Ejercicio 9

Grafique la densidad espectral de potencia (normalizada) de cero a 256 KHz, para los siguientes codificaciones, considerando tasa de transmisión de 64.000 símbolos binarios (equiprobables) por segundo:

a) Unipolar NRZ de 4 Volts de amplitud
b) Polar RZ de ± 2 Volts de amplitud
c) Bipolar NRZ de ± 2 Volts de amplitud
d) 2B1Q ± 3 y ± 1 Volts de amplitud

Sabiendo que:

$R = 64Kbits \rightarrow 256KHz = x.R \rightarrow x = 4$

a) Unipolar NRZ de 4 Volts de amplitud

$$R_b[k] = \begin{bmatrix} \frac{A^2}{2} & k = 0 \\ \frac{A^2}{4} & k \neq 0 \end{bmatrix}$$

$T = T_b = 15,625\mu S \ \hat{} \ A = 4V$

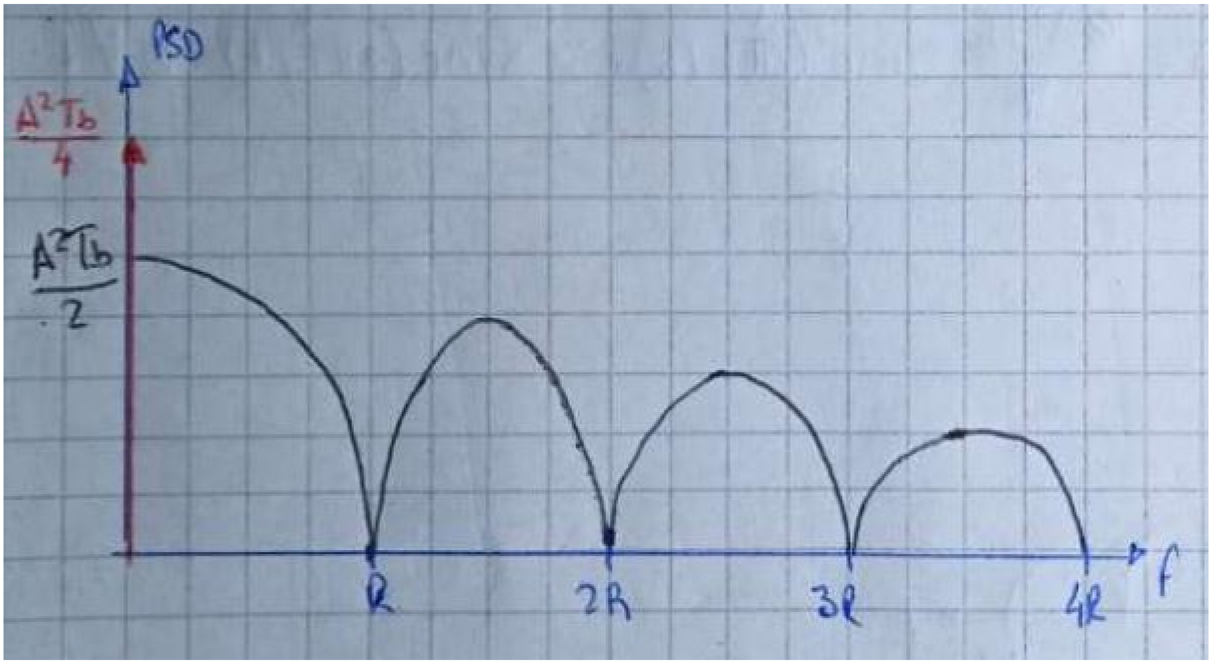
$$PSD = \frac{T_b^2.sinc^2(\pi.f.T_b)}{T_b}.\left(\frac{A^2}{2}.e^{j.2\pi.0.f.T_b} + \frac{A^2}{4}.\sum_{k=-\infty}^{\infty} e^{j.2\pi.k.f.T_b}\right)$$

$$PSD = T_b.sinc^2(\pi.f.T_b).\left(\frac{A^2}{2} + \frac{A^2}{4}.\sum_{k=-\infty}^{\infty} e^{j.2\pi.k.f.T_b}\right)$$

$$PSD = T_b.sinc^2(\pi.f.T_b).\frac{A^2}{2} + T_b.sinc^2(\pi.f.T_b).\frac{A^2}{4}.\sum_{k=-\infty}^{\infty} e^{j.2\pi.k.f.T_b}$$

$$PSD = \frac{T_b.A^2}{2}.sinc^2(\pi.f.T_b) + \frac{T_b.A^2}{4}.sinc^2(\pi.f.T_b).\sum_{k=-\infty}^{\infty} \delta\left(f - \frac{n}{T_b}\right)$$

$$PSD = \frac{T_b.A^2}{2}.sinc^2(\pi.f.T_b) + \frac{T_b.A^2}{4}.sinc^2(\pi.f.T_b).\delta\left(f - \frac{n}{T_b}\right)$$



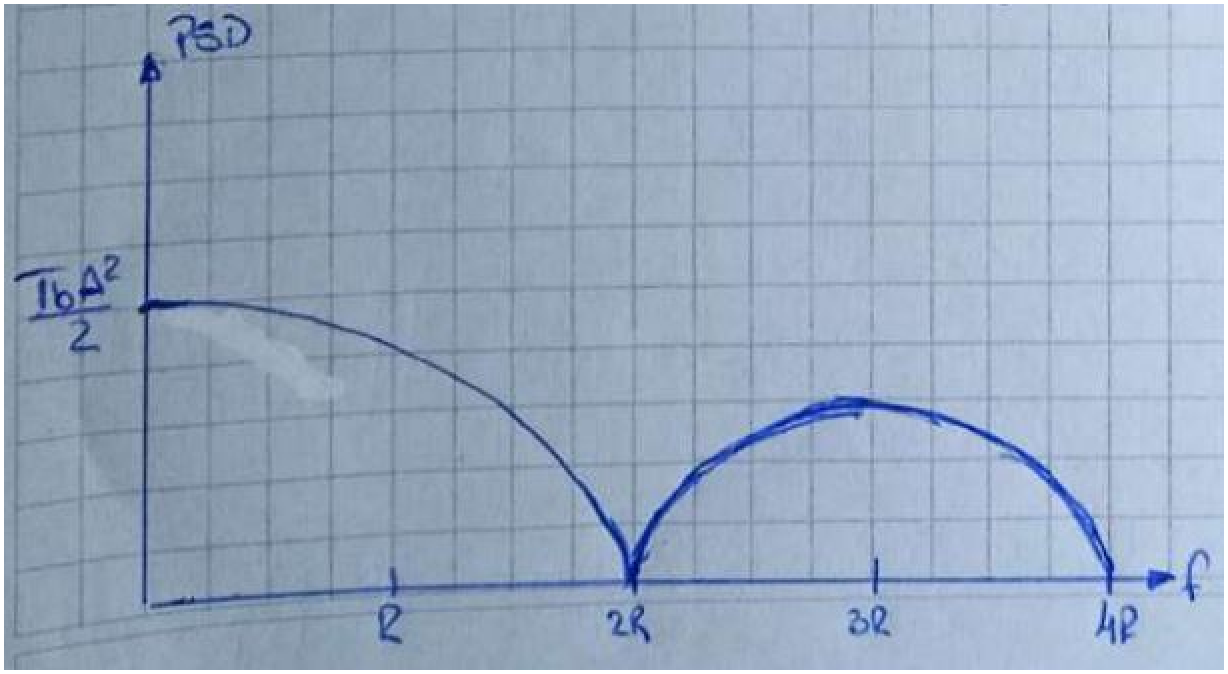
b) Polar RZ de ±2 Volts de amplitud

$$R_b[k] = \begin{bmatrix} A^2 & k = 0 \\ 0 & k \neq 0 \end{bmatrix}$$

$$T = \frac{T_b}{2} \ \hat{}\ A = 2V$$

$$PSD = \frac{T^2.sinc^2(\pi.f.T)}{T}.\sum_{k=-\infty}^{\infty} R_b[k].e^{j.2\pi.f.k.T}$$

$$PSD = \frac{T_b.A^2}{2}.sinc^2\left(\pi.f.\frac{T_b}{2}\right)$$



c) Bipolar NRZ de ± 2 Volts de amplitud

$$R_b[k] = \begin{bmatrix} \frac{A^2}{2} & k=0 \\ -\frac{A^2}{4} & |k|<1 \\ 0 & |k|>1 \end{bmatrix}$$

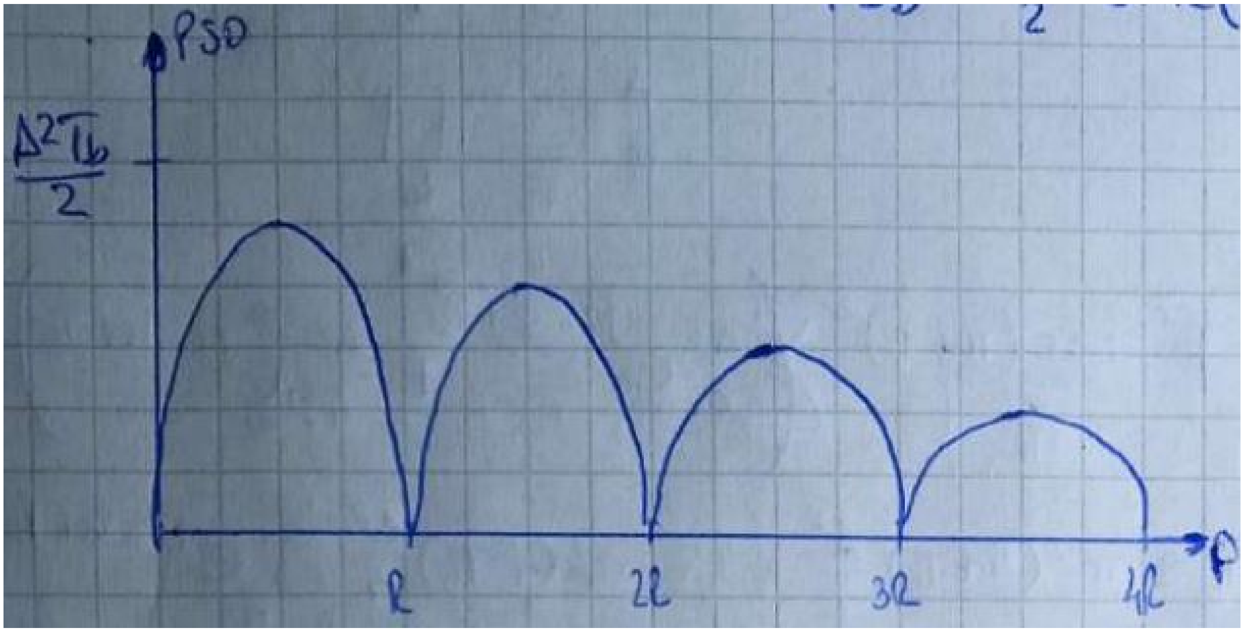
$T = T_b$ ^ $A = 2V$

$$PSD = \frac{T^2.sinc^2(\pi.f.T)}{T}.\left(\frac{A^2}{2} + \left(-\frac{A^2}{4}\right).e^{j.2\pi.f.T} + \left(-\frac{A^2}{4}\right).e^{-j.2\pi.f.T}\right)$$

$$PSD = T_b.sinc^2(\pi.f.T_b).\left(\frac{A^2}{2} + \left(-\frac{A^2}{4}\right).2.\left(\frac{e^{j.2\pi.f.T_b} + e^{-j.2\pi.f.T_b}}{2}\right)\right)$$

$$PSD = \frac{T_b.A^2}{2}.sinc^2(\pi.f.T_b).\left(1 - \left(\frac{e^{j.2\pi.f.T_b} + e^{-j.2\pi.f.T_b}}{2}\right)\right)$$

$$PSD = \frac{T_b.A^2}{2}.sinc^2(\pi.f.T_b).(1 - \cos(2\pi.f.T_b))$$



d) 2B1Q ± 3 y ± 1 Volts de amplitud

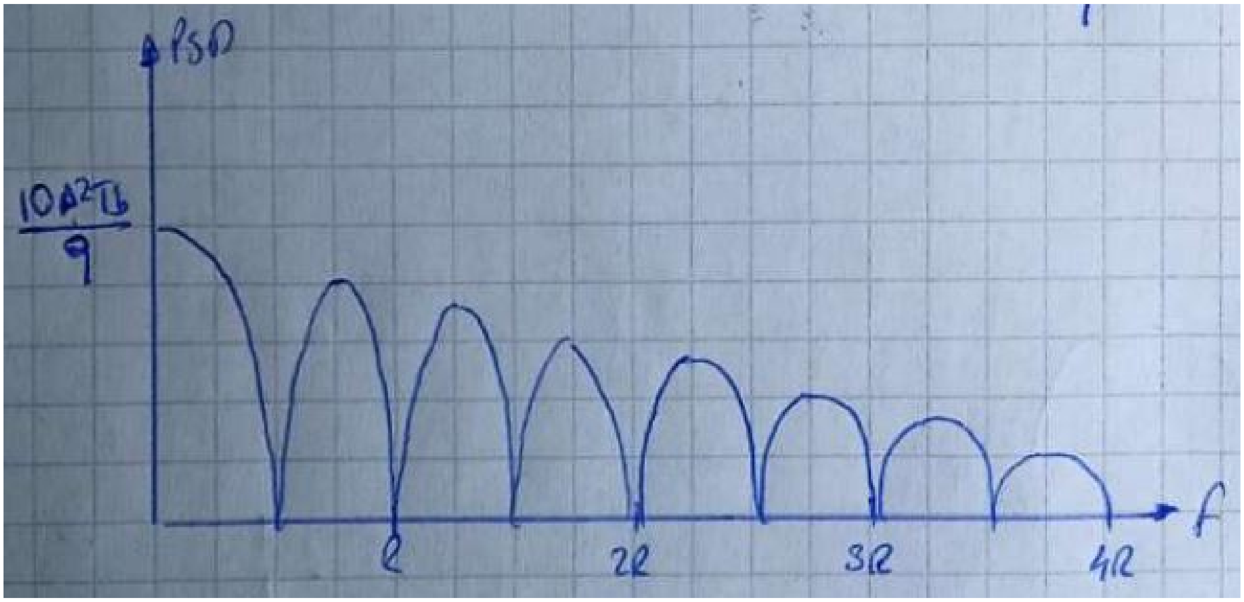
$$R_b[k] = \begin{bmatrix} \frac{5}{9}.A^2 & k = 0 \\ 0 & k \neq 0 \end{bmatrix}$$

$$T = 2.T_b \ \hat{}\ A = 3V$$

$$PSD = \frac{T^2.sinc^2(\pi.f.T)}{T}.\frac{5}{9}.A^2$$

$$PSD = 2.T_b.\frac{5}{9}.A^2.sinc^2(2\pi.f.T_b)$$

$$PSD = \frac{10.T_b.A^2}{9}.sinc^2(2\pi.f.T_b)$$



PSD
$\frac{10A^2T_b}{9}$
f
R
2R
3R
4R