

PDF 2/3/21
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$$X_1(t) = 1 \sin(2\pi 1000t)$$

$$X_2(t) = 3 \sin(2\pi 1000t) \quad (F \text{ lat top})$$

$$X_3(t) = 6 \sin(2\pi 1000t)$$

$$X_4(t) = 9 \sin(2\pi 1000t)$$

$$F_s = 4 \text{ kHz} \quad T_s = \frac{1}{F_s} = \frac{1}{4 \times 10^3} = 0.25 \text{ msec}$$

ANS $\phi = 45^\circ$

$$S_1 = \frac{45^\circ}{360} \times 0.25 \text{ m} = 0.03125 \text{ m sec}$$

$$X_1(t) = 1 \sin(2\pi \times 10^3 \times 0.03125 \times 10^3)$$

$$X_1(t) = 1 \sin(2\pi \times 0.03125)$$

$$S_1 = X_1(t) = 0.195$$

$$S_2 = X_2(t) = 3 \sin(2\pi \times 10^3 t)$$

$$S_2 = \frac{135^\circ}{360} \times 0.25 \text{ m} = 0.09375 \text{ m sec}$$

$$X_2(t) = 3 \sin(2\pi \times 10^3 \times 0.09375 \times 10^3)$$

$$X_2(t) = 3 \sin(2\pi \times 0.09375)$$

$$S_2 = X_2(t) = 1.666$$

$$X_3(t) = 6 \sin(2\pi \times 10^3 t)$$

$$S_3 = \frac{225}{360} \times 0.25 \text{ m} = 0.15625 \text{ m sec}$$

$$X_3(t) = 6 \sin(2\pi \times 10^3 \times 0.15625 \times 10^3)$$

$$X_3(t) = 6 \sin(2\pi \times 0.15625)$$

$$X_3(t) = 4.98$$

modulation
channel

channel

Source
Decoder

Encoder

$$X(t) = 9.5 \sin(2\pi \times 10^3 t)$$

$$m(t) = \frac{315}{360} \times 0.25 \sin(2\pi \times 10^3 t) = 0.21875 \sin(2\pi \times 10^3 t)$$

$$X(t) = 9.5 \sin(2\pi \times 10^3 t)$$

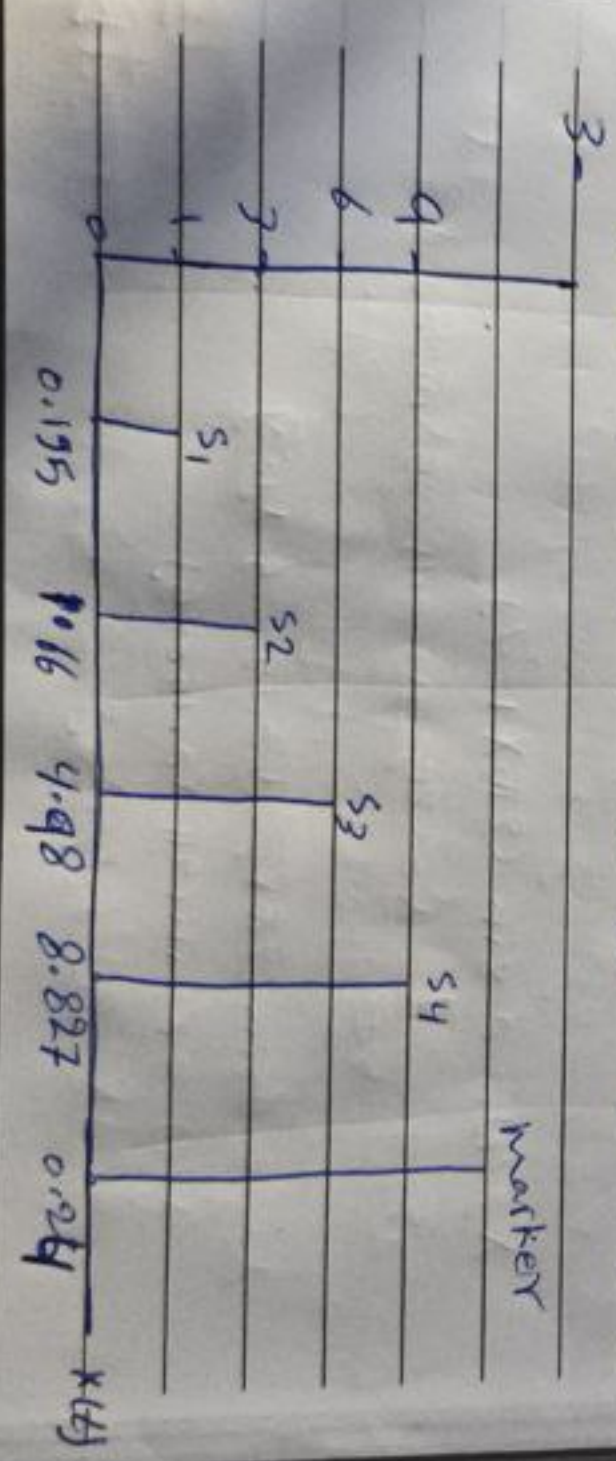
$$X(t) = 8.827 \sin(2\pi \times 10^3 t)$$

marker 345.6

$$\text{marker} = \frac{345.6}{360} \times 0.25 \sin(2\pi \times 10^3 t) = 0.24 \sin(2\pi \times 10^3 t)$$



المركب
جدا



-8-

4. Bw = ?

$$4. BW = ?$$

$$F_s = 4 \text{ kHz}$$

$$T_s = 0.25 \text{ mSec}$$

$$T_x = \frac{T_s}{N} = \frac{0.25 \times 10^{-3}}{5} = 0.05 \text{ mSec}$$

$$V = \frac{1}{\pi x} = \frac{1}{0.05 \times 10^{-3}}$$

$$V = \frac{10^3}{0.05} = 20000$$

$$v = 20 \text{ kbit/sec}$$

$$B_{BW} = \frac{1}{2} v$$

$$= \frac{1}{2} \times 20 \text{ k}$$

$$B_{BW} = 10 \text{ kHz}$$

- a -

Q1/ 2120

Q1/ $V = 3 \text{ bit}$ $b = 0.01 \text{ msec}$

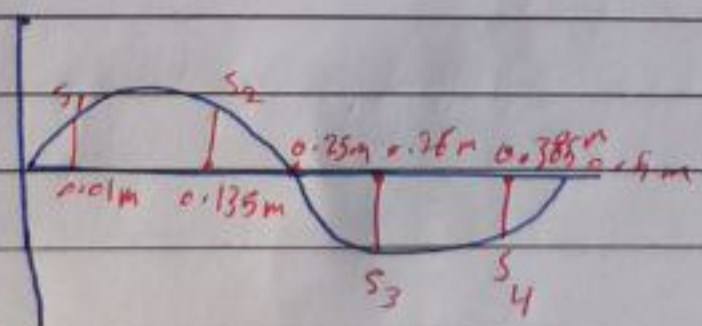
$X(t) = 2 \sin(2\pi \times 2000t)$ $F_s = 2 \times 2 \text{ km}$

$F_s = 2 \times 2 \times 2 \times 10^3 = 8 \text{ kHz}$

$T_s = \frac{1}{F_s} = \frac{1}{8 \times 10^3} = 0.125 \text{ msec}$

$F_c = 2 \text{ kHz}$ $T_c = \frac{1}{F_c} = \frac{1}{2 \times 10^3} = 0.5 \text{ msec}$

$T_s \text{ msec}$	$X(t)$
0.01 m	$X_1(t) = 2 \sin(2\pi \times 2 \times 10^3 \times 0.01 \times 10^3)$ $S_1 \times X_1(t) = 0.25$
0.01 + 0.125	$X_2(t) = 2 \sin(2\pi \times 2 \times 10^3 \times 0.135 \times 10^3)$ $S_2 = 1.98$
0.135 + 0.125	$S_3 = 2 \sin(2\pi \times 2 \times 10^3 \times 0.26 \times 10^3)$ $S_3 = 0.25$
0.26 + 0.125	$S_4 = 2 \sin(2\pi \times 2 \times 10^3 \times 0.385 \times 10^3)$ $S_4 = -1.98$



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Sample	quantization	quantization error	coding
0.25	0.25	$0.25 - 0.25 = 0$	100 (4)
1.98	1.75	$1.98 - 1.75 = 0.23$	111 (7)
-0.25	-0.25	$-0.25 - (-0.25) = 0$	011 (3)
-1.98	-1.75	$-1.98 - (-1.75) = -0.23$	000 (0)

Q2/ $F_m = 4 \text{ KHz}$ $r = 60 \text{ k bit/sec}$

$x_{\text{max}} = 2$ $V_{\text{rms}} = 0.2 \text{ V}$

$\frac{S}{N} = ?$

$P = \frac{N_{\text{rms}}^2}{R}$ with $R = 1$

$P = (V_{\text{rms}})^2 = (0.2)^2$

$P = 0.04 \text{ W}$

$\gamma = V \cdot F_s$

$F_s = 2B_m$
 $= 2 \times 4 \times 10^3$

$V = \frac{\gamma}{F_s} = \frac{60 \text{ K}}{8 \text{ K}}$

$F_s = 8 \text{ KHz}$

$V = 8 \text{ bit}$

$$\frac{S}{N} = \frac{3P \cdot 2^V}{X_{\text{max}}}$$

$$= \frac{3 \times 0.04 \times 2^{2 \times 8}}{(2)^2}$$

$$= \frac{3 \times 0.04 \times 2^{16}}{4}$$

$$\frac{S}{N} = 1966.08$$

$$\frac{S}{N} \text{ dB} = 10 \log \frac{S}{N}$$

$$\frac{S}{N} = 10 \log (1966.08)$$

$$\frac{S}{N} \text{ dB} = 32.93 \text{ dB}$$

نموذج 2-3

Q1/ $V = 3 \text{ bit}$ $X(t) = 2.5 \sin(2\pi \cdot 2500t)$
 $F_s \leftarrow 2(2500) \quad T_s = 0.015 \text{ msec}$

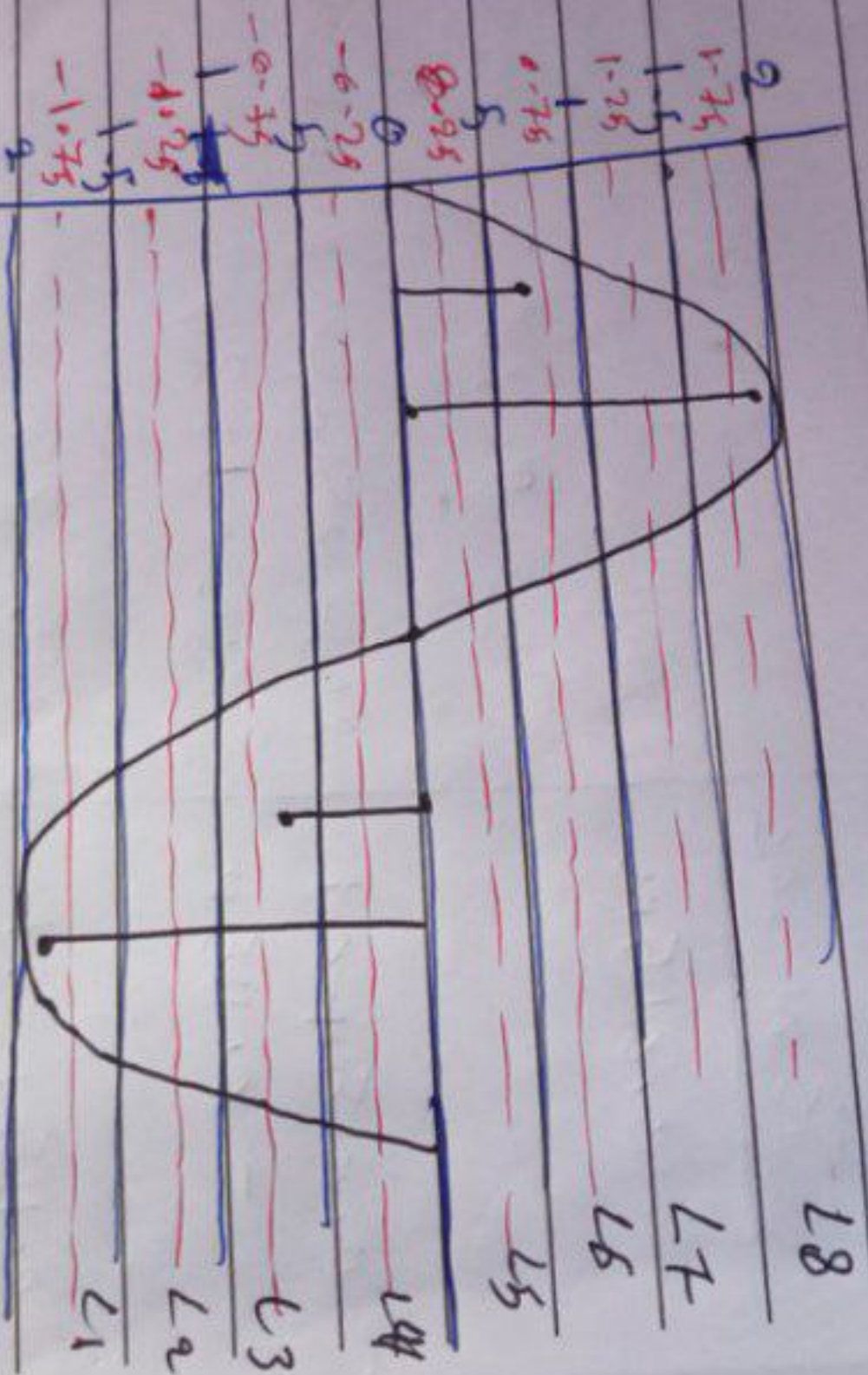
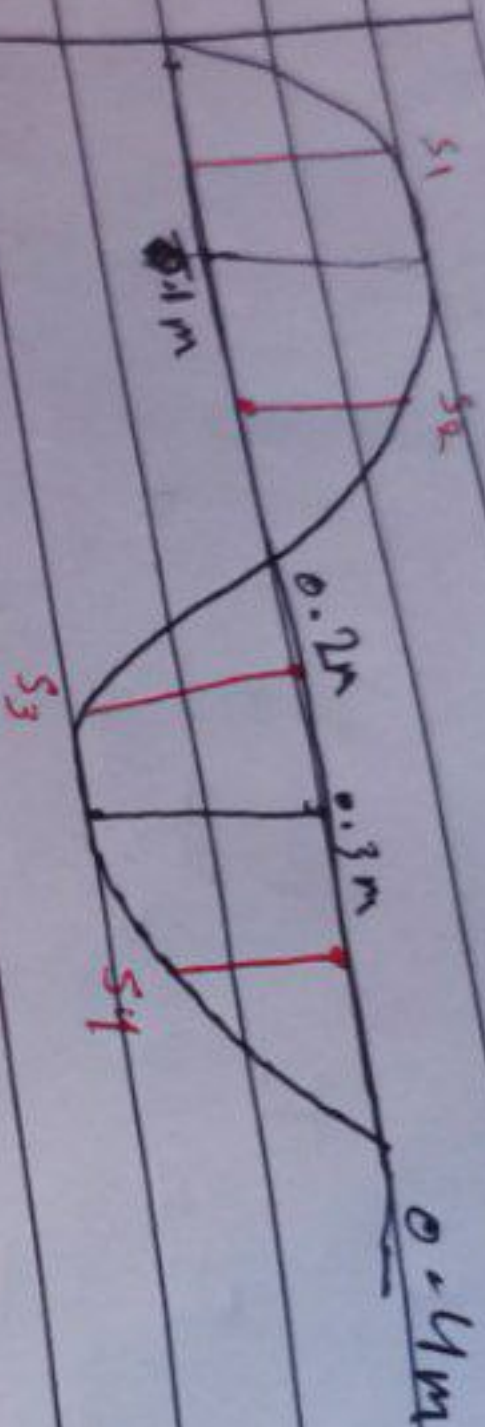
$F_0 = 2500 \text{ Hz} \Rightarrow F_0 = 2.5 \text{ KHz}$

$T_0 = \frac{1}{2500} = 0.4 \text{ msec}$

$F_s = 4 \times 2.5 \times 10^3 \Rightarrow F_s = 10 \text{ KHz}$

$T_s = \frac{1}{10 \times 10^3} = 0.1 \text{ msec}$

$T_s \text{ msec}$	$X(t) \rightarrow \text{Sample}$
0.015 m	$X(t) = 2.5 \sin(2\pi \times 2.5 \times 10^3 \times 0.015 \times 10^{-3})$ $X(t) = 0.46 \quad S1$
$0.015 + 0.1$ $= 0.115 \text{ m}$	$X(t) = 2.5 \sin(2\pi \times 2.5 \times 10^3 \times 0.115 \times 10^{-3})$ $X(t) = 1.94 \quad S2$
$0.115 + 0.1$ $= 0.215 \text{ m}$	$X(t) = 2.5 \sin(2\pi \times 2.5 \times 10^3 \times 0.215 \times 10^{-3})$ $X(t) = -0.46 \quad S3$
$0.215 + 0.1$ $= 0.315 \text{ m}$	$X(t) = 2.5 \sin(2\pi \times 2.5 \times 10^3 \times 0.315 \times 10^{-3})$ $X(t) = -1.94 \quad S4$



$000\ 41$
 $000\ 42$
 $010\ 43$
 $011\ 44$
 $100\ 45$
 $101\ 46$
 $110\ 47$
 $111\ 48$

$$q = 2^V \Rightarrow 2^3 = 8$$

$$\delta = \frac{2 \times \text{max}}{q} = \frac{2 \times 2}{8} = \frac{4}{8}$$

$$\delta = 0.5$$

$$\varepsilon = \frac{\delta}{2} = \frac{0.5}{2} = 0.25$$

Sample	quantization	quantization error	Coding
0.46	0.75	$0.46 - 0.75 = -0.29$	101
1.94	0.75	$1.94 - 1.75 = 0.19$	111
-0.46	-0.75	$-0.46 + 0.75 = 0.29$	010
-1.94	-1.75	$-1.94 + 1.75 = -0.19$	000

PDF 6 زياد

$$x_1(t) = 2 \sin(2\pi \times 10^3 t)$$

$$x_2(t) = 4 \sin(2\pi \times 10^3 t)$$

$$x_3(t) = 6 \sin(2\pi \times 10^3 t)$$

$$x_4(t) = 8 \sin(2\pi \times 10^3 t)$$

~~Not a~~

Natural

$$F_s = 4 \text{ kHz}$$

$$T_s = \frac{1}{F_s} = \frac{1}{4 \times 10^3} = 0.25 \text{ msec}$$

$$S_1 = \frac{45}{360} \times 0.25 \text{ m} = 0.03125 \text{ msec}$$

$$x_1(t) = 2 \sin(2\pi \times 10^3 \times 0.03125 \times 10^3)$$

$$x_1(t) = 2 \sin(2\pi \times 0.03125)$$

$$x_1(t) = 0.39 \text{ V}$$

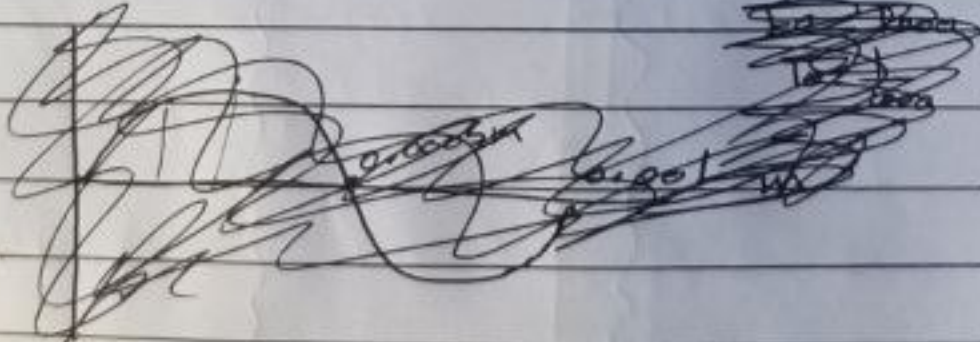
$$0.04125 \text{ msec}$$

$$S_1 = 0.03125 \text{ m} + 0.01 \text{ m} = 0.04125$$

$$x_1(t) = 2 \sin(2\pi \times 10^3 \times 0.04125 \times 10^3)$$

$$x_1(t) = 2 \sin(2\pi \times 0.04125)$$

$$x_1(t) = 0.51 \text{ V}$$



تحتوي على 12

$$X_2(t) = 4 \sin(2\pi \times 10^3 t)$$

$$S_2 = \frac{135}{360} \times 0.25 \text{ m} = 0.09375 \text{ mSec}$$

$$X_2(t) = 4 \sin(2\pi \times 10^3 \times 0.09375 \times 10^3)$$

$$X_2(t) = 4 \sin(2\pi \times 0.09375)$$

$$X_2(t) = 2.22 \text{ V} \quad S_2$$

$$S_2 = 0.09375 + 0.01 = 0.10375 \text{ mSec}$$

$$X_2(t) = 4 \sin(2\pi \times 10^3 \times 0.10375 \times 10^3)$$

$$X_2(t) = 4 \sin(2\pi \times 0.10375)$$

$$X_2(t) = 2.42 \text{ V} \quad S_2$$

$$X_3(t) = 6 \sin(2\pi \times 10^3 t)$$

$$S_3 = \frac{225}{360} \times 0.25 \text{ m} = 0.15625 \text{ mSec}$$

$$X_3(t) = 6 \sin(2\pi \times 10^3 \times 0.15625 \times 10^3)$$

$$X_3(t) = 6 \sin(2\pi \times 0.15625)$$

$$X_3(t) = 4.98 \text{ V}$$

$$S_3 = 0.15625 + 0.01 = 0.16625 \text{ mSec}$$

$$X_3(t) = 6 \sin(2\pi \times 10^3 \times 0.16625 \times 10^3)$$

$$X_3(t) = 6 \sin(2\pi \times 0.16625)$$

$$X_3(t) = 5.18 \text{ V}$$

$$X_4(t) = 8 \sin(2\pi \times 10^3 t)$$

$$S_4 = \frac{315}{360} \times 0.25 \text{ m} = 0.21875 \text{ mSec}$$

$$X_4(t) = 8 \sin(2\pi \times 10^3 \times 0.21875 \times 10^3)$$

$$X_4(t) = 8 \sin(2\pi \times 0.21875)$$

$$X_4(t) = 7.84 \text{ V}$$

$$S_4 = 0.21875 + 0.01 = 0.22875 \text{ mSec}$$

$$X_4(t) = 8 \sin(2\pi \times 10^3 \times 0.22875 \times 10^3)$$

$$X_4(t) = 8 \sin(2\pi \times 0.22875)$$

$$X_4(t) = 7.92 \text{ V}$$

315.6 mSec

marker

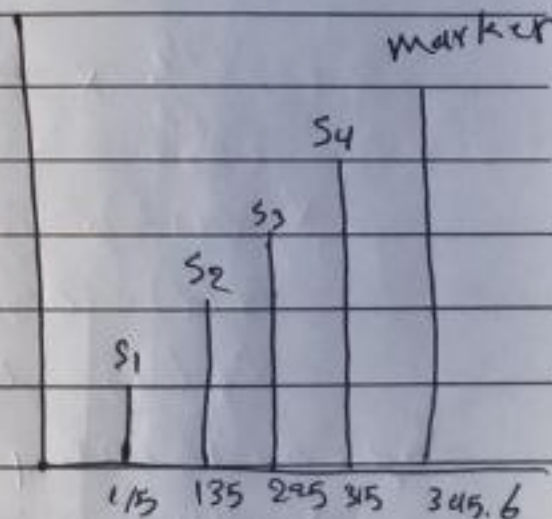
$$\frac{345.6}{360} \times 0.25 \text{ m} = 0.24 \text{ m}$$

$$0.24 + 0.01 =$$

$$0.25 \text{ mSec}$$

345.6 mSec

marker



- b -

7 25 ans

$$F_b = 4 \text{ Mbps}$$

BPSK

QPSK

64-ary PSK

① BPSK

$$BW = 2F_b$$

$$F_s = F_b$$

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

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

$$BW = 2F_b$$

$$= 2 \times 4 \text{ M}$$

$$BW = 8 \text{ MHz}$$

$$F_s = 4 \text{ MHz}$$

$$T_b = \frac{1}{F_b} = \frac{1}{4 \times 10^6} \text{ bit/sec}$$

$$T_s = \frac{1}{4 \times 10^6} \text{ sec}$$

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QPSK

$$B_w = F_b$$
$$F_s = \frac{F_b}{2}$$

$$T_s = 2T_b$$

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

$$B_w = 4 \text{ MHz}$$

$$F_s = \frac{4 \text{ M}}{2} = 2 \text{ MHz}$$

$$T_b = \frac{1}{F_b} = \frac{1}{4 \times 10^6} \text{ bit/sec}$$

$$T_s = 2T_b = 2 \times \frac{1}{4 \times 10^6}$$

$$T_s = \frac{1}{2 \times 10^6} \text{ sec}$$

3- 64-ary PSK

$$M = 64$$

$$M = 2^V$$

$$V = \frac{\log M}{\log 2} = \frac{\log 64}{\log 2} = 6 \text{ bit}$$

$$BW = \frac{2F_b}{N} = \frac{2 \times 4 \times 10^6}{6}$$

$$BW = 1.33 \text{ MHz}$$

$$F_s = \frac{F_b}{N} = \frac{4 \times 10^6}{6}$$

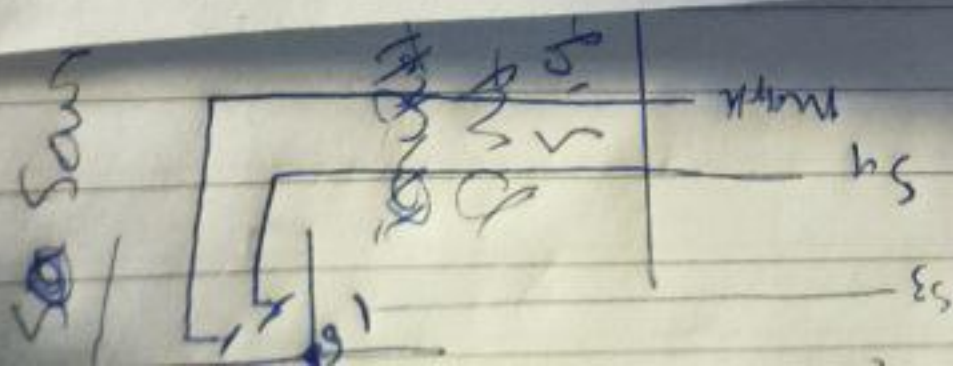
$$F_s = 0.67 \text{ MHz or } F_s = 0.7 \text{ MHz}$$

$$T_b = \frac{1}{F_b} = \frac{1}{4 \times 10^6} \text{ bit/sec}$$

$$T_s = N T_b = 6 \times \frac{1}{4 \times 10^6}$$

$$T_s = 1.5 \times 10^{-6} \text{ sec}$$

= 18+



2

find the

$B_w = 1.4 \text{ MHz}$
 $F_b = 4 \text{ MHz}$

$$B_w = \frac{2F_b}{N} = \frac{2 \times 4 \times 10^6}{8}$$

$$B_w = 1.04 \text{ MHz}$$

show that $B_w = 1.04 \text{ MHz}$ and
 $F_b = 4 \text{ Mbps}$ and 64-ary PSK .

PDF of Q -Zigzag
 or zigzag

$F_b = 2 \text{ Mbps}$
 8-PSK 32-ary PSK

8-PSK

$$B_w = 2.5 \text{ MHz}$$

$$T_s = T_b$$

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

$$F_s = 5 \text{ MHz}$$

1. BPSK

$$BW = 4 \text{ MHz}$$

$$F_s = 2 \text{ MHz}$$

$$T_b = \frac{1}{2 \times 10^6} \text{ bit/sec}$$

$$T_s = \frac{1}{2 \times 10^6} \text{ sec}$$

② QPSK

$$BW = F_b \quad BW = 2 \text{ MHz}$$

$$T_s = 2 T_b$$

$$T_s = \frac{2}{2 \times 10^6} = \frac{1}{1 \times 10^6} \text{ sec}$$

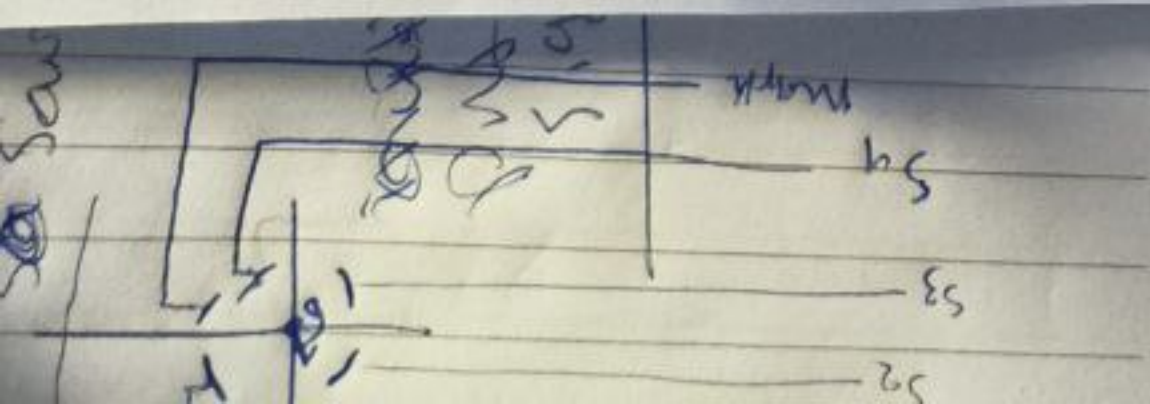
$$F_s = \frac{F_b}{2}$$

$$F_s = \frac{2 \text{ M}}{2} = 1 \text{ MHz}$$

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

$$T_b = \frac{1}{2 \times 10^6}$$

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3) 32-ary PSK

$$B_{ws} = \frac{2F_b}{N}$$

$$M = 32$$

$$V = \log 32 = 5 \text{ bit}$$

$$B_{ws} = \frac{2 \times 2M}{5} = \frac{4M}{5} \text{ Hz}$$

$$F_b = \frac{F_b}{N} = \frac{2M}{5} = \frac{2}{5} \text{ MHz}$$

$$T_b = \frac{1}{F_b} = \frac{1}{2 \times 10^6}$$

$$T_s = N T_b$$

$$T_s = 5 \times \frac{1}{2 \times 10^6} = \frac{5}{2 \times 10^6} \text{ sec}$$

Ans

~~non-synchronous communication system~~
~~is a communication system in which the~~

②

32-ary PSK

$$B_w = 900 \text{ kHz}$$

$$n = \frac{2 \times 2 \times 10^6}{900 \times 10^3} \approx 5 \text{ bit}$$

Show that 32-ary PSK

and $B_b = 2 \text{ MHz}$ in $B_w = 900 \text{ kHz}$