# TUTORIAL NO:- 6

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Batch :- B1
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Q1] Given the generator polynomial $g(x) = 1 + x + x^3$
a) write the generator matrix G.
b) Draw the encoder circuit.
c) what are the code words generated for the messages [1001] and [1011]?

a) $g(x) = 1 + x + x^3$
$g(x) = 1 + 1(x) + 0(x^2) + 1(x^3) + 0(x^4) + 0(x^5) + 0(x^6)$

$\therefore$ The code vectors for $g(x)$ will be $g(x) = [1101000]$

$(7,4)$, $n=7$, $k=4$
$\therefore x g(x) = x(1+x+x^3) = x + x^2 + x^4$
$\therefore x g(x) = (0) + 1(x) + 1(x^2) + 0(x^3) + 1(x^4) + 0(x^5) + 0(x^6)$
$x g(x) = 0110100$

$x^2 g(x) = x^2(1+x+x^3) = x^2 + x^3 + x^5$
$x^2 g(x) = 0 + 0(x) + 1(x^2) + 1(x^3) + 0(x^4) + 1(x^5) + 0(x^6)$
$x^2 g(x) = 0011010$

$x^3 g(x) = x^3(1+x+x^3) = x^3 + x^4 + x^6$
$x^3 g(x) = 0 + 0(x) + 0(x^2) + 1(x^3) + 1(x^4) + 0(x^5) + 1(x^6)$
$x^3 g(x) = 0001101$

∴ After arranging codevector:

$$[g] = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

As $[g] = [P \vdots I_k]$

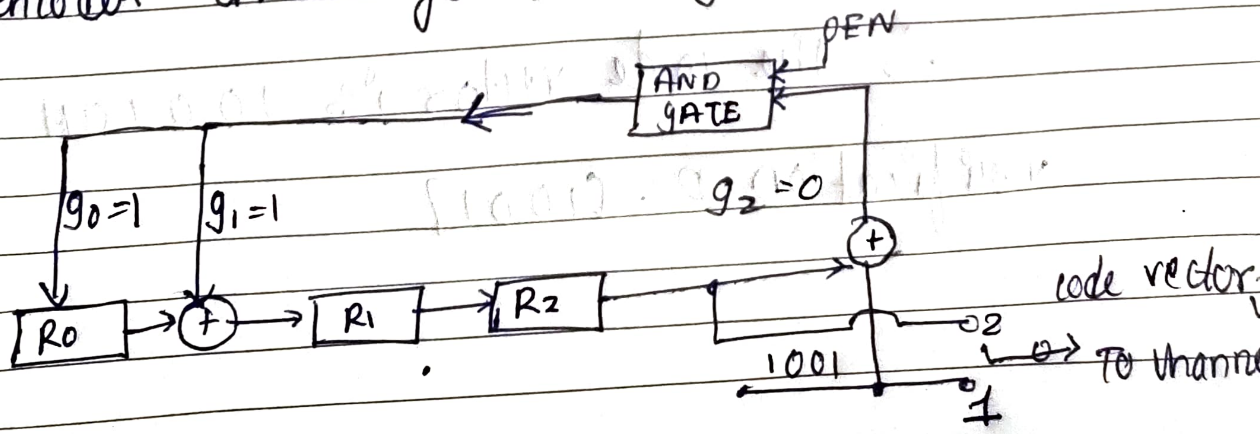
but the elements of 3rd row and 4th row, ie last 4 elements of [g] don't belong to $I_k$.

So we'll add 3rd row with 1st row and placing it in 3rd row.

Add 4th row with 1st & 2nd & place it in 4th row.

$$\therefore [g] = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

b) Encoder circuit for (7,4) cyclic code:



c] codewords generated for the message [1001] & [1011]
for the message $D = [1001]$, the shift register contain,

$R_0' = R_2 \oplus m$

$R_1' = R_2 \oplus m \oplus R_0$

$R_2' = R_1$

| m (input) | Before shifting $R_0$ | $R_1$ | $R_2$ | After shifting $R_0'$ | $R_1'$ | $R_2'$ |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 |

∴ The code vector is [0111001]

For message $D = [1011]$

| m Input D | Before shifting $R_0$ | $R_1$ | $R_2$ | After shifting $R_0'$ | $R_1'$ | $R_2'$ |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 | 0 |

∴ The code vector is 1001011

verification $D = [1001]$

$$r(x) = x^{n-k} \frac{d(x)}{g(x)}$$

$$= \frac{x^3(1+x^3)}{1+x+x^3}$$

$$\begin{array}{r|l}
x^3+x+1 & x^6+x^3 \quad (x^3+x \\
 & \underline{x^6+x^4+x^3} \\
 & x^4 \\
 & \underline{x^4+x^2+x} \\
 & x^2+x
\end{array}$$

$$[V] = \underbrace{011}_{R}\underbrace{1001}_{D}$$