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INTERNAL ASSESSMENT TEST – III

Sub:	DIGITAL COMMUNICATIONS							Code:	21EC51
Date:	15/ 03 / 2024	Duration:	90 mins	Max Marks:	50	Sem:	V	Branch:	ECE

Answer any 5 full questions

		Marks	CO	RBT
1	a) With a block diagram of QPSK Transmitter and Receiver, explain generation and demodulation of a QPSK signal. (6M) b) Draw the QPSK wave form showing in phase and quadrature components for the sequence 01101000. (4M)	[10]	CO1	L2
2	Explain the matched filter receiver with the relevant mathematical theory.	[10]	CO2	L2
3	a) Explain the design of band limited signals with controlled ISI .Describe the time domain and frequency domain characteristics of a duo binary signal. (6M) b) Write short notes on eye diagram (4M)	[10]	CO2	L2

4	With a neat block diagram explain the concept of frequency hopping spread spectrum	[10]	CO3	L2
5	a) Explain the Nyquist criterion for distortion less base band transmission and obtain the ideal solution for zero ISI (5M) b) The binary sequence 111010010001101 is the input to Pre coder whose output is used to modulate a Duo Binary transmitting filter. Determine the Pre coded sequence, transmitted sequence, received sequence and decoded sequence.(5M)	[10]	CO2	L3
6	With a neat block diagram explain the concept of CDMA system based on IS95	[10]	CO3	L2
7	a) Explain the generation and detection of DPSK with a neat block diagram (6M) b) Describe briefly M ary QAM. Obtain the constellation of QAM for M=4 and draw the signal space diagram (4M)	[10]	CO1	L2

CCI HOD

1a)

In QPSK, the phase of the carrier takes

one of the four equally spaced values (30)

such as $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$.

For this set of values, we may define the transmitted signal as

$$s_i(t) = \sqrt{\frac{2E}{T}} \cos\left[2\pi f_c t + (2i-1)\frac{\pi}{4}\right], \quad 0 \le t \le T$$

$i = 1, 2, 3, 4$

$f_c = \frac{n}{T}$

n-non-zero integer

Here, T is the symbol duration and E is the energy of each symbol.

Each possible value of the phase corresponds to a pair of bits (dibit).

$$s_i(t) = \sqrt{\frac{2E}{T}} \cos\left[(2i-1)\frac{\pi}{4}\right] \cos(2\pi f_c t) - \sqrt{\frac{2E}{T}} \sin\left[(2i-1)\frac{\pi}{4}\right] \sin(2\pi f_c t)$$

$0 \le t \le T$

$E = 2E_b$ and $T = 2T_b$ $\quad\quad i = 1, 2, 3, 4.$

Basis functions are

$$\phi_1(t) = \sqrt{\frac{2}{T}} \cos(2\pi f_c t), \quad 0 \le t \le T$$

$$\phi_2(t) = \sqrt{\frac{2}{T}} \sin(2\pi f_c t), \quad 0 \le t \le T$$

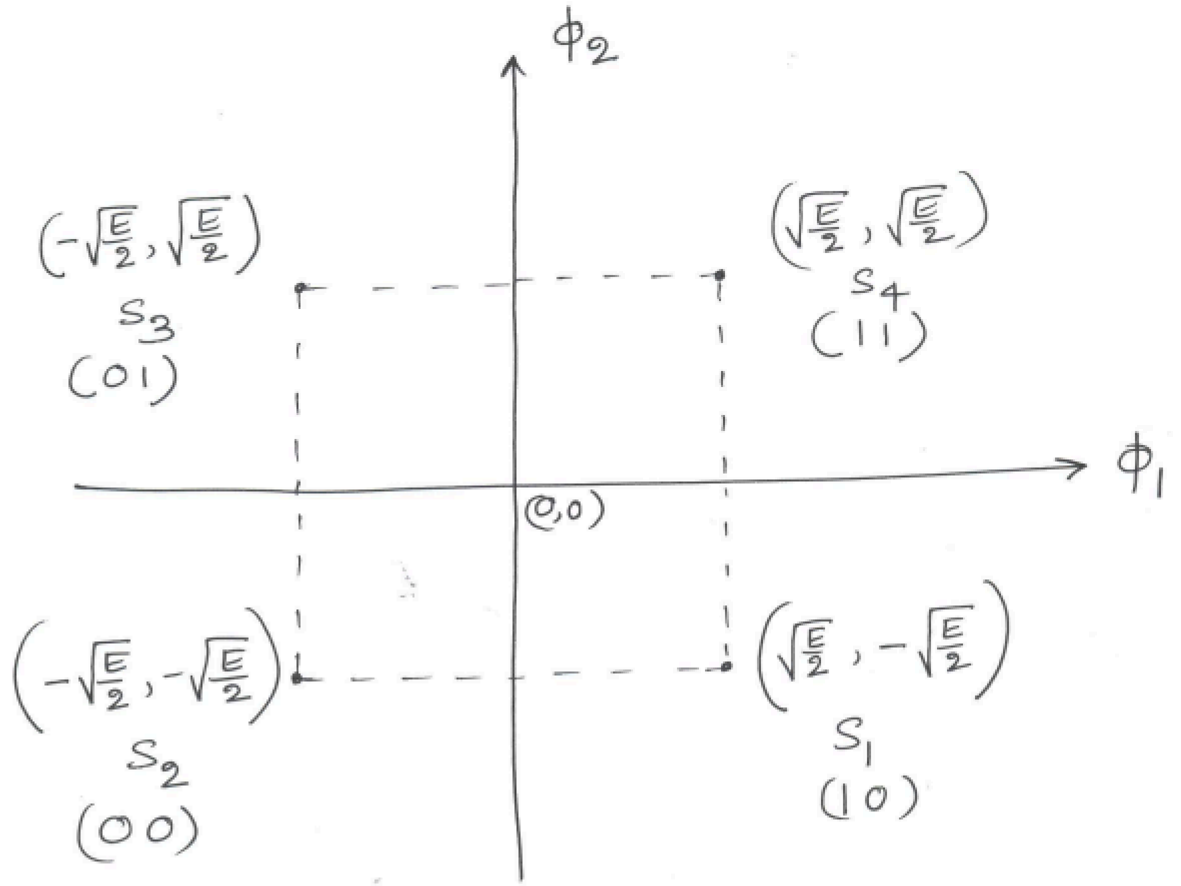
$$\therefore s_i(t) = \sqrt{E} \cos\left[(2i-1)\frac{\pi}{4}\right] \phi_1(t) - \sqrt{E} \sin\left[(2i-1)\frac{\pi}{4}\right] \phi_2(t), \quad 0 \le t \le T$$

∴ The coordinates of message points are

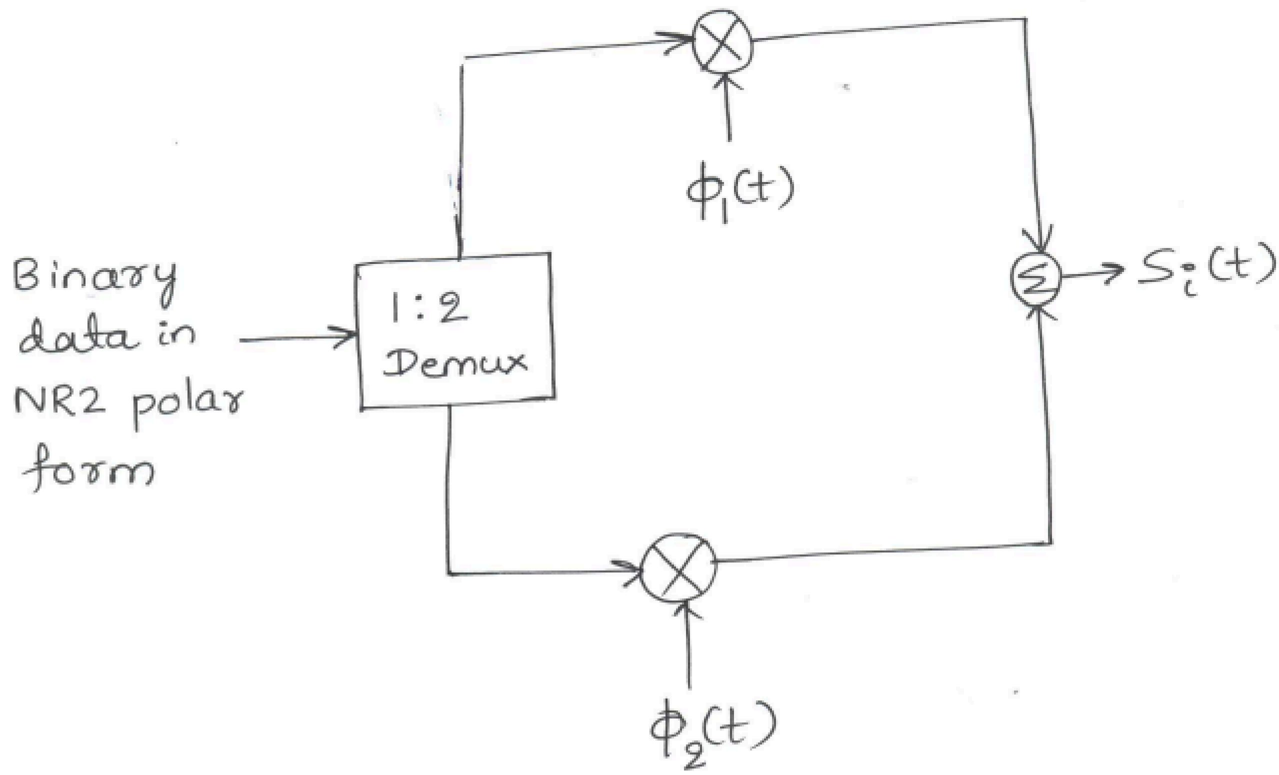
$$\begin{bmatrix} \sqrt{E} \cos\left[(2i-1)\frac{\pi}{4} \right] \\ -\sqrt{E} \sin\left[(2i-1)\frac{\pi}{4} \right] \end{bmatrix} \quad i = 1, 2, 3, 4.$$

i	phase	coordinates	aibits
1	$\frac{\pi}{4}$	$\sqrt{\frac{E}{2}}, -\sqrt{\frac{E}{2}}$	10
2	$\frac{3\pi}{4}$	$-\sqrt{\frac{E}{2}}, -\sqrt{\frac{E}{2}}$	00
3	$\frac{5\pi}{4}$	$-\sqrt{\frac{E}{2}}, \sqrt{\frac{E}{2}}$	01
4	$\frac{7\pi}{4}$	$\sqrt{\frac{E}{2}}, \sqrt{\frac{E}{2}}$	11

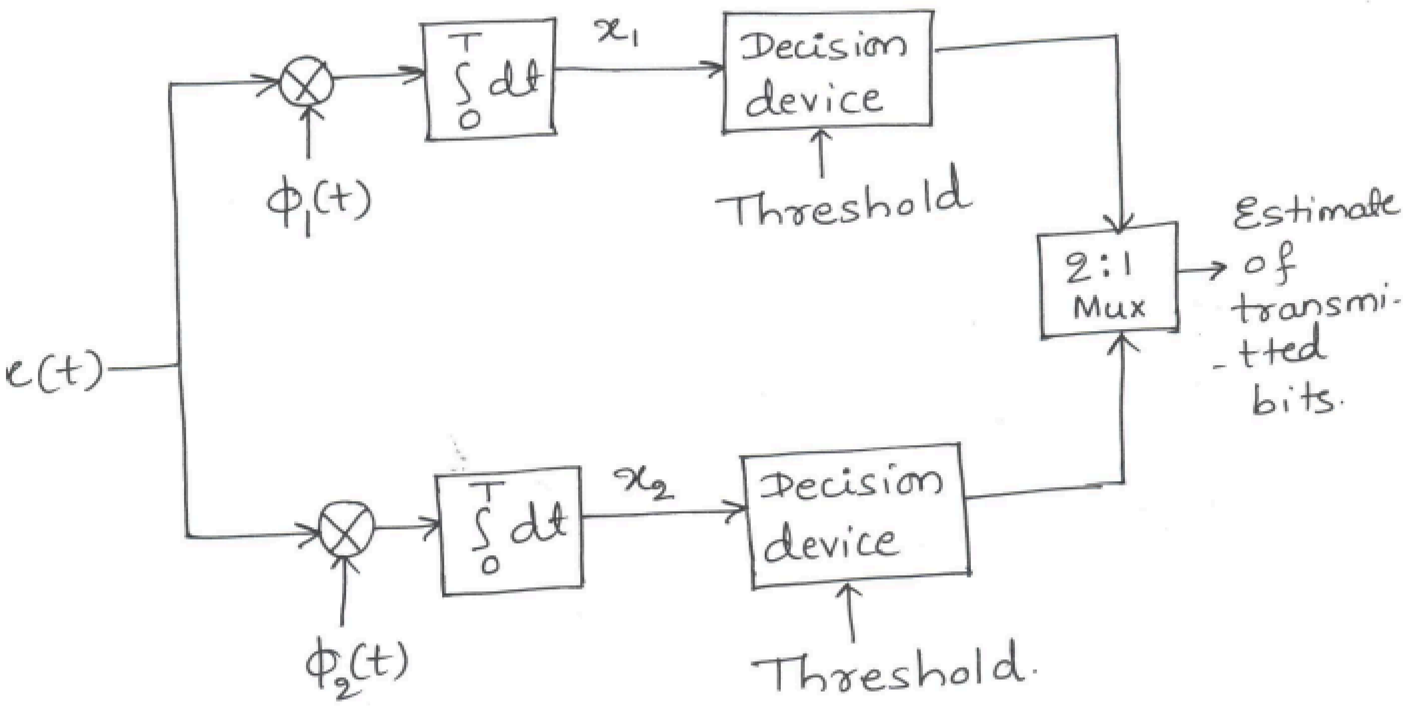
Based on these coordinates, signal space diagram of QPSK system may be drawn as follows.



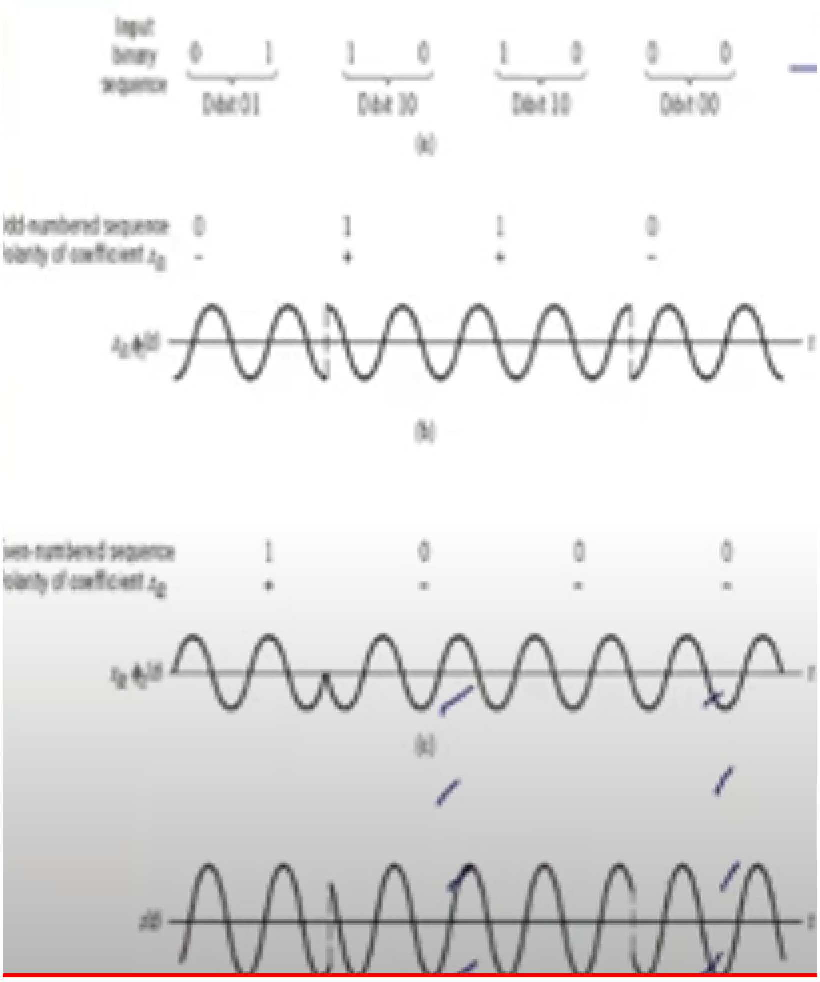
Block diagram of transmitter



Block diagram of receiver



1 b



2.

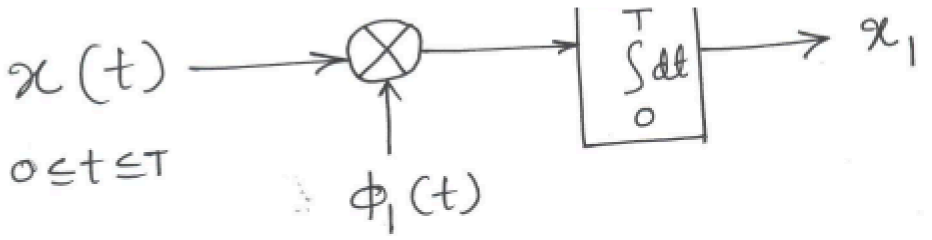
Correlation receiver consists of multiple correlators which involve multipliers and integrators.

Analog multipliers are hard to build.

Matched filter is an alternative to 53

correlator which avoids the use of multipliers.

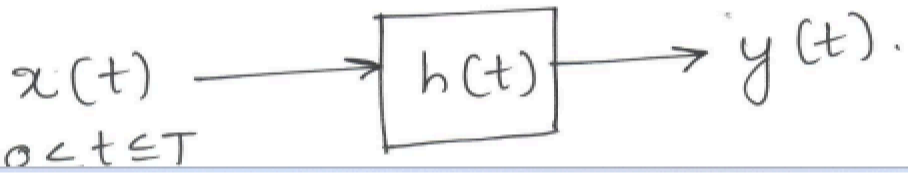
Consider the following correlator.

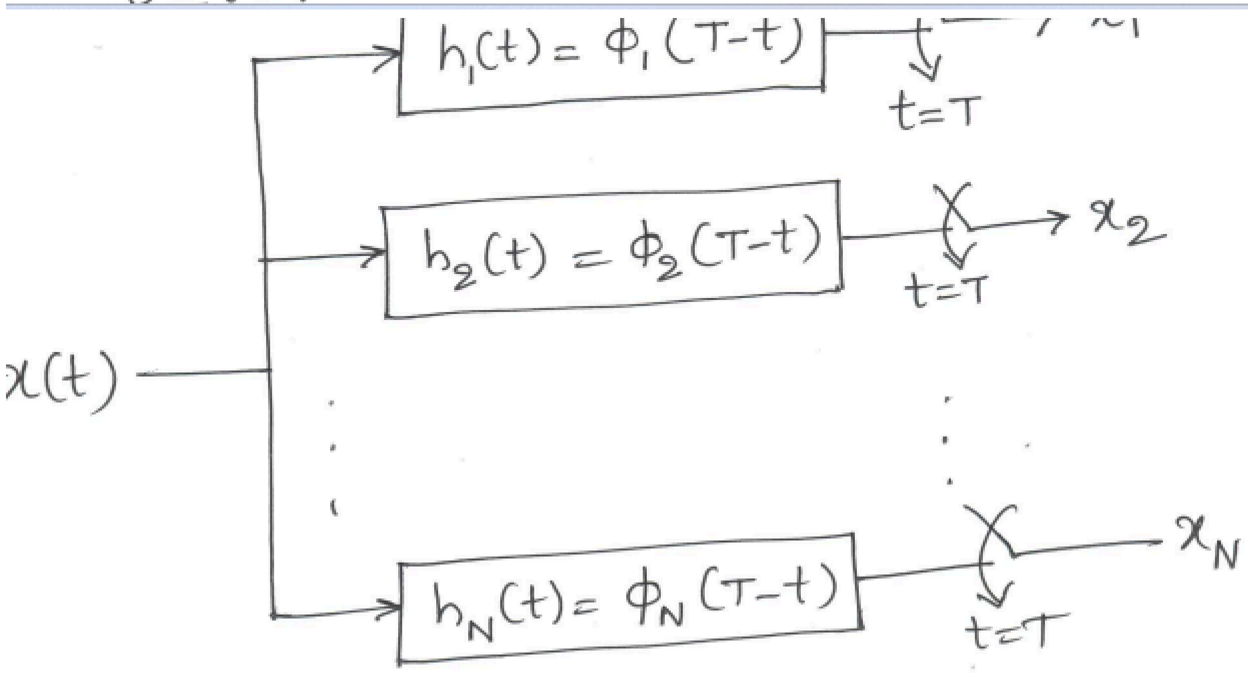


Output of the correlator,

$$x_1 = \int_0^T x(t)\,\phi_1(t)\,dt \quad \ldots (1)$$

Consider the following LTI system with impulse response h(t).

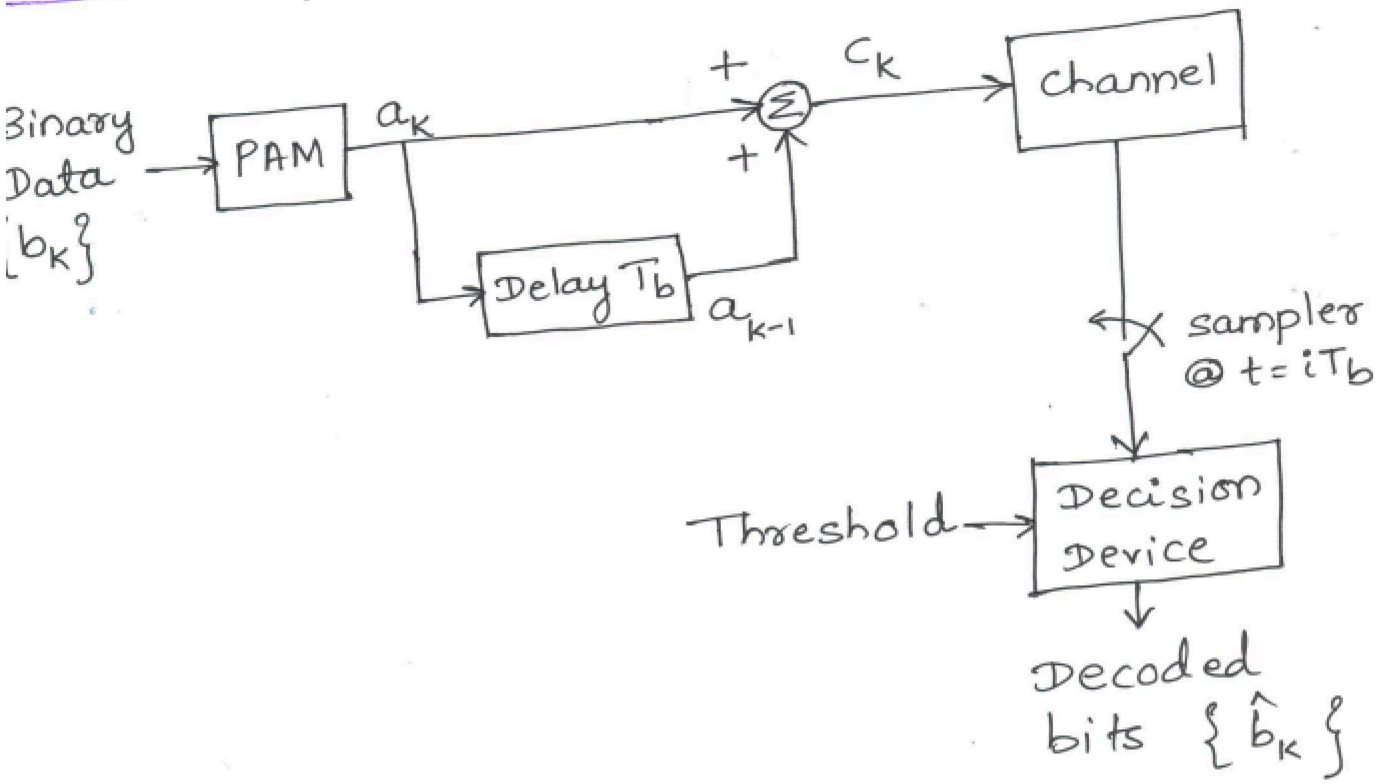




3.a

By adding ...
the transmitted signal in a controlled
manner, it is possible to achieve a bit
rate of $2B_0$ bits per second in a chann
of bandwidth B_0 Hz.
Such schemes are called correlative codin
schemes.
Duobinary coding is one such method.

Block diagram of a ...



$$a_k = PAM(b_k)$$

$$= \begin{cases} +1V & \text{if } b_k = 1 \\ -1V & \text{if } b_k = 0 \end{cases} \quad \ldots (1)$$

The output of duobinary coder,

$$c_k = a_k + a_{k-1} \quad \ldots (2)$$

We assume an ideal channel with freque ncy response,

$$H_c(f) = T_b \,, \quad -\frac{R_b}{2} \le f \le \frac{R_b}{2} \quad \ldots (3)$$

The overall frequency response of ary system is given by,

$$H(f) = \left[1 + e^{-j2\pi f T_b}\right] H_c(f)$$

$$= \left[1 + e^{-j2\pi f T_b}\right] T_b \,, \quad -\frac{R_b}{2} \le f \le \frac{R_b}{2} \quad \ldots (4)$$

$$\therefore \; H(f) = e^{-j\pi f T_b} \left[e^{j\pi f T_b} + e^{-j\pi f T_b} \right] T_b$$

$$\therefore \quad H(f) = e^{-j\pi f T_b}\left[e^{j\pi f T_b} + e^{-j\pi f T_b}\right] T_b$$

$$= e^{-j\pi f T_b}\, 2\cos(\pi f T_b)\, T_b$$

$$-\frac{R_b}{2} \le f \le \frac{R_b}{2} \quad \ldots (5)$$

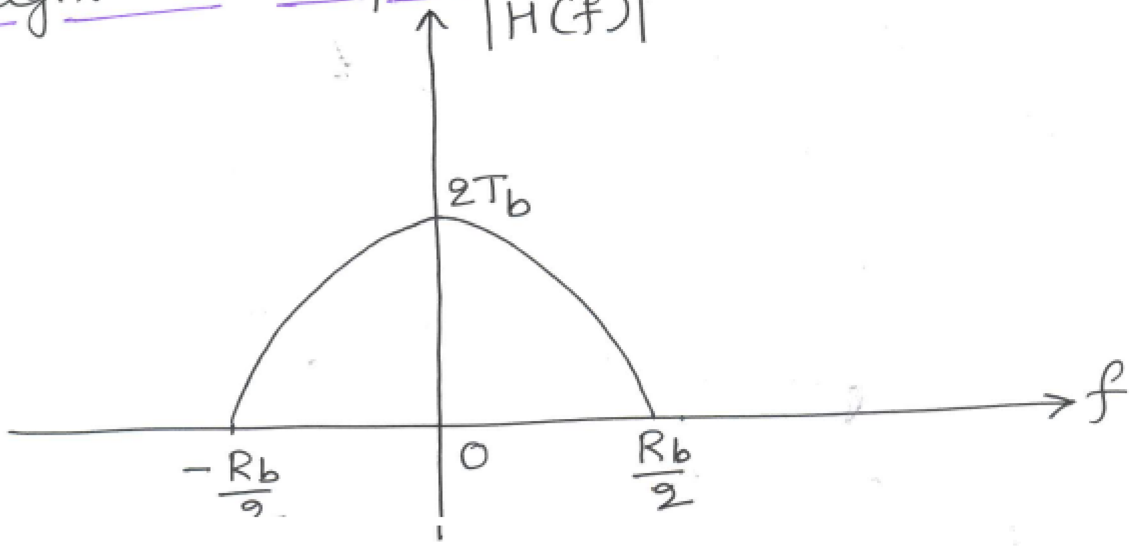
$\therefore$ Magnitude response,

$$|H(f)| = 2T_b \cos(\pi f T_b), \quad -\frac{R_b}{2} \le f \le \frac{R_b}{2}$$

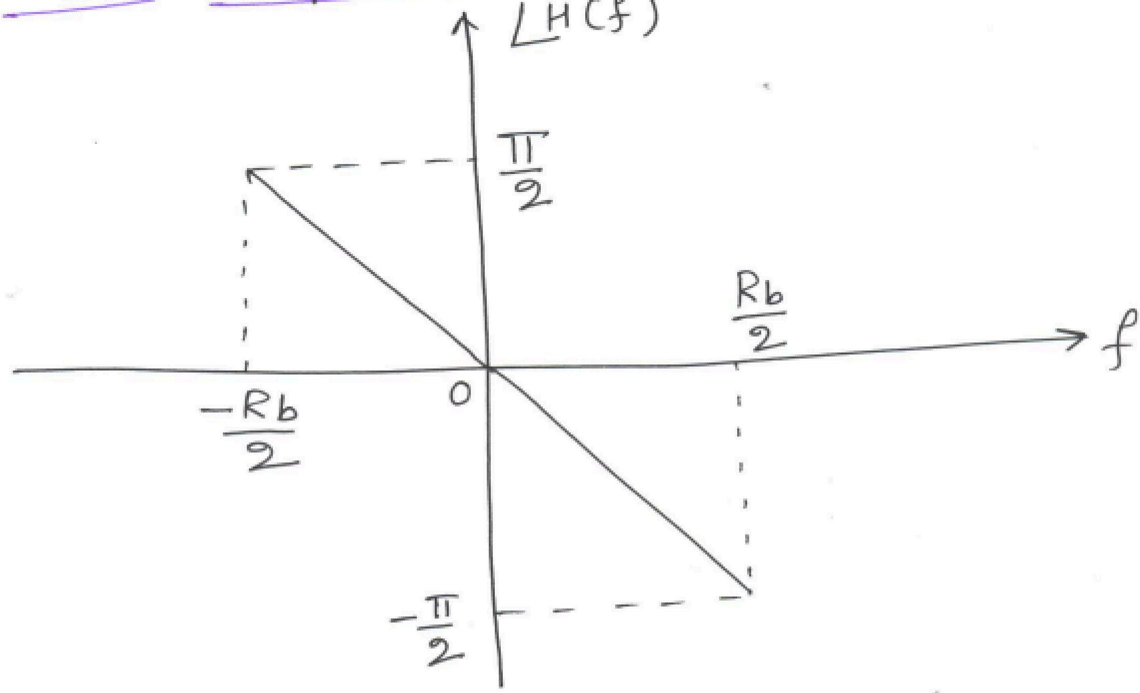
Phase response,

$$\angle H(f) = -\pi f T_b, \quad -\frac{R_b}{2} \le f \le \frac{R_b}{2}$$

Magnitude Response

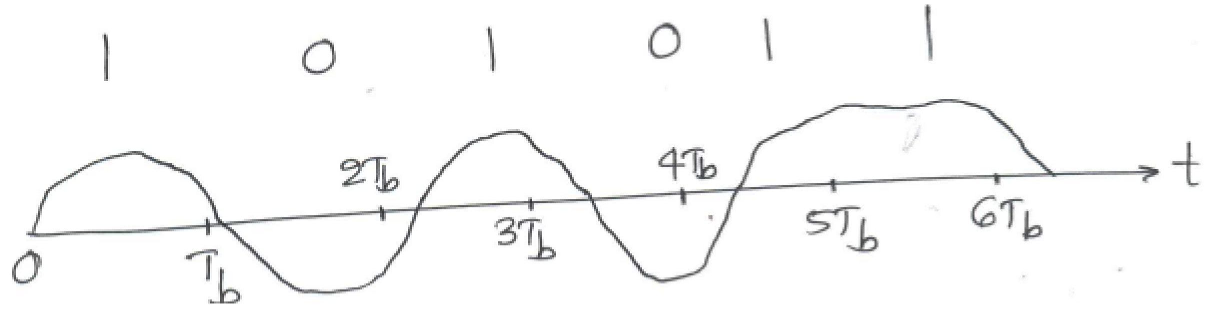


Phase response

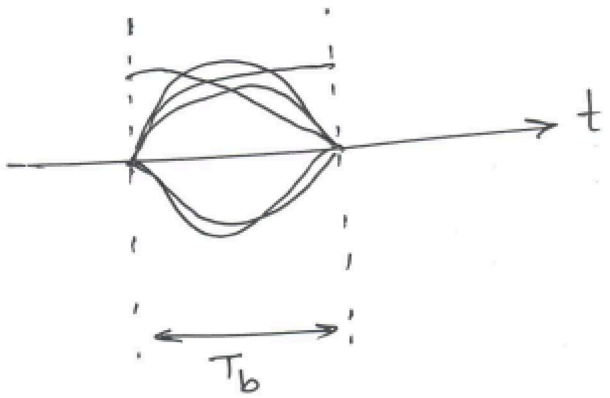


3.b

Consider a received binary
ws, which is distorted by the channel.



Let us map the received
successive bit interval into one interval
as follows



4.refer notes for 4,5,6 and 7 questions