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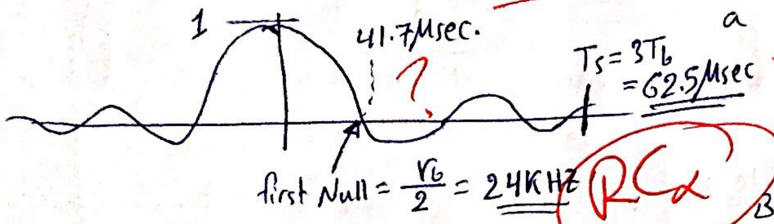
Mid ExamI. Dig. Comm 0953422 9/4/2018

Q.1 **(5 Points ABET 3,2)**

For a 10 KHz band limited baseband channel, we need to design a system to transmit a 48 kbps data.

What is the axis signal(s):

one axis represent a sinc. ✗



(4)

$BW = 10KHZ$

$r_b = 48Kbps$

$BW = \frac{r_b}{2m}(1+\alpha)$

set $\alpha = 0$

so $m = \frac{r_b}{2BW} = 2.4$

choose $m = 3$

$size = 2^3 = 8$

$10K = \frac{48K}{2 \times 3}(1+\alpha)$

$\Rightarrow \alpha = 1/4$

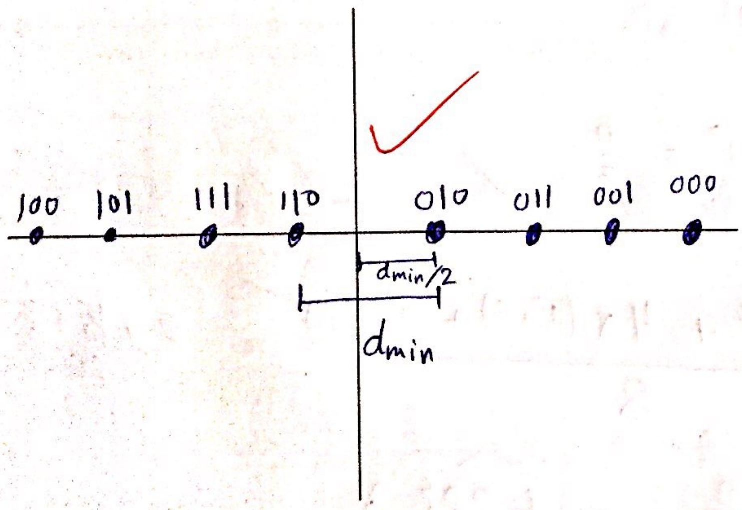
What is the constellation size:

8 ✓

What is the roll-off factor:

0.25 ✓

Draw the constellation and label the points in binary:

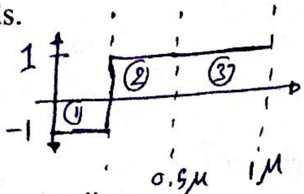


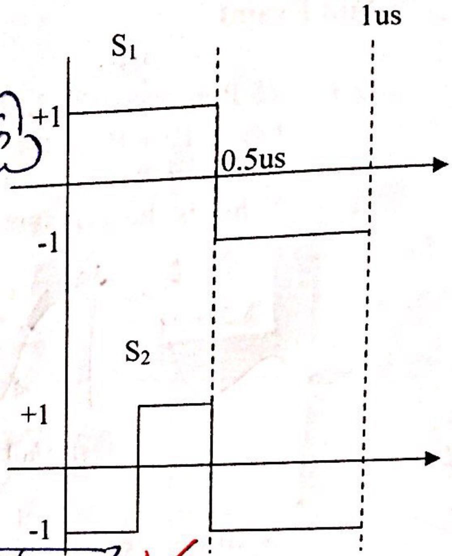
m = 3

0	0	0
0	0	1
0	1	1
0	1	0
1	1	0
1	1	1
1	0	1
1	0	0

Q.2 **(5 Points)**
Find Energies and the correlation coefficient for the following two signals.

$\rho_{12} = \dfrac{\langle S_1, S_2 \rangle}{|S_1||S_2|} \Rightarrow$





$\rho_{12} = 0.5$

① & ② cancel each other

$\rho_{12} = \int_{0.5\mu}^{1\mu} 1\, dt = 1(0.5\mu) = \boxed{0.5 \times 10^{-6} \Rightarrow \rho_{12}}$

$E_1 = \int_0^{0.5\mu} (1)^2 dt + \int_{0.5\mu}^{1\mu} (-1)^2 dt = 0.5\mu + 0.5\mu$

$\Rightarrow \boxed{E_1 = 1 \times 10^{-6} \text{ Joule}}$

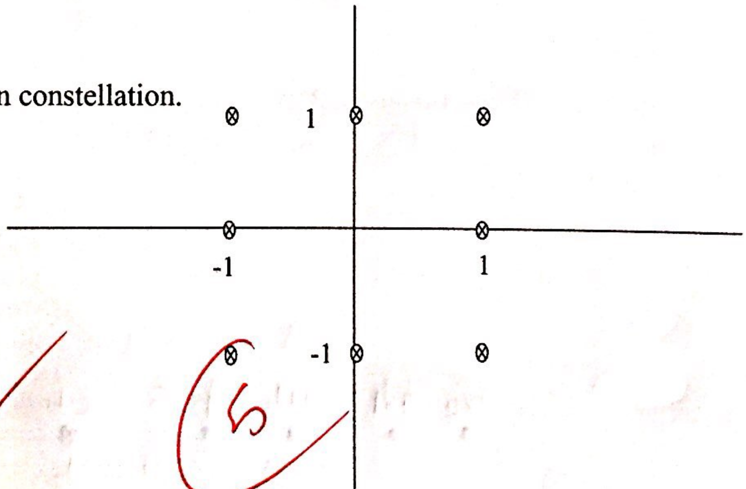
$E_2 = \int_0^{0.25\mu} (-1)^2 dt + \int_{0.25\mu}^{0.5\mu} (1)^2 dt + \int_{0.5}^{1\mu} (-1)^2 dt = 0.25\mu + 0.25\mu + 0.5\mu$

$\Rightarrow \boxed{E_2 = 1 \times 10^{-6} \text{ Joule}}$

- Can we use these signals as carrier waveforms, why?

yes we can / since the reflection coefficient $\neq 0$.

Q.3 **(5 Points)**
Find the PAPR for the shown constellation.



$PAPR = \dfrac{\text{Peak}}{\text{Average}}$

* Peak:

$\text{Peak} = (1)^2 + (1)^2 = 2$

* Average:

$E_{av} \Rightarrow \dfrac{2 \times (1)^2 + 4 \times (1^2 + 1^2) + 2 \times (1)^2}{8} = \dfrac{2 + 8 + 2}{8} = \dfrac{12}{8} = \boxed{1.5}$

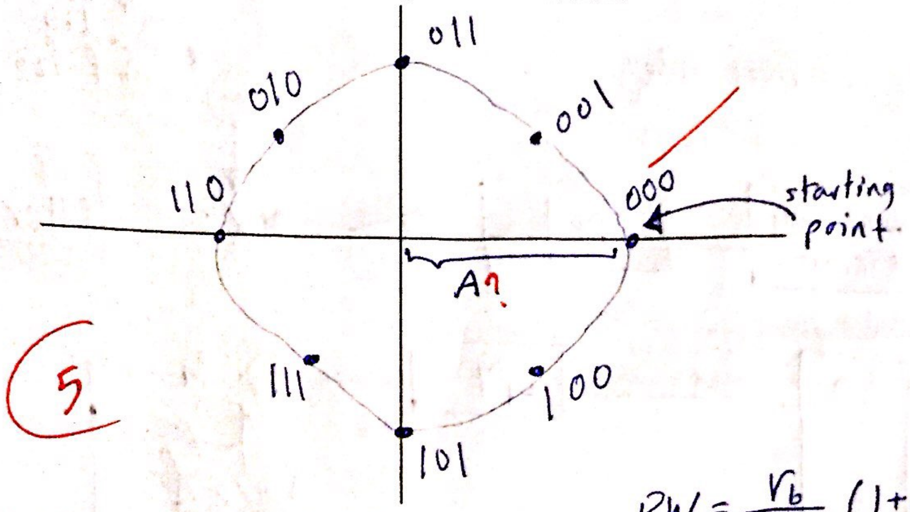
$PAPR = \dfrac{2}{1.5} = 1.333$

Pass Band $f_c = 100MHz$ $r_b = 200Kbps$ $\alpha = 0.2$ $d_{min} = 4$ $m = 3$

Q.4 **(5 Points 2,1,1,1)**

An 8 PSK system operating at 200kbps with carrier of 100MHz and $RC_{0.2}$ has minimum distance d_{min}=4.

1- Draw and label (in binary) the signal constellation.



2- Find the required channel BW?

$$BW = \frac{r_b}{m}(1+\alpha) = \frac{200K}{3}(1+0.2) = 80KHZ$$

BW= 80KHZ. ✓

3- Find the average power?

$$A^2 = \frac{d_{min}^2}{4\sin^2(\frac{\pi}{M})} = \frac{16}{4 \times \sin^2(\frac{\pi}{8})}$$

$A^2 = 27.31$ ✓

so $P_{av} = \frac{A^2}{2} = 13.657$ Watt

P_{av}= 13.657 Watt. ✓

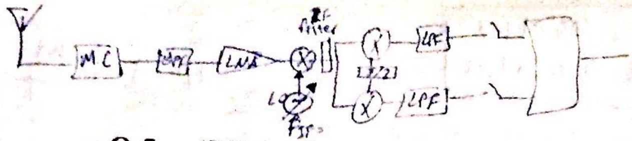
4- Write the general equation for the transmitted signal?

$$\phi_t(t) = \overbrace{A_i\, P(t)}^{A} \cos(2\pi \times 100 \times 10^6 t + \theta_i)$$

$$= A \angle \theta_i$$ ✓

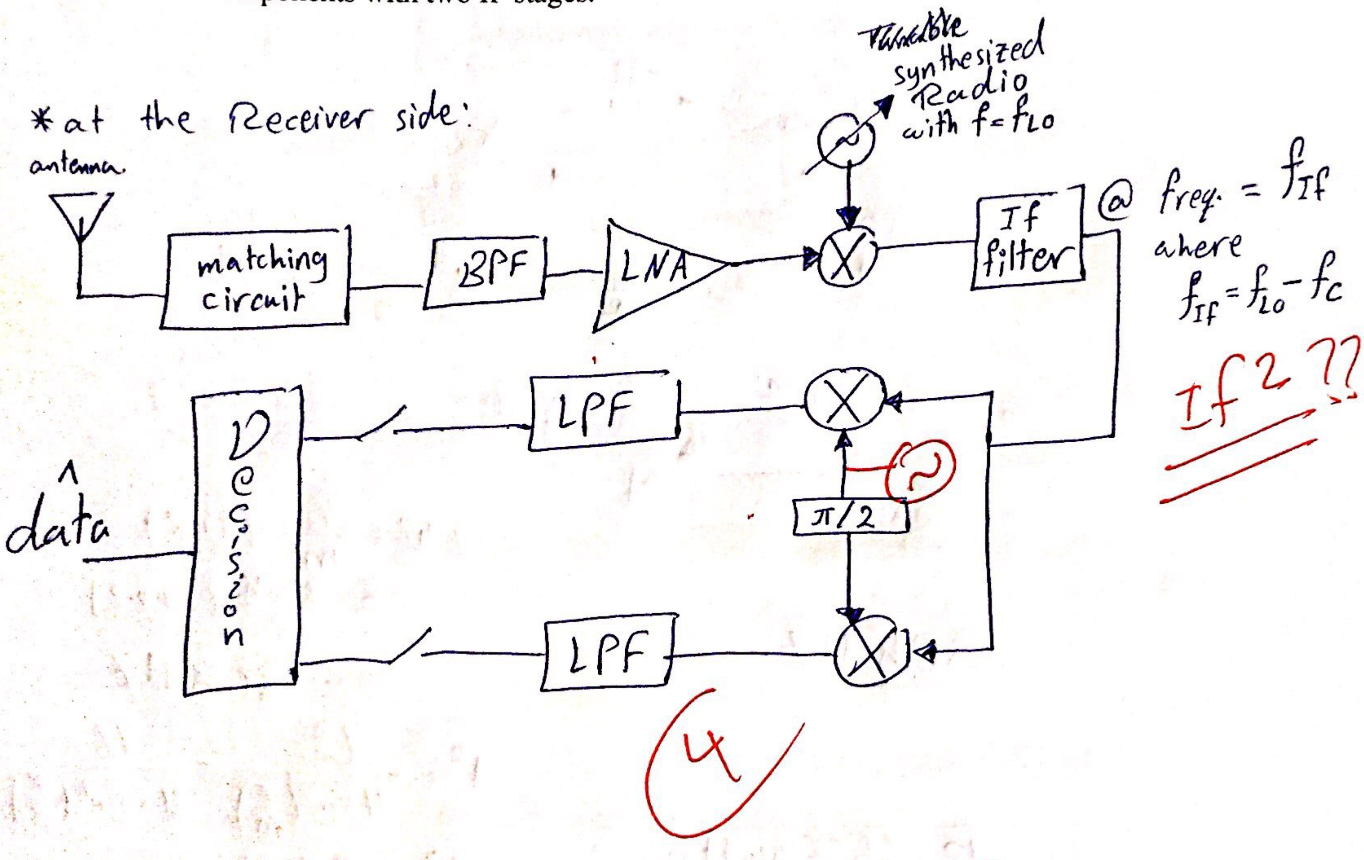
where

$$P(t) = \frac{\text{sinc}(t/\tau)\cos(\frac{\pi \alpha t}{\tau})}{1 - (\frac{2\alpha t}{\tau})^2} \quad ; \alpha = 0.2$$



Q.5 **(5 Points)**

Draw the block diagram of a quadrature receiver showing all important components with two IF stages.



Q.6 **(5 Points 1 each)**

1.	Orthogonal signals are used as carrier waveforms.	T	F
2.	Two dimensional modulation is possible in band limited base band systems.	T	F
3.	RF BPF is used to limit the noise bandwidth.	T	F
4.	FSK has the best performance in fading channels.	T	F
5.	FSK is a band efficient modulation.	T	F