

A generator matrix is in standard form if it has an identity matrix as its leftmost submatrix. This form simplifies the encoding process and is often preferred for its ease of use in systematic codes.

4.Canonical Generator Matrix:

A canonical generator matrix is one that is structured to create codes with specific mathematical properties. The choice of a canonical form may depend on the desired characteristics of the code, such as performance in error correction or detection.

5.Sparse Generator Matrix:

A sparse generator matrix is characterized by having a small number of non-zero entries. Sparse matrices can be advantageous in terms of storage and computation efficiency, especially in situations where resources are limited.

6.Cyclic Generator Matrix:

Cyclic codes have a special property where cyclically shifting a codeword results in another valid codeword. A cyclic generator matrix is structured to create cyclic codes, simplifying the encoding and decoding processes for such codes.

7.Orthogonal Generator Matrix:

An orthogonal generator matrix is associated with codes that exhibit orthogonal properties. These codes may have applications in communication systems where interference is a concern.

Conclusion:

In information theory and coding, Generator Matrices and Parity Check Matrices are indispensable tools for ensuring reliable data transmission and storage. The Generator Matrix, with its linear transformation properties, plays a pivotal role in encoding information systematically into codewords, simplifying the process of data transmission and storage. Its systematic structure facilitates efficient decoding, allowing for the direct extraction of the original message from a portion of the codeword. On the other hand, the Parity Check Matrix serves as a critical component in error detection, providing a means to verify the integrity of received codewords. The orthogonality between the rows of the Generator and Parity Check Matrices, along with their relationship G×HT=0, ensures that errors can be efficiently identified through the syndrome. These matrices are essential in the design of error-correcting codes, contributing to the robustness of communication systems and the integrity of stored data. Their properties and relationships lay the foundation for creating codes that withstand the challenges posed by noise and interference, ultimately enhancing the reliability and accuracy of information transmission in diverse applications.