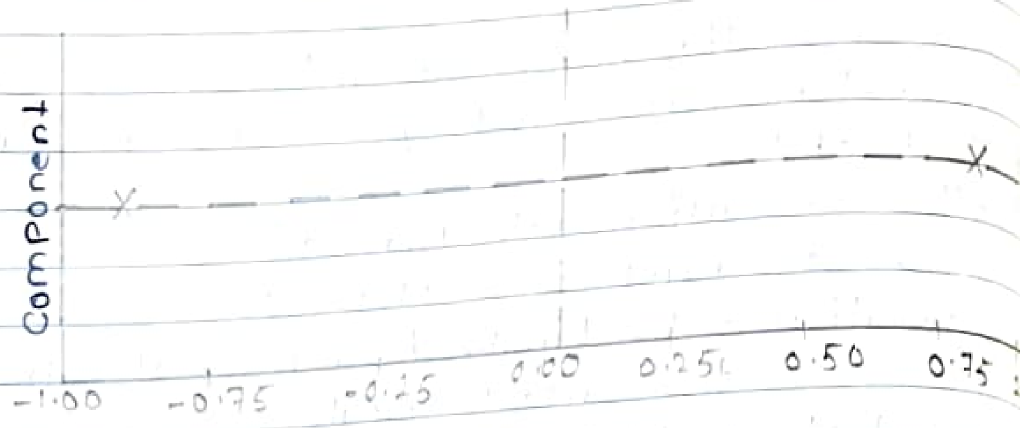
Q.3 Draw signal space representation for BPSK & Cal Euclidean distance.

→



BPSK has two symbols.

$$s_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos[2\pi f_c t] \text{ For bit } 1$$

$$s_2(t) = -\sqrt{\frac{2E_b}{T_b}} \cos[2\pi f_c t] \text{ For bit } 0$$

- Euclidean distance =

$$d = \sqrt{\int_0^{T_b} [s_1(t) - s_2(t)]^2 \, dt} \qquad = 2\sqrt{E_b}$$

$$= 2\sqrt{E_b}.$$

Q.5. Write formula For calculating error Probability

→

$$P_b = Q\left[\sqrt{\frac{2E_b}{N_0}}\right]$$

E_b = Energy per bit N_0 = Noise Power Spec

$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-u^2/2} \, du.$$

EXP NO :- 03

Write an algorithm for LBC encoding & Decoding.

• Algorithm for Encoding ⇒

1] Input the message vector m of length k.

2] Take the generatatic matrix [G] of size k x n.

3] Multiply the message vector with generator matrix.

$$c = m.G [\bmod 2]$$

Where c is the codeword legnth of n

4] output of Codeword c.

• Algorithm for Decoding ⇒

1] Recive the Codeword 'R

2] Compute the syndrome :

$$S = R.H^T \ (\bmod 2)$$

where H is the parity check matrix.

3] If S=0, the R is erro-free.

4] If S≠0 use the sydrome to located the error position & correct it.

5] Extract the original msg bit from the correct Codeword.

For a systematic (6,3) linear block code, the generator matrix G is given by.

$$G = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

Find out all codewords.

Here $k = 3$ [msg bit]

$n = 6$ [codeword length]

Binary data is transmitted rate of 10 Mbps over whose BW is 8 MHz. find signal energy per bit of BPSK receiver if probablity of error $< 10^{-4}$ [Gi... W/Hz and $\phi(3.71) = 10^{-4}$].

- From BER expression,

$$P_b = \phi\left[\sqrt{\frac{2E_b}{N_0}}\right]$$

$$\therefore \sqrt{\frac{2E_b}{N_0}} = 3.71.$$

So, E_b

$$\frac{2E_b}{N_0} = [3.71]^2$$

$$E_b = \frac{N_0[3.71]^2}{2}$$

Substitute, $N_0 = 2 \times 10^{-10}$

$$E_b = \frac{(2 \times 10^{-10})(13.76)}{2} = \underline{1.376 \times 10^{-9}} \text{ joules}$$

Compare.

Parameter	BPSK	QPSK	8-PSK
BER	$Q\left[\sqrt{\frac{2E_b}{N_0}}\right]$	$Q\left[\sqrt{\frac{2E_b}{N_0}}\right]$	$Q\left(\sqrt{2\log_2 M \sin^2}\right.$
Bit/Sym	1	2	3
B.W efficien	Low	Double of BPSK	Higher
Power efficiency	High	Same as BPSK	Lower

Expt No:- 10

What is cyclic code? Write down the properties.

- A cyclic code is a type of linear block code in which any cylic shifit of a codeword results in another valied codeword.
- That means, $C = [C_0, C_1, C_2, --, C_{n-1}]$.

  Valid codeword $C' = [C_{n-1}, C_0, C_1, --, C_{n-2}]$.

* Properties =

1] Linearity → The sum of any two codeword is also a codeword.
2] cyclic property.
3] Polynomial Representation.
4] Generator Polynomial.
5] Division Property.

For [7,4] Cyclic Code Find all Possible generator Polynomial.

→ For a [7,4] cyclic code:

$n = 7$, $k = 4$ $\quad n-k = 3$.

So,

$g(x)$ must be a degree-3 Polynomial.

∴ Factorize x^7+1 over $GF(2)$

$x^7+1 = (x+1)(x^3+x+1)(x^3+x^2+1)$

∴ Possible generator Polynomial are:

Any 3-degree-3 Factor of x^7+1;

$g_1(x) = x^3+x+1$

$g_2(x) = x^3+x^2+1$.

Hence, Possible generator Polynomials,

$g(x) = x^3+x+1$ OR $g(x) = x^3+x^2+1$.

Find out all entropies: $H(x)$, $H(y)$, $H(x,y)$, $H(x/y)$, & $I(x,y)$ if the joint probablity matrix is given as:

$$P(x,y) = \begin{vmatrix} 0.6 & 0.4 \\ 0.4 & 0.6 \end{vmatrix}$$

$$\text{Sum} = 0.6 + 0.4 + 0.4 + 0.6 = 2.0$$

$$\therefore P'(x,y) = \frac{1}{2}\begin{bmatrix} 0.6 & 0.4 \\ 0.4 & 0.6 \end{bmatrix} \begin{bmatrix} 0.3 & 0.2 \\ 0.2 & 0.3 \end{bmatrix}$$

- Marginal Probablities.
$P(x_1) = 0.3 + 0.2 = 0.5$
$P(x_2) = 0.3 + 0.2 = 0.5$
$P(y_1) = 0.3 + 0.2 = 0.5$
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So both x and y are uniform random variables

$\therefore$ Enthropy =

$H(x) = -\sum P(x_i) \log_2 P(x_i)$

$H(x) = -[0.5 \log_2 0.5 + 0.5 \log_2 0.5] = \underline{1.0 \text{ bit}}$

Similarly,

$H(y) = \underline{1.0 \text{ bit}}$

$\therefore H(x,y) = -[0.3 \log_2 0.3 + 0.2 \log_2 0.2 + 0.2 \log_2 0.2 + 0.3$

$\therefore \log_2 0.3 = -1.737$ & $\log_2 0.2 = -2.323$

So,

$H(x,y) = \underline{1.97 \text{ bits}}$

$\therefore H(x/y) = H(x \cdot y) - H(y) = 1.97 - 1 = \underline{0.97 \text{ bits}}$

$H(y/x) = H(y \cdot x) - H(x) = 1.97 - 1 = \underline{0.97 \text{ bits}}$

$I(x:y) = H(x) + H(y) - H(x \cdot y)$

$= 1 + 1 - 1.97 = \underline{\underline{0.03 \text{ bits}}}$

Q.3. It is requried to transmitt $1 * 10^6$ binary digit/s = 32-Ary PSK Scheme, calculate Bandwidth of the

→

Given,

$$R_b = 1 \times 10^6 \text{ bits/sec} \quad , M = 32$$

Each,

$$\log_2(32) = 5 \text{ bits/symbol}$$

symbol rate,

$$R_s = \frac{R_b}{\log_2 M} = \frac{1 \times 10^6}{5} = 200 \text{ kbaud.}$$

Bandwidth (ideal):

$$B = 200 \text{ kHz}$$

With $\alpha = 0.25$

$$\underline{B = 250 \text{ kHz}}$$

Q.5. Compare.

→

	Parameter	16-MPSK	16-QAM
①	Symbol Arr.	16 equally spaced point on a circle.	16 point arrange 4x4 grid.
②	minimul Euclidean	Smaller	Larger
③	Noise immunity	Lower	Higher
④	Power efficiency	High	Low
⑤	Bandwidth	Same	Same

The codeword is obtained by,

$$c = m \cdot G$$

Step 1 ⇒ list all possible message vectors (3 bits)

000, 001, 010, 011, 100, 101, 110, 111

Step 2 ⇒ Encode each msg using G.

- For m = [0 0 0]
  c = 00000
- For m = [0 0 1]
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- For m = [0 1 0]
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- For m = [1 0 0]
  c = 100011
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- For m [1 1 1]
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- Final set of codewords :-
  {00000, 001110, 010101, 011011, 100011, 10
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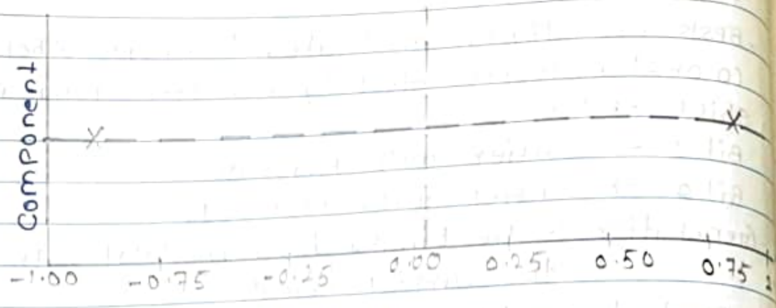

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EXP NO:- 03

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2	Bit/sym	1	2	3	[illegible]
3	B.W efficien	Low	Double of BPSK	Higher	Hi[illegible]
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