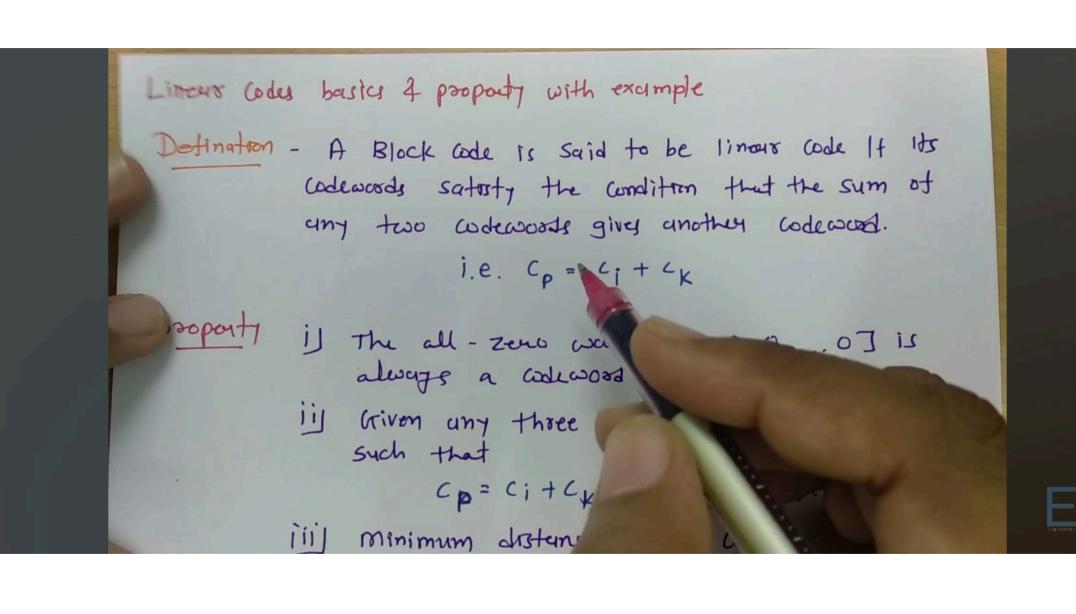
LBC Basics



Defination - A Block code is said to be linear code It its codewoods saturty the condition that the sum of any two codewoods gives another codewood.

boobont

- i) The all-zero woods [0,0,0,...0] is always a codewood.
- iij Given any three codeoxoods Ci, Cj and Ck such that

iii) minimum distance of the code



Criven any three code woods Cp, C) and Cp such that Cp= Ci+Cx, then d((is(j) = W(Cp) III Minimum distance of the code dmin = Wmin - (7,4) Hamming Code C, = 0001011 3 C10 = 1010011 4 C11 = C1 + C10 C1 = 1011000 Co = [0000000]

Minimum distance of the code dmin = Wmin (7,4) Hamming Code $C_1 = 0001011$ $\boxed{3}$ $C_{10} = 1010011$ $\boxed{4}$ $C_{11} = C_1 + C_{10}$ C11 = 1011000 [3] - C0 = [0000000] d(c1, c10) = 3 | d(c1, c10) = 3 = W(c11) WCC11) = 3

- (7,4) Hamming Code

$$C_1 = 0001011 \ 4$$
 $C_{10} = 10100011 \ 4$
 $C_{11} = C_1 + C_{10}$
 $C_{11} = 1011000 \ 3$

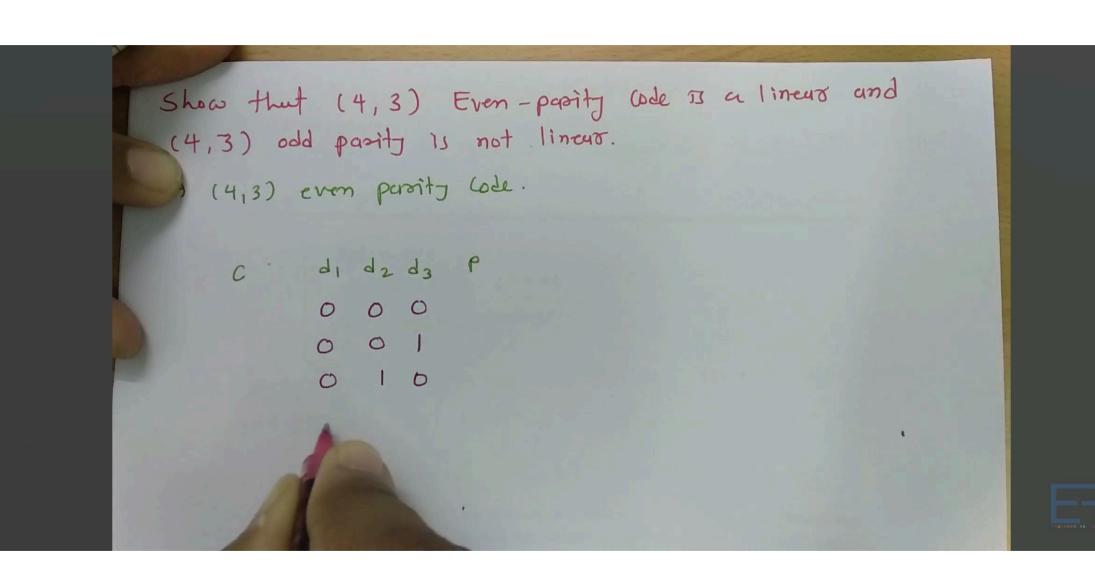
- $C_0 = [0000000]$
 $d(C_1, C_{10}) = 3 \ d(C_1, C_{10}) = 3 = W(C_{11})$
 $W(C_{11}) = 3$

- $C_{15} = [11119+1], \omega = 7$

other then C_{15} codes are heaving weight 344 .

 $d_{min} = W_{min}$

S.No.	m0	m1	m2	m3	p0	p1	p2
0	0	0	0	0	0	0	0
1	0	0	0	1	0	1	1
2	0	0	1	0	1	1	0
3	0	0	1	1	1	0	1
4	0	1	0	0	1	1	1
5	0	1	0	1	1	0	0
6	0	1	1	0	0	0	1
7	0	1	1	1	0	1	0
8	1	0	0	0	1	0	1
9	1	0	0	1	1	1	0
10	1	0	1	0	0	1	1
11	_1_	0	1	1	0	0	0
12	1	1	0	0	0	1	0
13	1	1	0	1	0	0	1
14	1	1	1	0	1	0	0
15	1	1	1	1	1	1	1



(4,3) odd parity is not lineur.

-) (4,3) even parity code.

C	di	d2	d3	P	
Co	0	0	0	0	W
Cı	0	0	J	1	\rightarrow 0011 C_1 Q
(2	0	- 1	0	1	$\longrightarrow 0 0 \frac{c_2}{2} \frac{2}{2}$
C3	0	- 1	-1	0	K 0 1 1 0 [3] 2
C4	1	0	0	-1	dmin ((1,(2) = 2
(5	1	0	1	0	W((3) = 2
C ₆	- 1	J	0	0	
(7	1	- 1	1	1	- [dmin = N]



```
Odd parity (4,3) wde
   C d1 d2 d3 P
   c<sub>0</sub> 0 0 0
   0010
       0 100
    C4
    (7 1
```

```
Odd parity (4,3) code
   C d, d2 d3 P
   C0 0 0 0 1
      0010->
      0 100
   C3 0 1 1 1
     1000
               - CI+CZ is not present
   C4
   c5 1 0 1 1 in odd parity (4,3) wde
   C6 1 1 0 1 - It TS not linear block
                                  code.
```



Generator Matrix to generate Codeword in LBC

Generator matric, in Lineur code

to generate ade woods

- Using a matrix to generate adewoods is a better approach.

[[] = [i][G]

[c] = Code word

[i] = Intermation woods

[a] - Generator mortaix

The Generator matrix of an (n, K) linear code has

Grenosator matrix too (7,4) code is given by

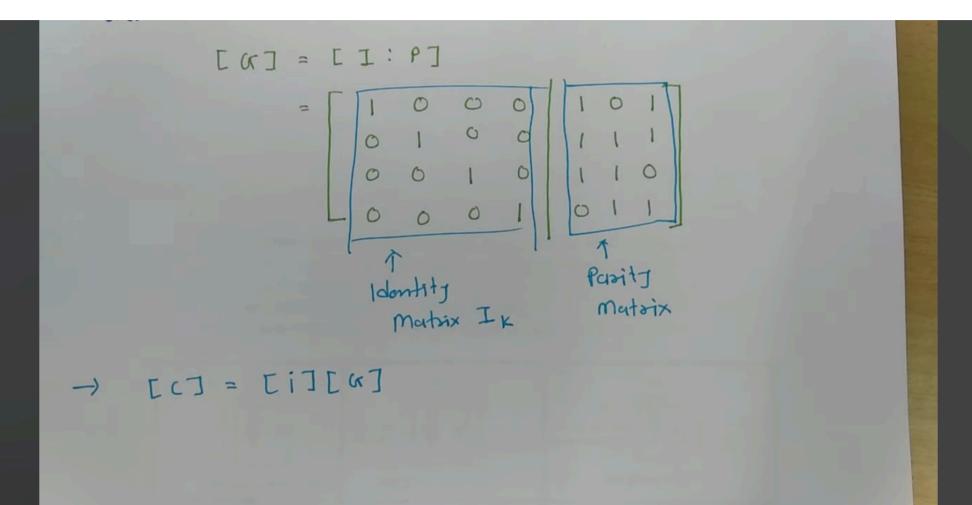


[i] = Intermation woods

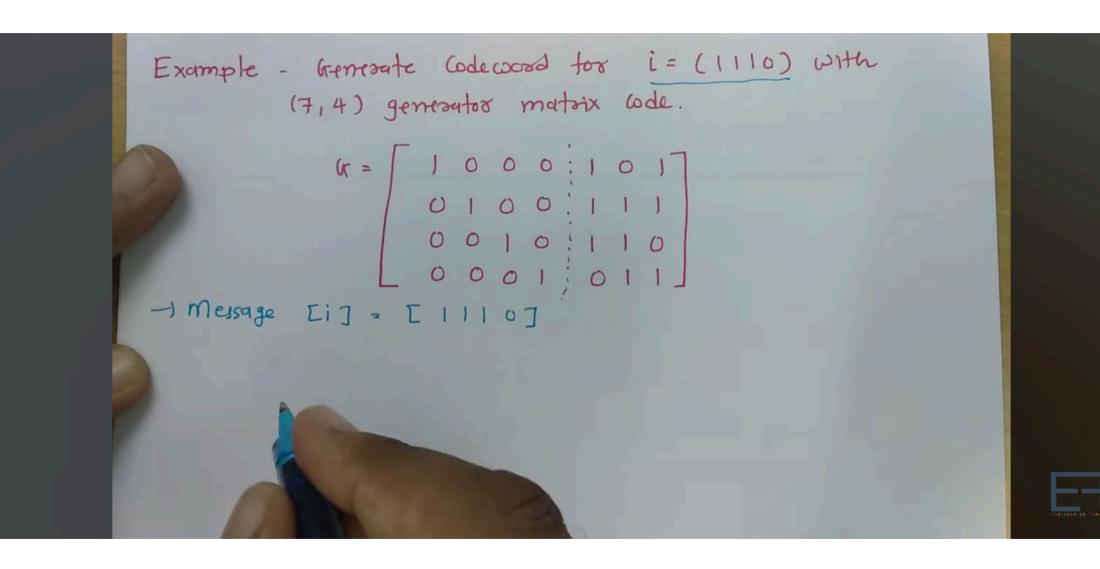
[a] = Generator mortaix

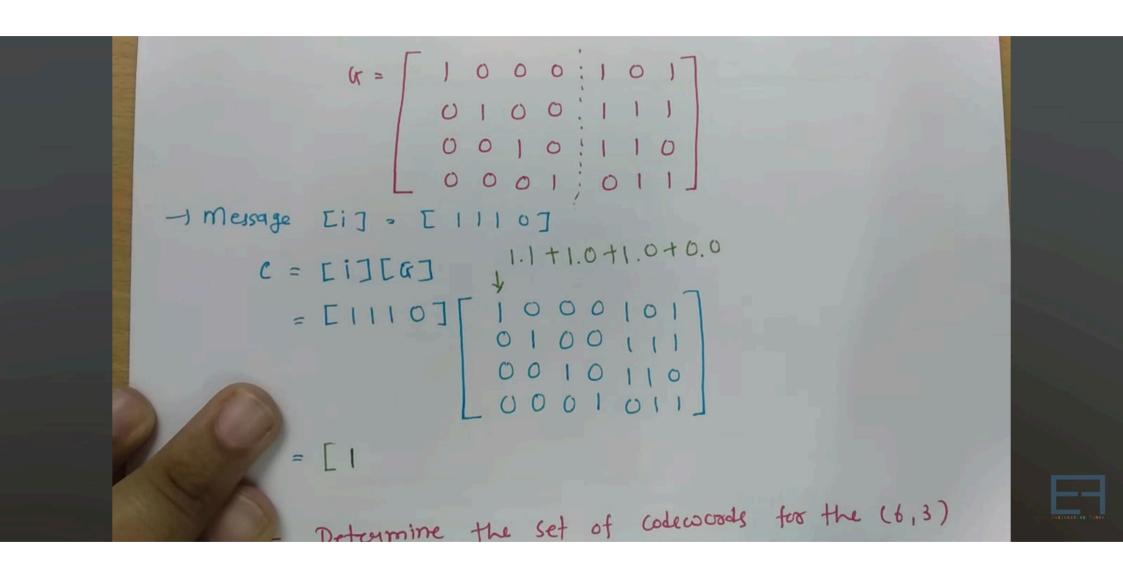
- The Grenesator matrix of an (n, K) linear code has
- Grenesator mortaix too (7,4) code is given by











```
-1 Message [i] = [1110]
     C = [I][G]
\frac{1.1 + 1.0 + 1.0 + 0.0}{4}
       = [1110] [1000101]
0100111
0010101]
        = [1110100]
         Determine the set of codewoods for the (6,3)
```

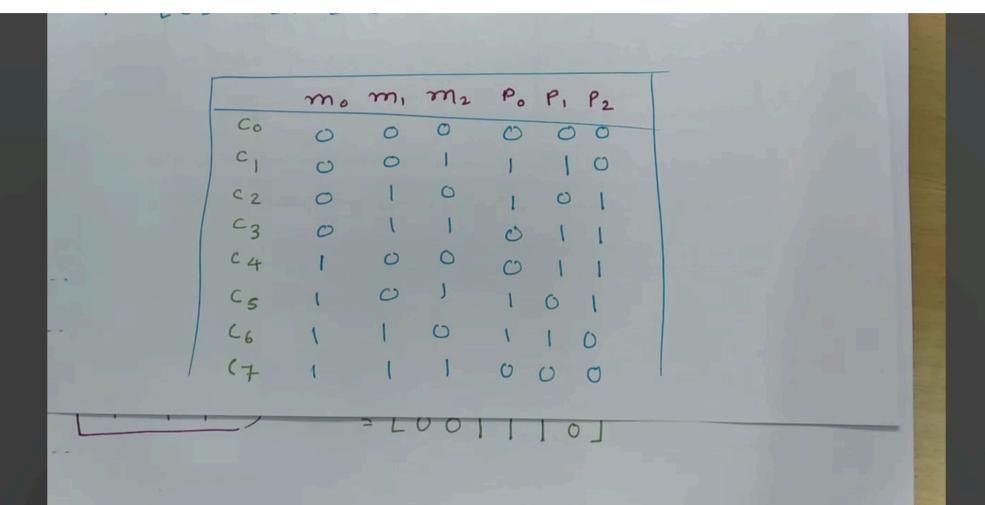
Example - Determine the set of codewoods for the (6,3) code with generator matrix -> n=6 $G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$ K = 3 $G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$ K = 3 G = 3mo m, m2

code with generator matrix -> n=6 $K = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 \end{bmatrix}$ $\rightarrow n = 6$ K = 3 $0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$ $\rightarrow message bits = 3$ mom, m2



```
K=3

-) Message bits = 3
                001110
mo m, m2
           -> c =[i][a]
           -) C_0 = [0 00][0 0011]
  1 0
                · [0000000]
           -) C1 = [001] [10001]
010101
001110
  10
               = [001110]
```

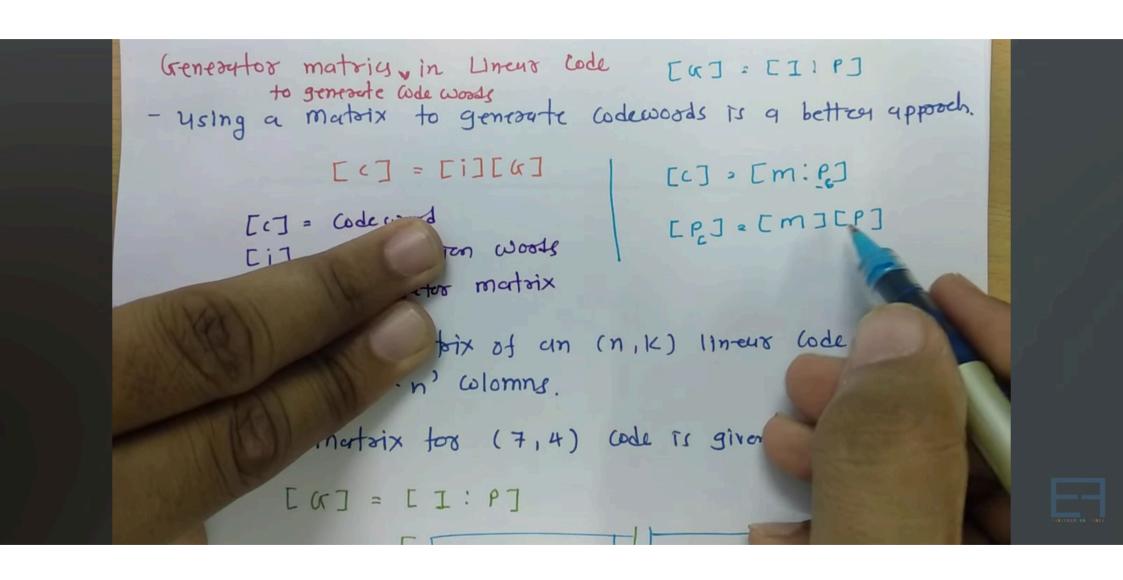




```
too the (6,3)
            code with generator matrix
                G = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 \end{bmatrix} \rightarrow n = 6

K = 3

\rightarrow m_{exsage} bits = 3
mom, m2
                   -> C = [i] [a] | C = [m, P]
                -) Co=[000][00001]
010101
                        · [0000000]
                 -) C1 = [001] [10001]
010101
001110
                         = [0011107
```



Systematic Generator Matrix

Systematic Generator matrix in Linear block codes

- A Kentoutor Matrix [K] = [Ik: P] is said to be in a systematic form If It gentoutes the systematic codewords.
- Here

$$[I_k] \longrightarrow K \times K \text{ moderix}$$

$$[G] \longrightarrow K \times (n-k) \text{ moderix}$$

$$[G] \longrightarrow K \times n \text{ moderix}$$

- In these matrix information bits are placed together
- Wdusosd



Systematic Generator matrix in Linear block codes

- A Kentoutor Matrix [K] = [Ik! P] is said to be in a systematic form If It gentrates the systematic codewords.

 [C] = [i] [K] = [m, P]
- Here

- In the atrix Informa
- Wd

other



- In these matrix information bits are placed together
- Wdusood

- so when you get codewood

- Ident natoix keeps Intomatom together
- Parater Parater Parater hit



- adusos

- so when you get codewood

- Identity matrix keeps Information together
- Parity matrix generates Parity bits



1, 12 13 14 P, P2P3-2 [i1, i2, i3, i4][1000:101 01001111 00101110 0001:011 - so when you get codewood C = (1, 12, 13, 14, P1, P2, P3) Identity matrix keeps Information together Parity matrix generates parity bits. P12 1, + 12 + 13 P2 = 12 + 13 + 14 P3 = 11 + 12 + 14

The (5,3) linear code hus the generator metrix

- Determine Systematic toom of a.
- generate codecoord for Intormation (011) with Systematic & & Non-systematic or.



The (5,3) linear code hus the generator mertoix

- Determine Systematic toom of a.
- generate codecoord for Intormation (011) with Systematic & & Non-systematic or.

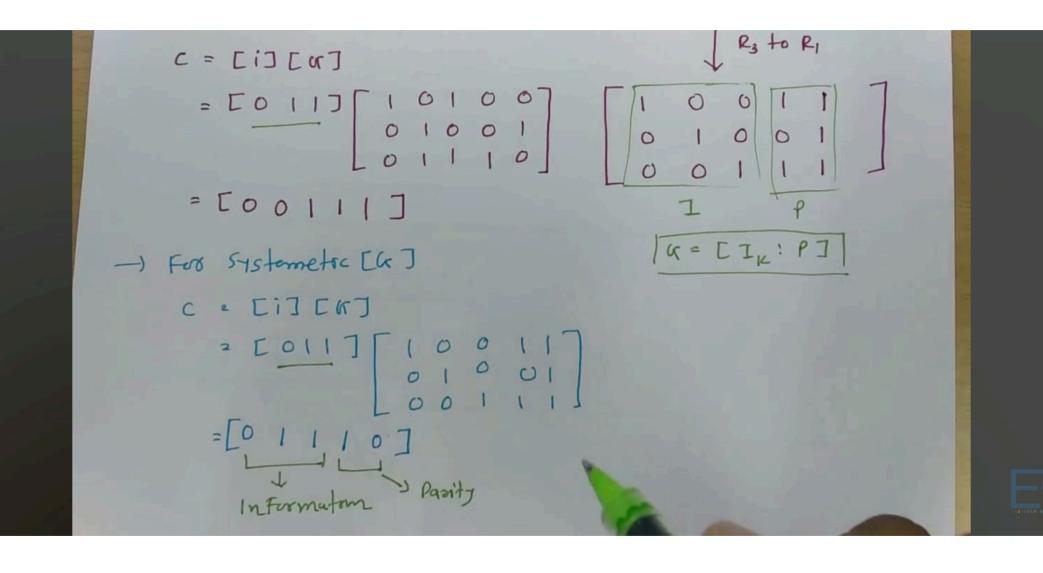


[G] = [X 1 0 1 0 0 7] Add [X 1 0 (1) 0 0 7] [X 1 0 (1) 0 0 1] [X 1 0 (1) 0 0 1] [X 1 0 (1) 0 0 1] Add R3 to R1 K = CIK: P]



[G] = [X 1 0 1 0 0 7] Add [X 1 0 (1 0 0 0 7] [X 1 0 (1 0 0 0 7] [X 1 0 (1 0 0 1 7] [X 1 0 (1 0 0 1] [X 1 0 - For Non Systematic [a] c = [i] [u] = [0 1 1] [1 0 1 0 0] [1 0 0 1 1] [0 1 0 0] [0 1 0 0] [0 1 0 0] [0 1 0 = [00111] [G = [IK: P]





Parity check matrix

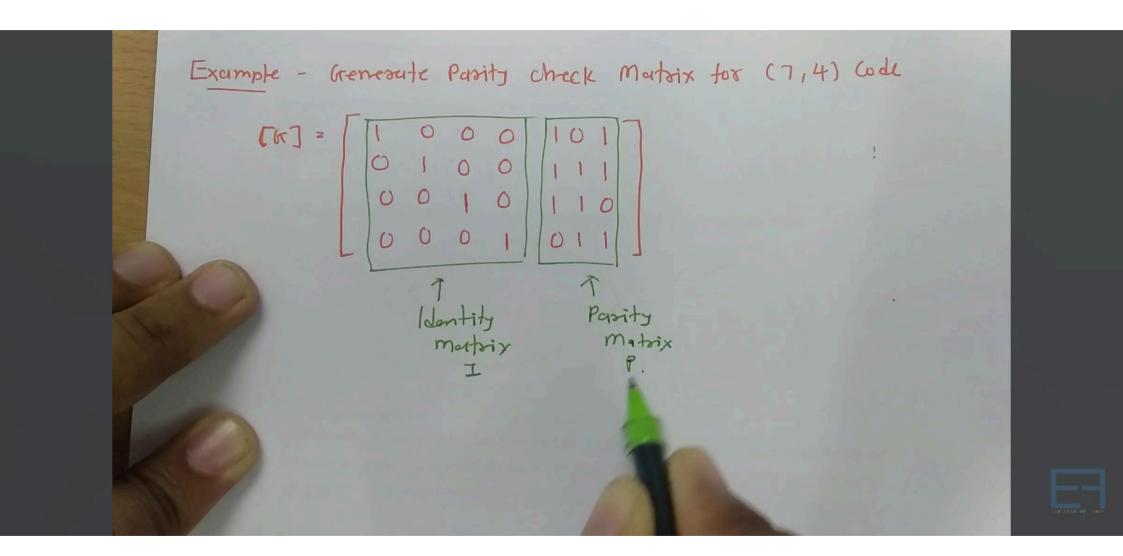
Parity Check Matarces in Linear block Codes with Examples.

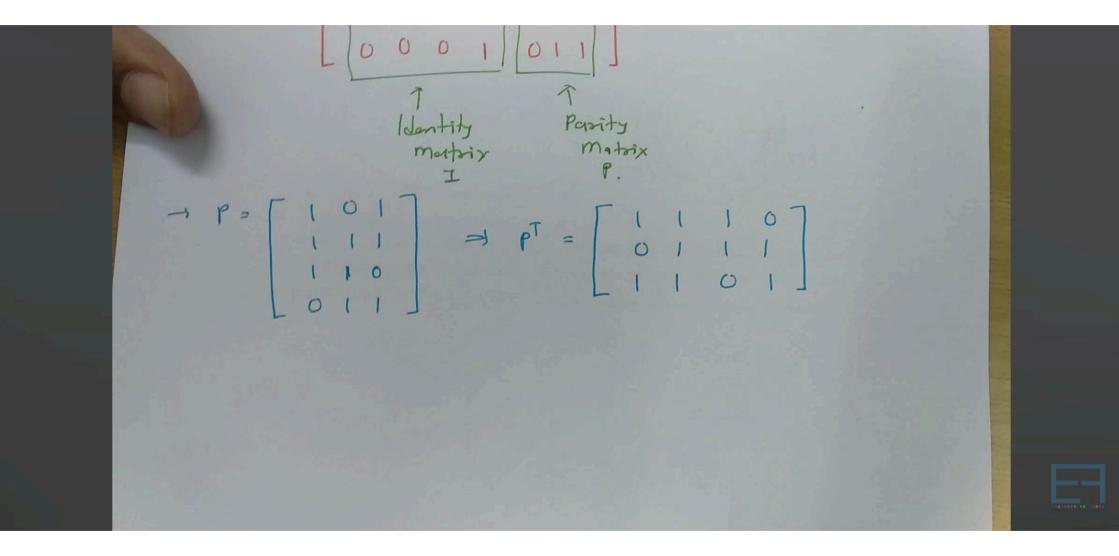
- From Generator matrix [G] = [IK|P] we can
 implify parity matrix.
 - By taking PT we can make passity threek Matrix [H]

 [H] = [PT: In-K]
- Parity cheek matrix is used at Px to decode data.

Example - Generate Parity check Matrix for (7,4) Code







Monthly Monthly I Parity Matrix P. = In-1 = I7-4 = I3 = [0 0 0]

$$\Rightarrow P = \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix} \Rightarrow P^{T} = \begin{bmatrix} 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 \end{bmatrix} \\
\Rightarrow I_{n-k} = I_{7-4} = I_{3} \\
= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \\
\Rightarrow [H] = [P^{T}: I_{n-k}] \\
= \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \end{bmatrix}$$



Prove that GHT and CHT = O.



Prove that GHT and CHT = O.

