22/1...

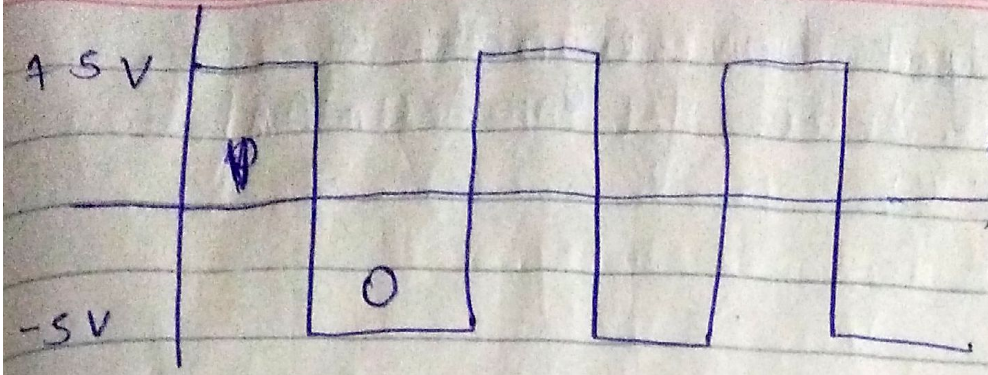
In the wire commutation the technique of modulation are:-
PCM, DPCM, DM, ADM.

In wireless communication, the technique of modulation are:-
ASK, FSK, PSK, QPSK.

Binary Signalling Schemes.

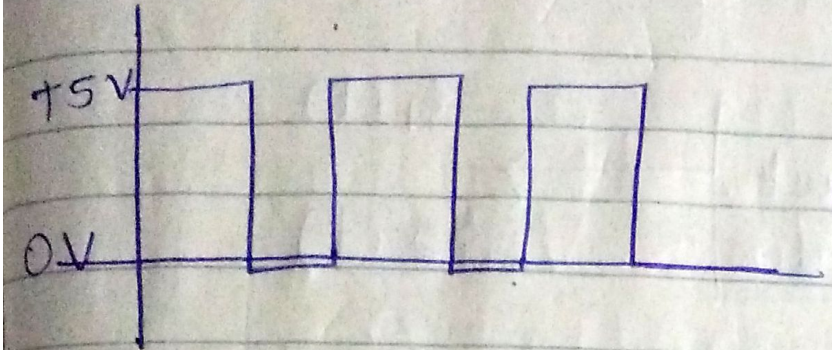
ASK, PSK and FSK scheme are used to transmit digital signal through free space.
In this schemes one bit is transmitted in a specific time in a specific time instant through free space.

In this schemes one of the parameter of the carrier s/g will be switched b/w two possible values as the message s/g switches b/w 2 possible voltages so these schemes are called as signalling or switching or keying

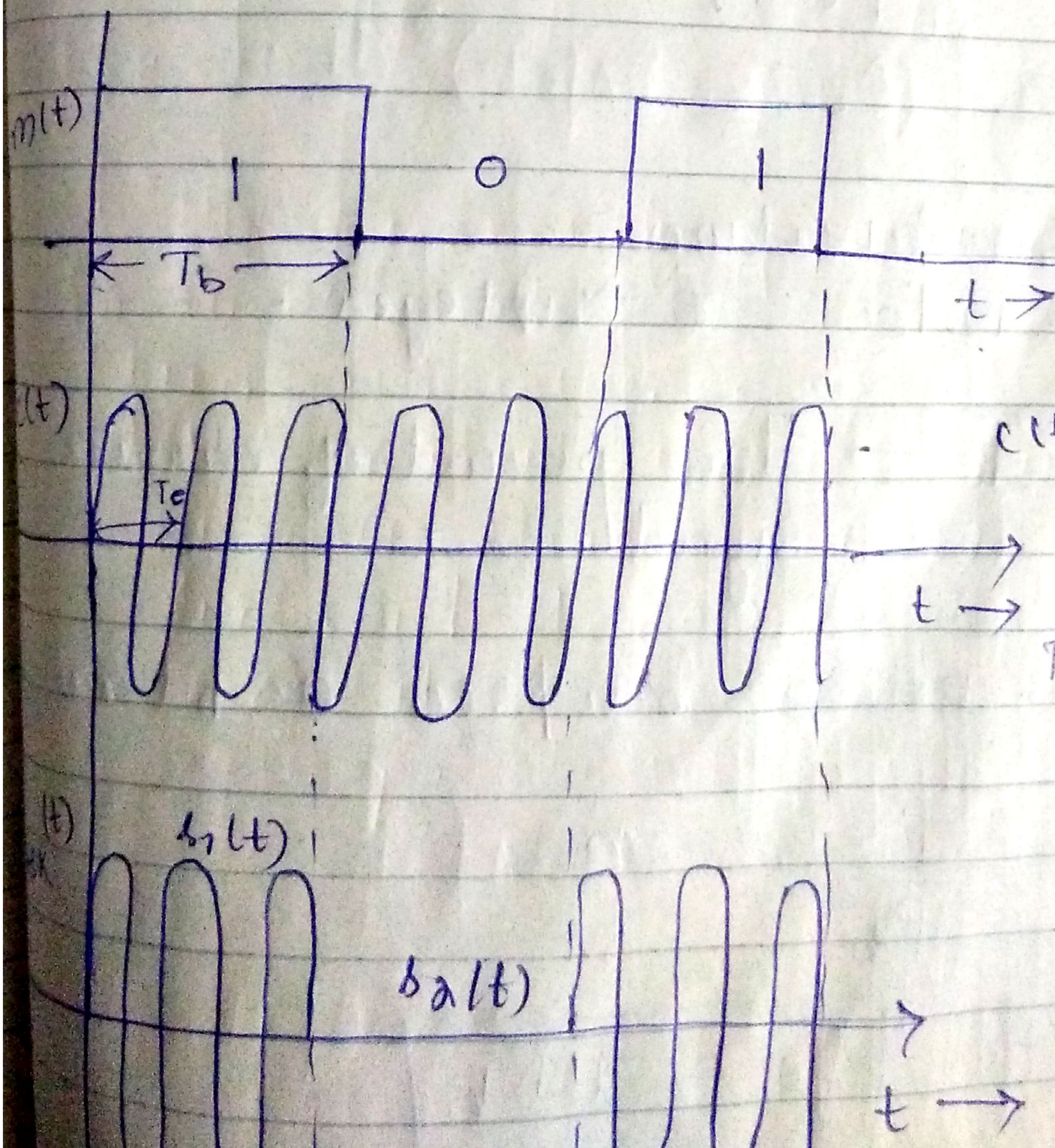


NRZ → not return to zero

m(t).



RZ → return to zero



T_b = Bit duration

c(t) can be
$A_c \cos 2\pi f_c t$
$A_c \sin 2\pi f_c t$

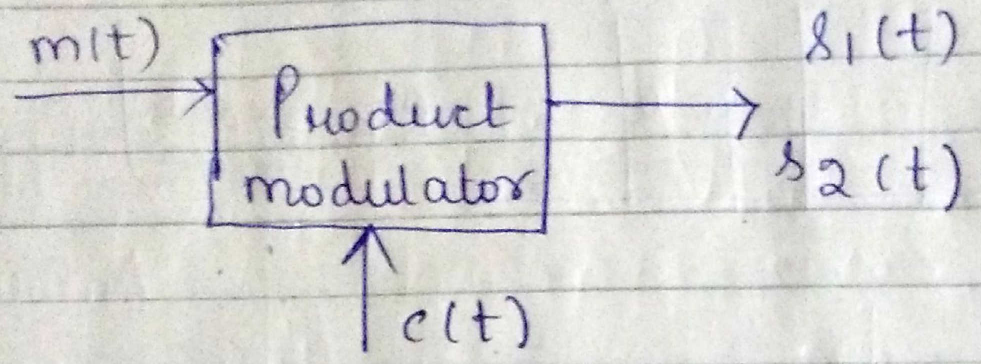
T_c = time of carrier.

In ASK we got two signals :-

(1) $s_1(t) = A_c \cos 2\pi f_c t$ or $A_c \sin 2\pi f_c t$

(2) $s_2(t) = 0$.

<u>Transmitter</u>.



T_b = bit duration

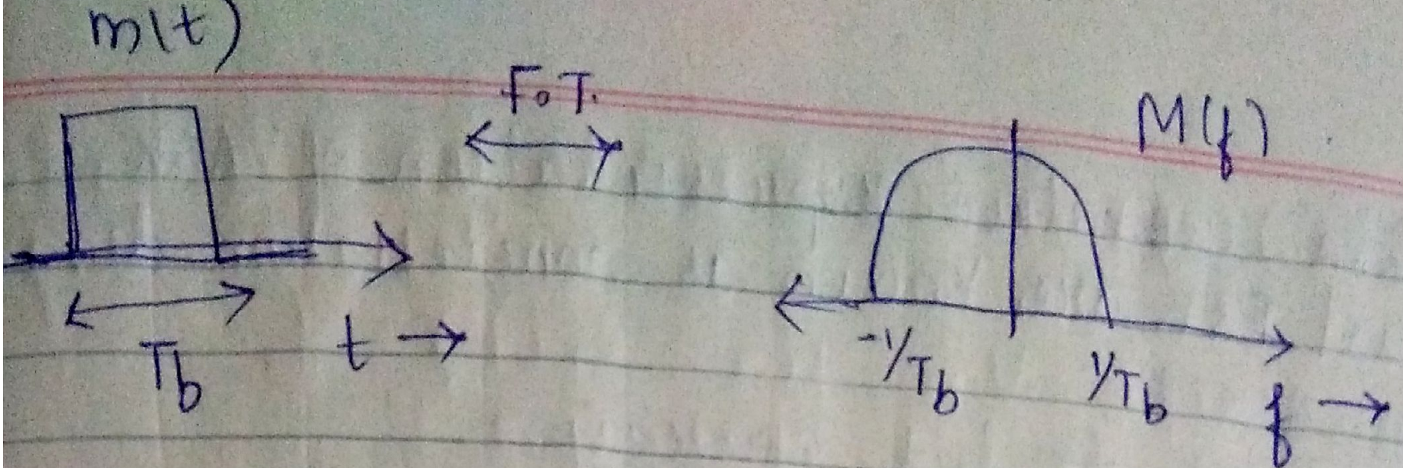
$T_b = n T_c$ $n \rightarrow$ integer.

$T_c \rightarrow$ Time period of carrier signal

$R_b \rightarrow$ no:- of bits/sec or bit rate

$\rightarrow \dfrac{1}{R_b} = \dfrac{n}{f_c}$.

$\rightarrow \boxed{f_c = n R_b}$



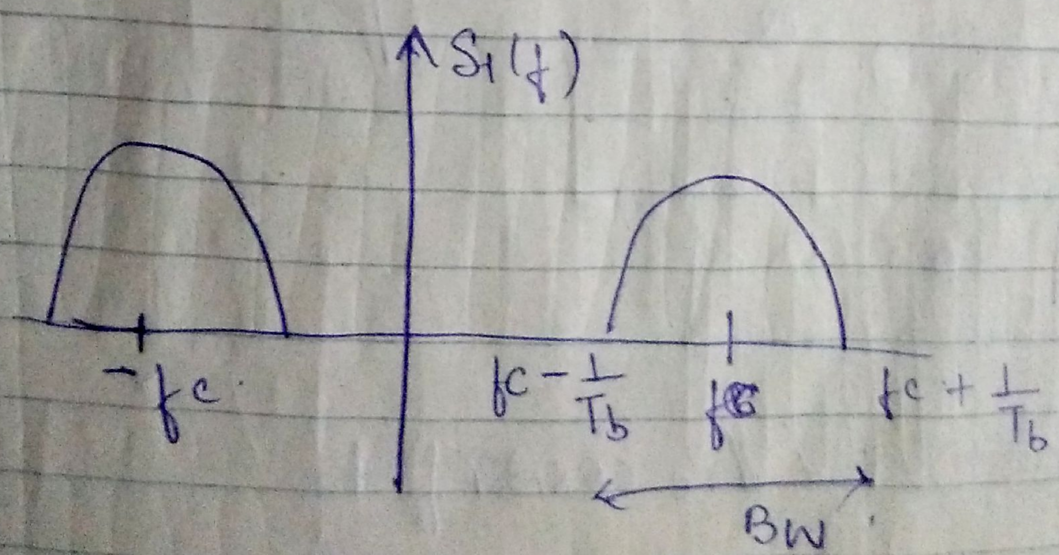
$$s(t) = c(t)\, m(t)$$

$$s(t) = A_c \cos 2\pi f_c t \cdot m(t)$$

$$= \frac{A_c}{2}\left[e^{j2\pi f_c t} + e^{-j2\pi f_c t}\right] \cdot m(t)$$

$$S(f) = \frac{A_c}{2}\left[M(f-f_c) + M(f+f_c)\right]$$

$$S_1(f) = S(f) \quad ; \quad S_2(f) = 0$$



$$\boxed{BW = \frac{2}{T_b} = 2 \cdot R_b}$$

The geometric representation of ASK, FSK and PSK are known as constellation diagram.

For ASK :

$E_b \rightarrow$ bit energy

$$s_1(t) = A_c \cos 2\pi f_c t .$$
$$s_2(t) = 0 .$$

$$E_b = \int_{-\infty}^{\infty} x^2(t)\, dt .$$

$$= \int_0^{T_b} (A_c \cos 2\pi f_c t)^2\, dt .$$

For '1' $\boxed{E_b = \frac{A_c^2}{2}(T_b)}$

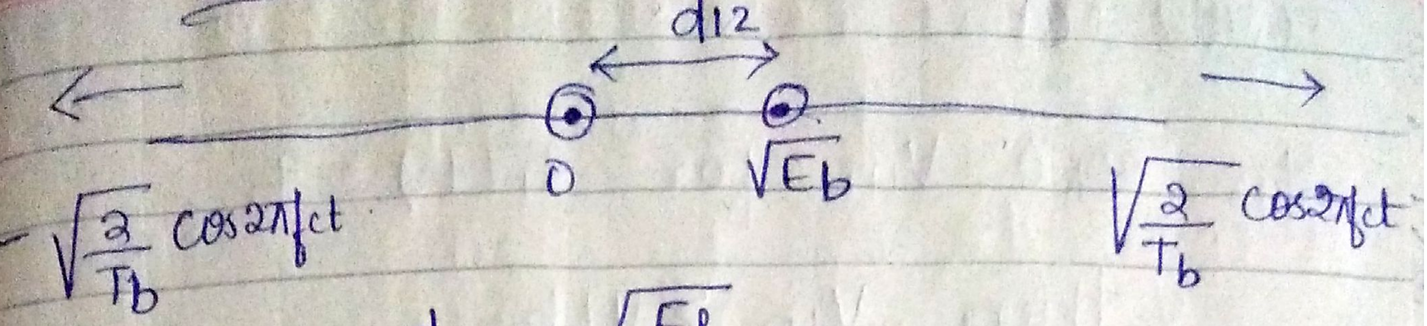
For '0' $\boxed{E_b = 0}$

$$s_1(t) = A_c \cos 2\pi f_c t$$

$$= \sqrt{\frac{2E_b}{T_b}} \cos 2\pi f_c t .$$

$$s_2(t) = 0 .$$

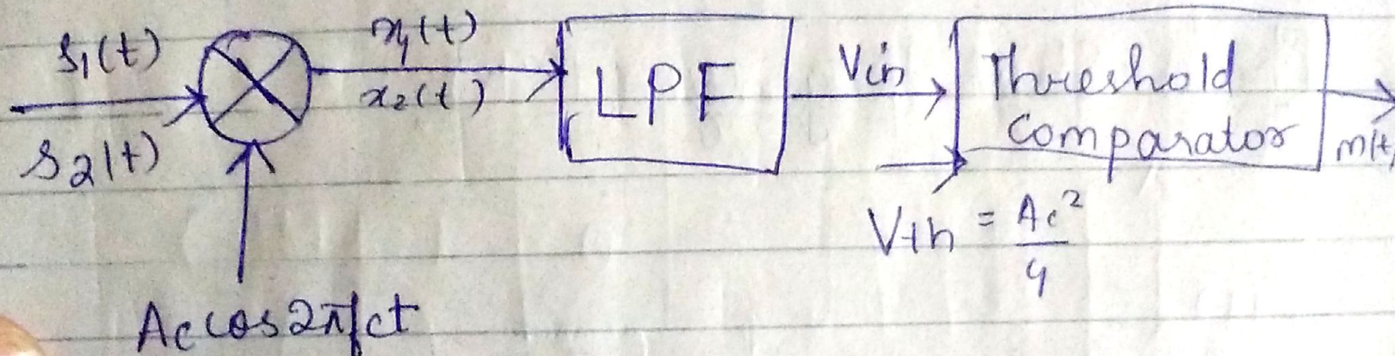
Constellation diagram of ASK



$$d_{12} = \sqrt{E_b}$$

$$P_e \propto \frac{1}{d_{12}} \quad (P_e = \text{probability of error})$$

ASK Receiver



$$x(t) = A_c^2 \cos^2 2\pi f_c t$$

$$= \frac{A_c^2}{2}\left[1 + \cos 4\pi f_c t\right]$$

$$\Big\downarrow \text{LPF}$$

$$\frac{A_c^2}{2}$$

If $V_{in} > V_{th} \longrightarrow 1$

$x_2(t) = 0$.

For Vin for $s_1(t) = 1$

then $V_{in} > V_{th}$

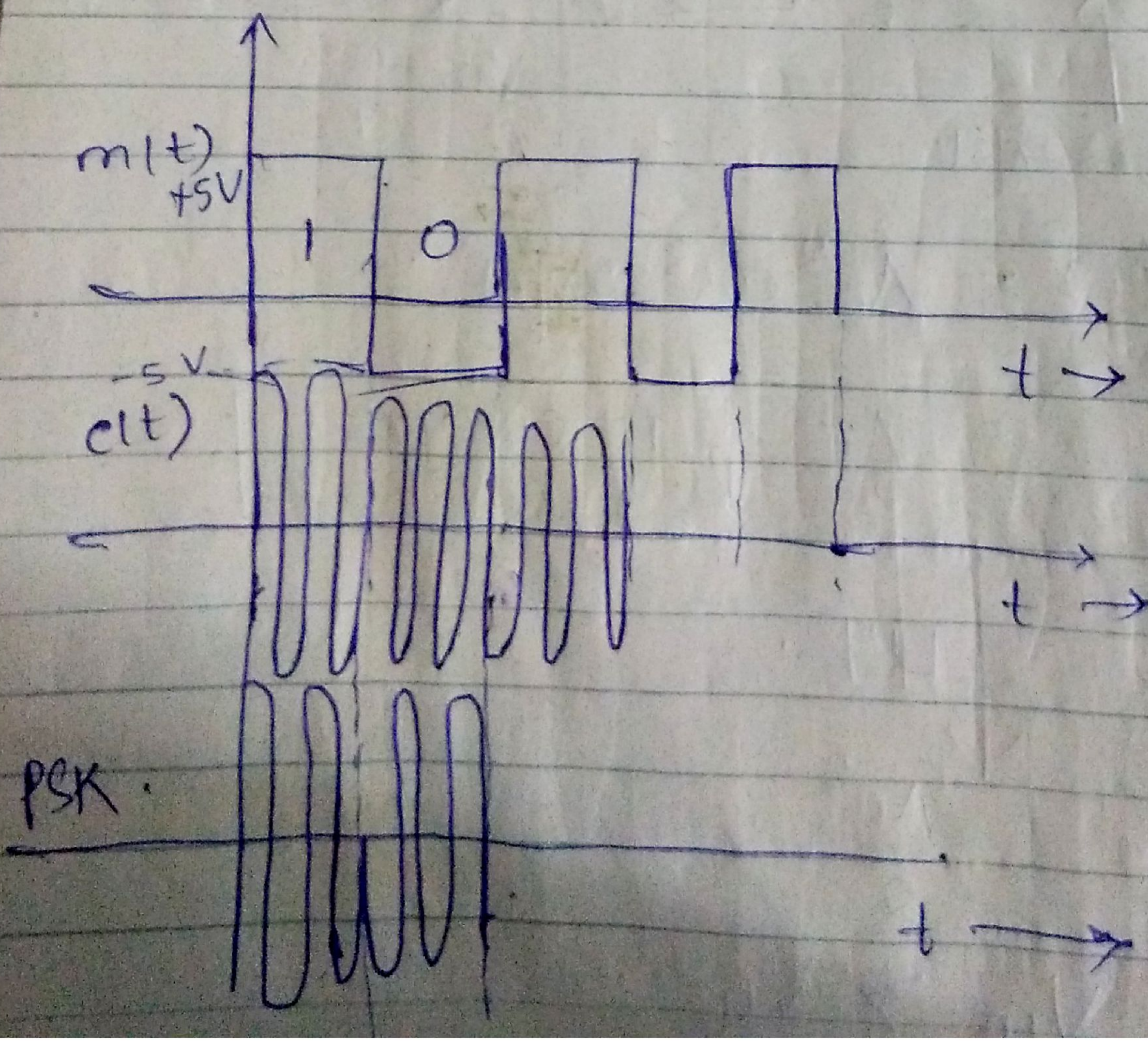
so $m(t) = 1$

For Vin for $s_2(t) = 0$

then $V_{in} < V_{th}$

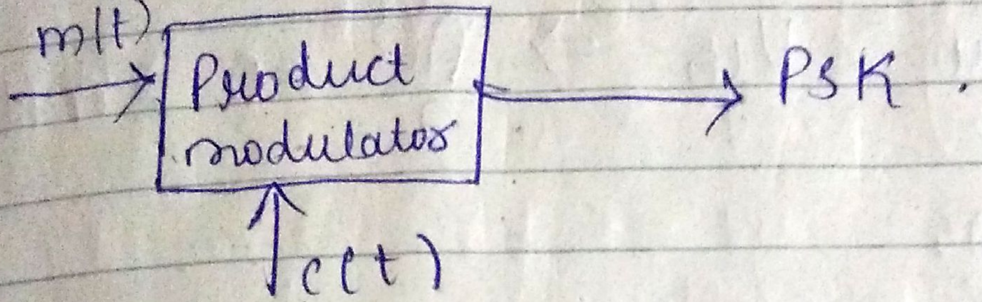
so $m(t) = 0$.

Phase Shift Keying (PSK)



$$\boxed{f_c = n R_b}$$

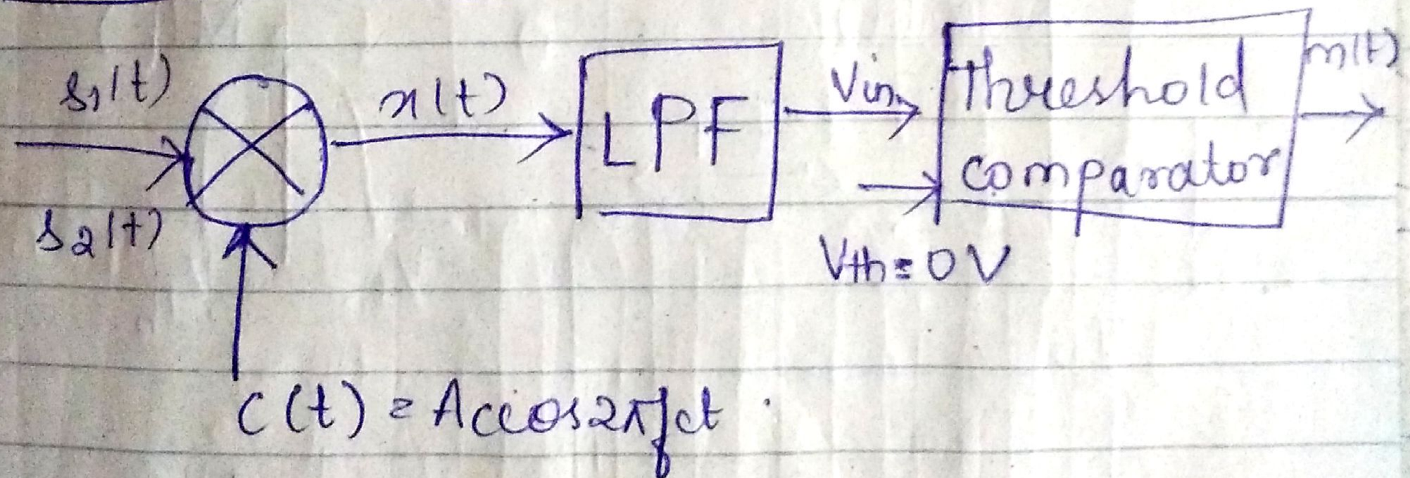
Transmitter of PSK.



$s_1(t) = A_c \cos 2\pi f_c t$

$s_2(t) = -A_c \cos 2\pi f_c t$

PSK Receiver.



$$x(t) = A_c^2 \cos^2 2\pi f_c t$$

$$= \frac{A_c^2}{2}\left(1 + \frac{\cos 4\pi f_c t}{2}\right)$$

At logic 1 → after LPF $= \frac{A_c^2}{2} = V_{in}$

At logic 0 (after LPF) $\Rightarrow V_{in} = -\frac{A_c^2}{2}$

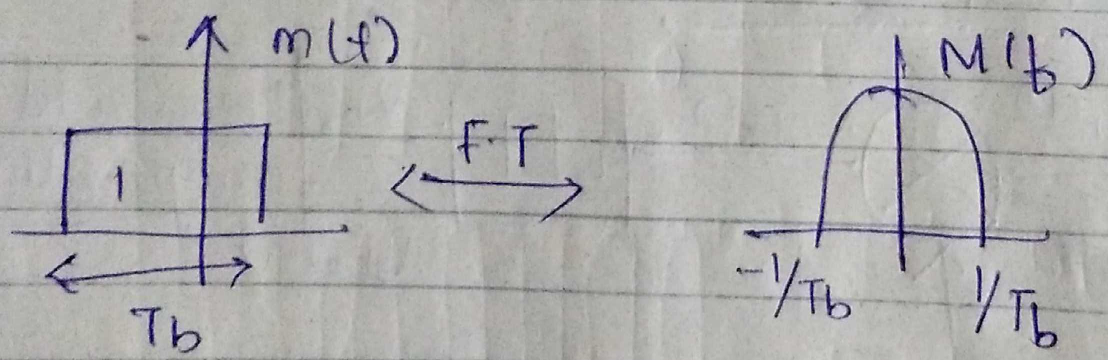
At logic 1;

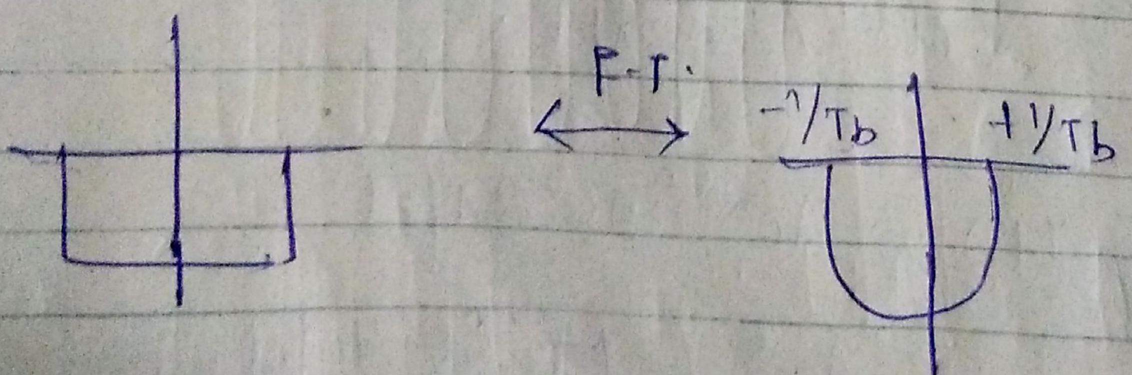
$V_{in} > V_{th} \Rightarrow \frac{A_c^2}{2} > 0 \Rightarrow m(t) = 1$

At logic 0,

$V_{in} < V_{th} \Rightarrow \frac{-A_c^2}{2} < 0 \Rightarrow m(t) = 0$

<u>Frequency spectrum</u>



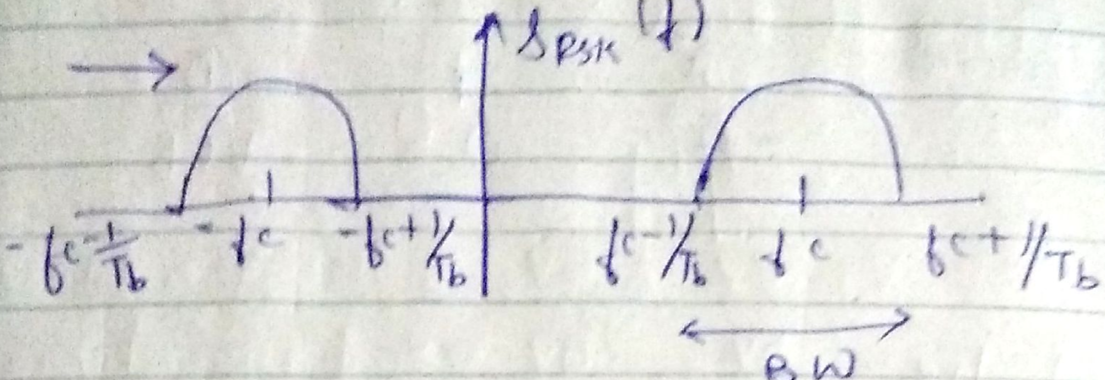


$s(t) = c(t)\, m(t)$

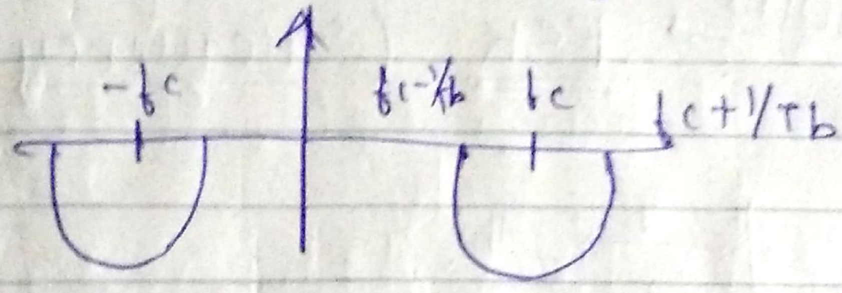
$= A_c \cos 2\pi f_c t\, m(t)$

$$= \frac{A_c}{2}\left[M(f-f_c) + M(f+f_c)\right]$$

'1' $\longrightarrow$



'0' $\longrightarrow$



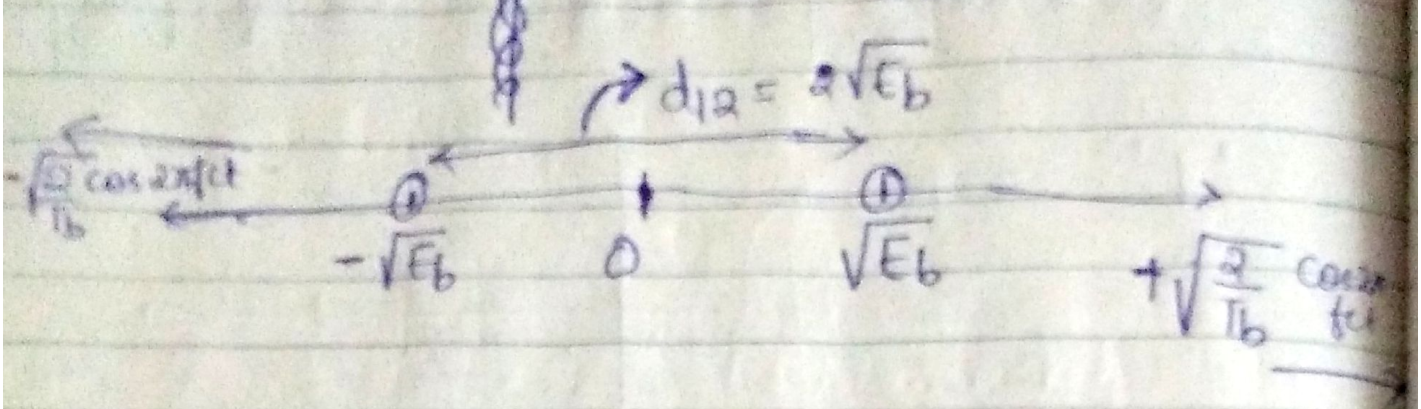
$$\boxed{\text{Bandwidth} = \frac{2}{T_b} = 2R_b}$$

<u>Constellation diagram</u>

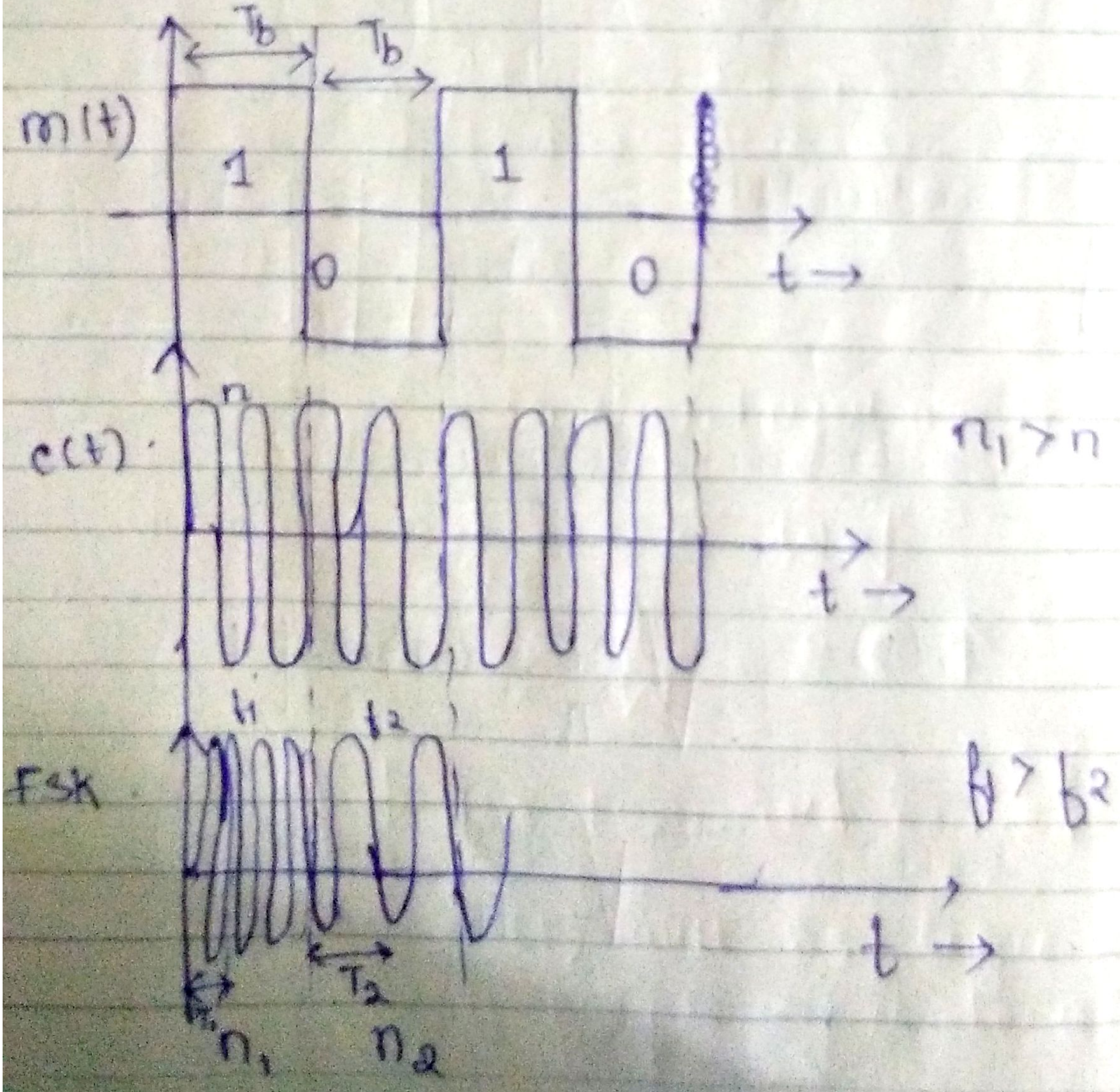
$$s_1(t) = \sqrt{\frac{2E_b}{T_b}}\cos 2\pi f_c t$$

$$s_2(t) = -\sqrt{\frac{2E_b}{T_b}}\cos 2\pi f_c t$$

$P_e \propto \frac{1}{d_{12}}$



23/10/18 **FSK** (Frequency shift keying)



$T_b = n_1 T_1$

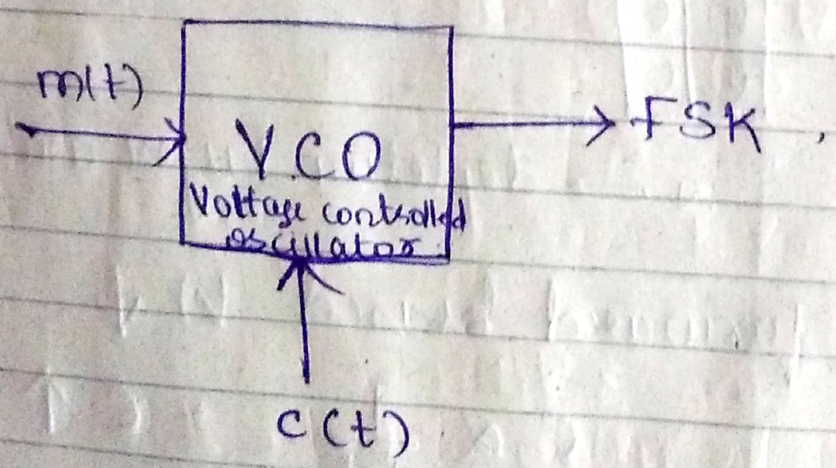
$T_b = n_2 T_2$

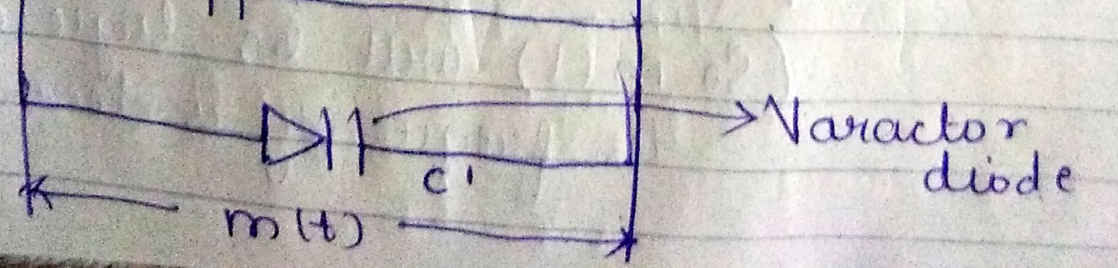
$T_b = \frac{1}{R_b}$

$T_1 = \frac{1}{f_1}$ $\boxed{f_1 = n_1 R_b}$

$\frac{1}{R_b} = \frac{n_2}{f_2}$ $\boxed{f_2 = R_b n_2}$

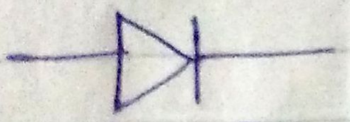
Transmitter





Varactor → variable capacitor

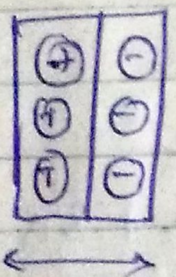
<u>Normal diode</u>.



0V 5V → reverse biased (open c... in...

5V 0V → forward biased (short circuit

$$f = \frac{1}{2\pi\sqrt{(L_1+L_2)(C'+C)}}$$



$\overleftrightarrow{\;W\;}$ → depletion layer width.

For forward biased $W \downarrow$.

$$C \propto \frac{1}{W} \;,\; C \uparrow$$

So $f \downarrow$ for Forward biased

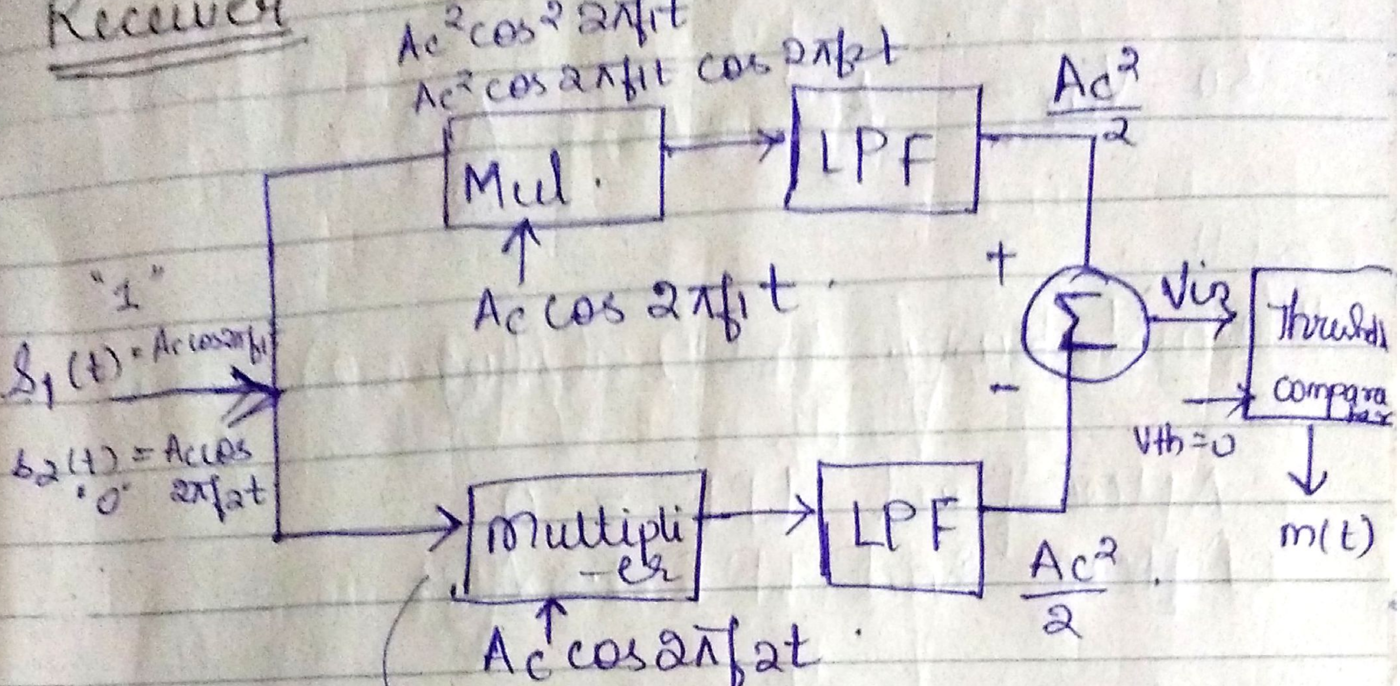
(So $m(t)$ will be logic 0)

as frequency is decreased

For reverse biased, $W\uparrow$, $C\downarrow$, $f\uparrow$.

(so m(t) will be logic 1 as frequency is increased).

Receiver



$$A_c^2\cos^2 2\pi f_2 t = \frac{A_c^2}{2}\left[1+\cos 4\pi f_2 t\right]$$

$$A_c^2 \cos 2\pi f_1 t \cos 2\pi f_2 t$$
$$= \frac{A_c^2}{2}\left[\cos 2\pi(f_1+f_2)t + \cos 2\pi(f_1-f_2)t\right]$$

LPF → only pass the constant value.

When $s_1(t)$ → For first LPF, $\frac{A_c^2}{2}$.
$s_2(t)$ → " " " $= 0$.

When $s_1(t)$ → For second LPF $= 0$
$s_2(t)$ → " " " $= A_c^2/2$

Case I

When taking logic 1

For first LPF = $\frac{A_c^2}{2}$

After second " = 0.

So $V_{in} = \frac{A_c^2}{2} - 0 = \frac{A_c^2}{2}$.

Case II

When taking $s_2(t)$ (Logic 0)

After first LPF = 0

After 2nd LPF = $\frac{A_c^2}{2}$

So $V_{in} = 0 - \frac{A_c^2}{2} = -\frac{A_c^2}{2}$.

For case 1.

$V_{in} > V_{th}$

$m(t)$ = logic 1.

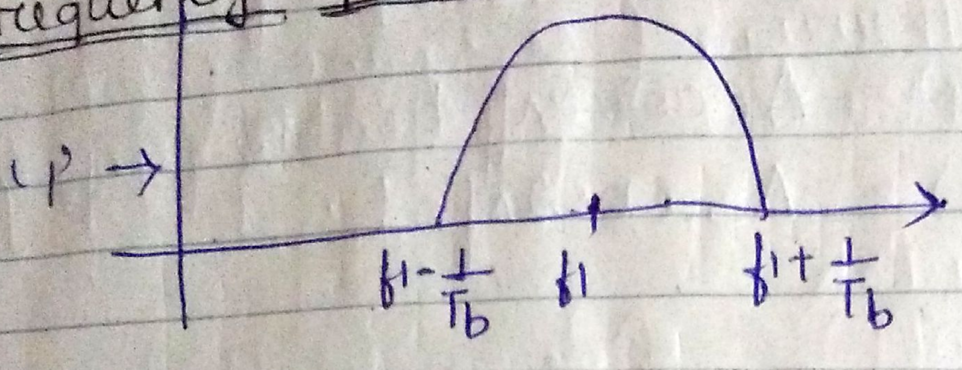
For case II:

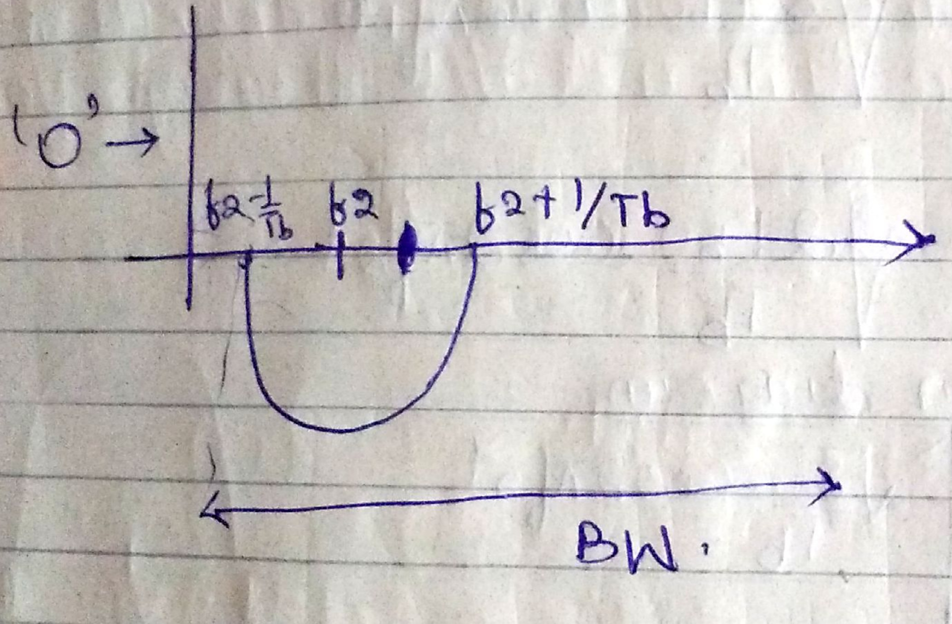
$V_{in} < V_{th}$.

$m(t)$ = logic 0.

So, we got m(t) same as we have been given.

Frequency Spectrum.





$$BW = \left(f_1 + \frac{1}{T_b}\right) - \left(f_2 - \frac{1}{T_b}\right)$$

$$= (f_1 - f_2) + \frac{2}{T_b}$$

$$\boxed{BW = f_1 - f_2 + 2R_b}$$

24/10/18

$$E_b = \frac{A_c^2}{2} T_b$$

$$\Rightarrow A_c = \sqrt{\frac{2E_b}{T_b}}$$

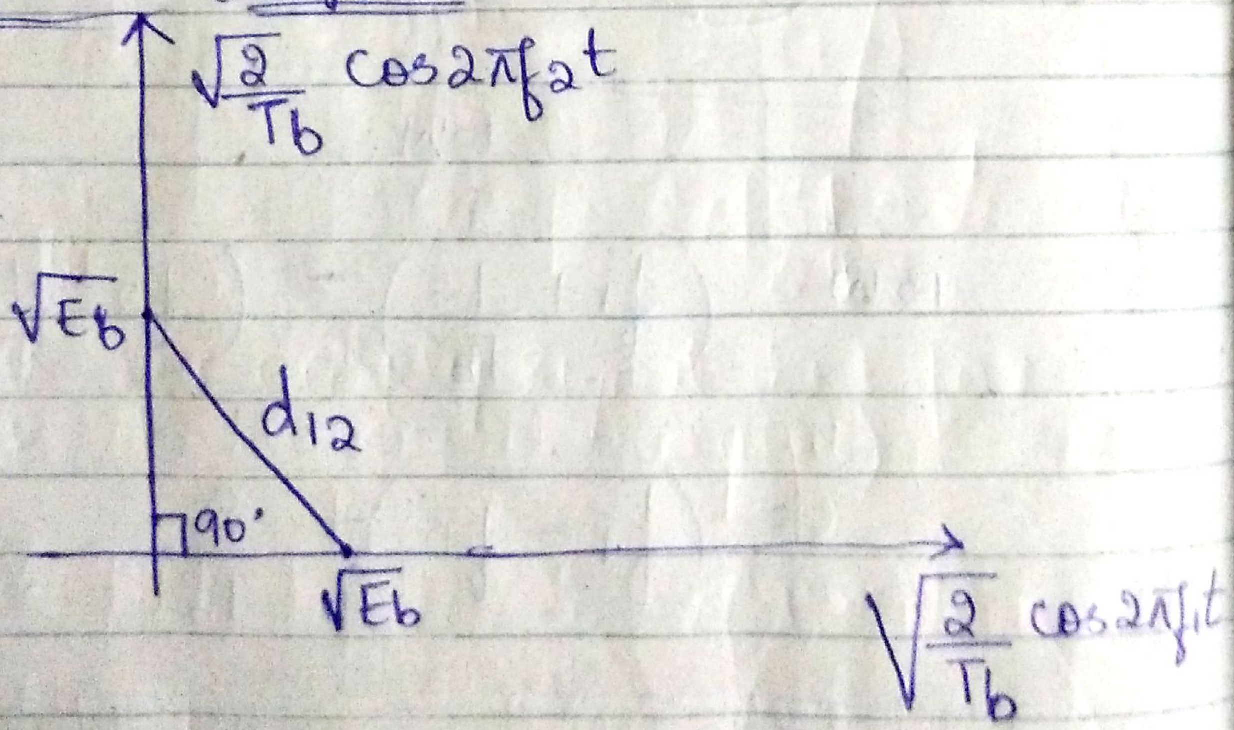
$$s_1(t) = A_c \cos 2\pi f_1 t \qquad \{f_1 > f_2\}$$

$$s_2(t) = A_c \cos 2\pi f_2 t$$

$$s_1(t) = \sqrt{\frac{2E_b}{T_b}} \cos 2\pi f_1 t$$

$$s_2(t) = \sqrt{\frac{2E_b}{T_b}} \cos 2\pi f_2 t$$

<u>Constellation diagram</u>



$$d_{12} = \sqrt{E_b + E_b}$$

$$= \sqrt{2E_b}$$

$$P_e \propto \frac{1}{d_{12}}$$

(Assuming that $s_1(t)$ and $s_2(t)$ are orthogonal to each other, so we are taking 90° between them).

These two functions ($s_1(t)$ and $s_2(t)$) are harmonically related to each other. These functions are orthogonal to each other.

Till now we have use 1 bit for transmitting, either 0 or 1 ie, we have studied Binary ASK, FSK and PSK.

<u>M-Array signalling</u>

$M = 2^N$ ($N \rightarrow$ no:- of bits transmitted at time instant).

In our syllabus we have 4-PSK or quadrature PSK.

$4 = 2^{2} \rightarrow$ 2 bits is transmitted

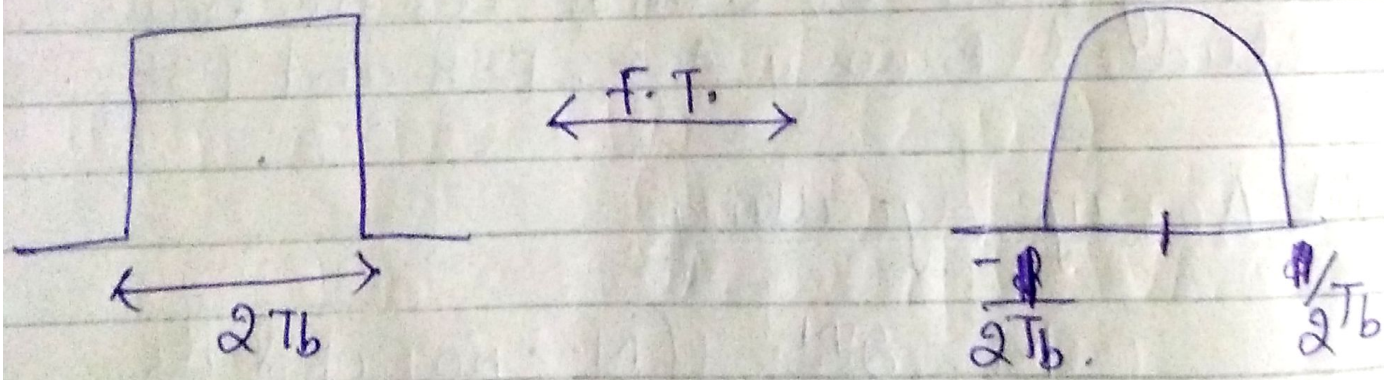
M-array signalling

ASK, PSK and FSK, in these keyings one bit is transmitted in a specific time instant through free space. i.e, $N = 1$. where, N is no:- of possible symbols.

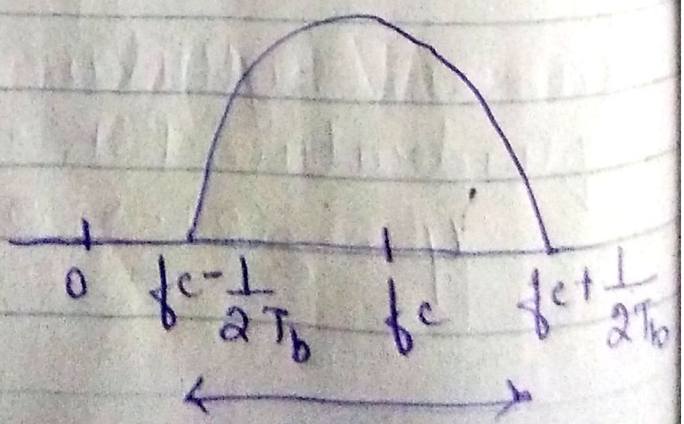
4-array PSK.

In this scheme 2 bit are transmitted in a specific time instant through free space.

$n = 2$ so $M = 4$.



This is for empty signal but for QPSK.



$$BW = \frac{1}{T_b}$$

$$BW = R_b$$

When,

$M = 2$ $\quad BW = 2R_b$

$M = 4$ $\quad BW = R_b$

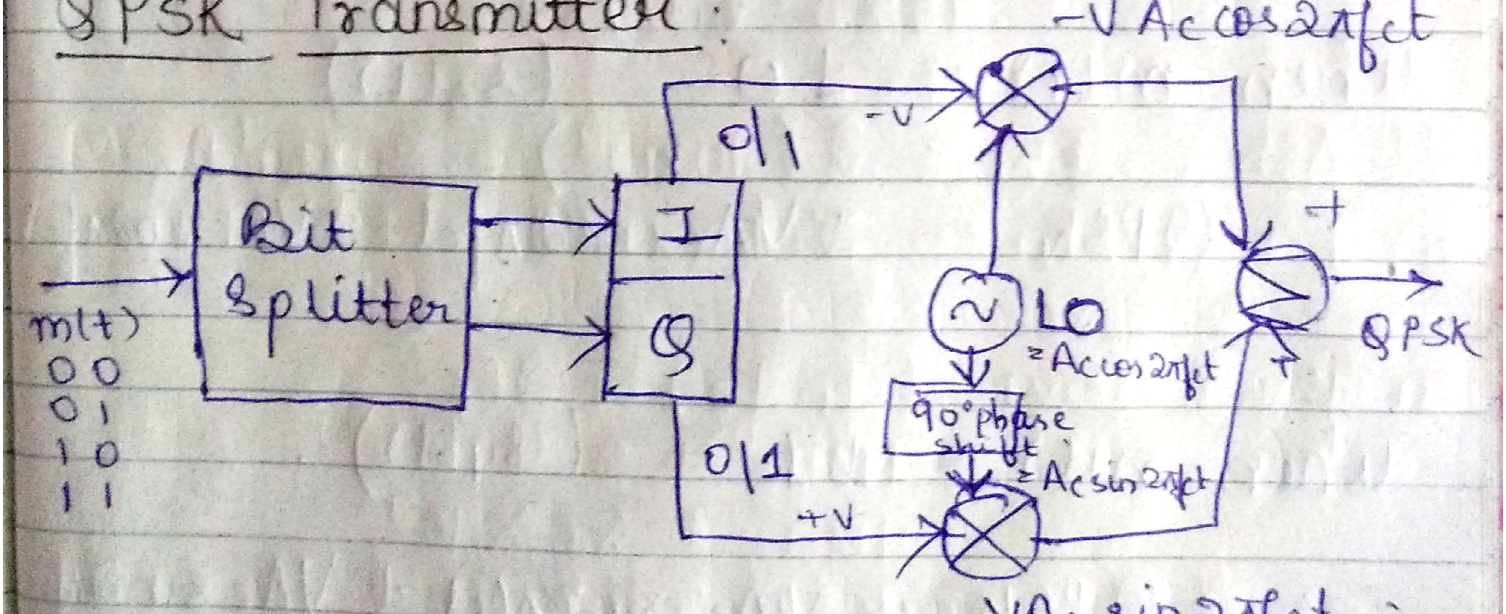
$M = 8$ $\quad BW = \frac{2}{3} R_b$

$= 0.667\, R_b = 0.6 R_b$

As the number of bits to be transmitted goes on increasing then channel B.W. requirement will be decreased but the system complexity will be increased

4-array PSK is also called Quadrature PSK. (QPSK).

QPSK Transmitter:



I → In phase.

Q → Quadrate phase.

0 → $-V$

1 → $+V$.

LO → local oscillator $= A_c \cos 2\pi f_c t$.

(Here we are assuming not return to zero thats why for "0" we have taken $-V$).

When $m(t) = 00$ $(s_1(t))$

1st 0 will go to I

2nd 0 will go to Q.

$$QPSK = -VA_c \cos 2\pi f_c t - VA_c \sin 2\pi f_c t$$

When $m(t) = 01$ $(s_2(t))$

$$QPSK = +VA_c \cos 2\pi f_c t - VA_c \sin 2\pi f_c t$$

When $m(t) = 10$ $(s_3(t))$

$$QPSK = -VA_c \cos 2\pi f_c t + VA_c \sin 2\pi f_c t$$

When $m(t) = 11$ $(s_4(t))$

$$QPSK = VA_c \cos 2\pi f_c t + VA_c \sin 2\pi f_c t$$

(Here we are assuming not return to zero thats why for "0" we have taken $-V$).

When $m(t) = 00$. $(s_1(t))$

$\underset{\text{2nd}}{0}\;\underset{\text{1st}}{0}$

1st 0 will go to I

2nd 0 will go to Q.

$QPSK = -VA_c \cos 2\pi f_c t - VA_c \sin 2\pi f_c t$

When $m(t) = 01$. $(s_2(t))$

$QPSK = +VA_c \cos 2\pi f_c t - VA_c \sin 2\pi f_c t$

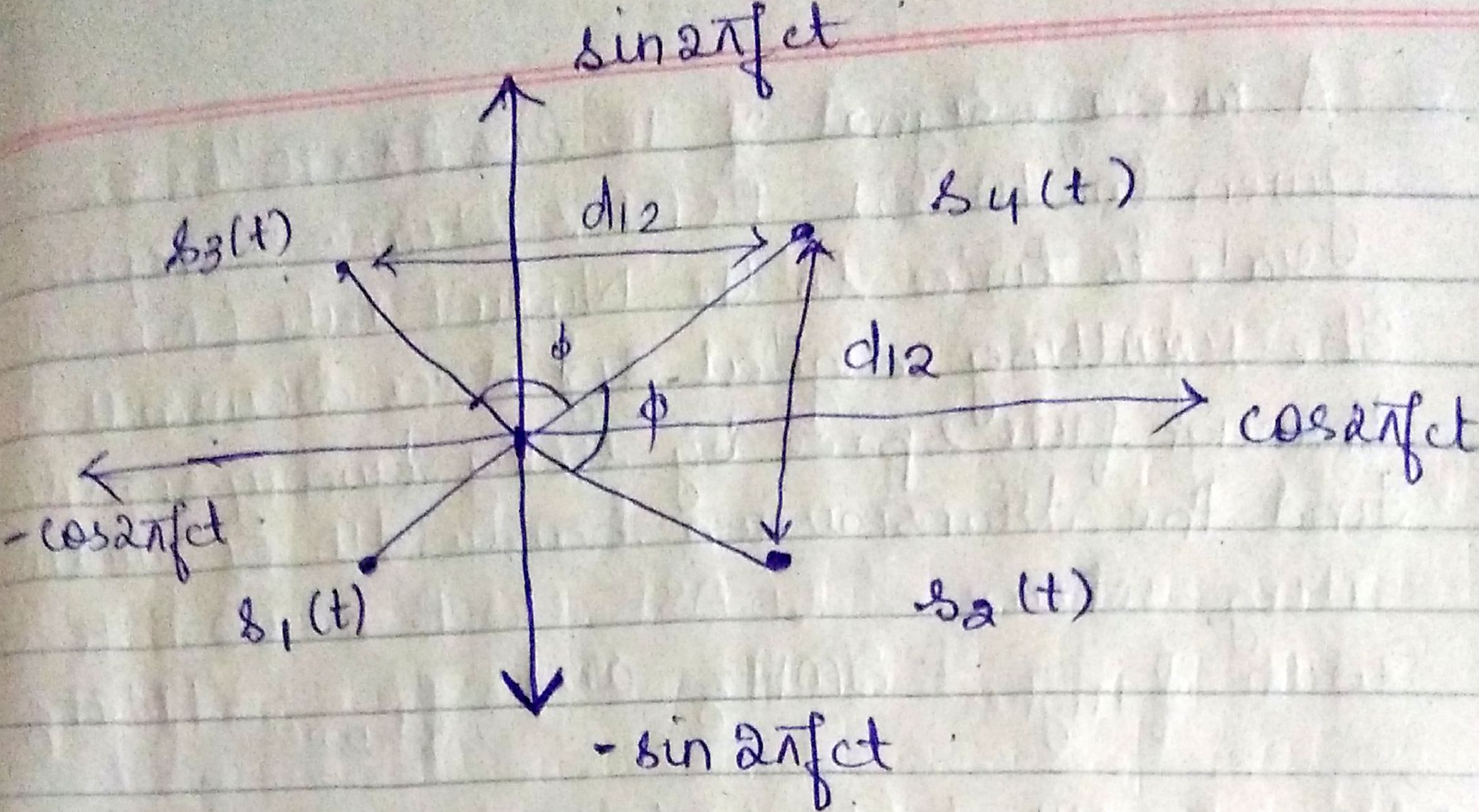
~~0100110010100~~ 1 2 4

When $m(t) = 10$ $(s_3(t))$

$QPSK = -VA_c \cos 2\pi f_c t + VA_c \sin 2\pi f_c t$

When $m(t) = 11$. $(s_4(t))$.

$QPSK = VA_c \cos 2\pi f_c t + VA_c \sin 2\pi f_c t$



General formula for any array PSK are :-

$$E_s = NE_b \qquad M = 2^N$$

$$d_{12} = 2\sqrt{E_s}\,\sin\left(\frac{\pi}{M}\right)$$

$$BW = \frac{2R_b}{N}$$

$$\phi = \frac{2\pi}{M}$$

★ As receiver section is complex, so we need not have to do it.