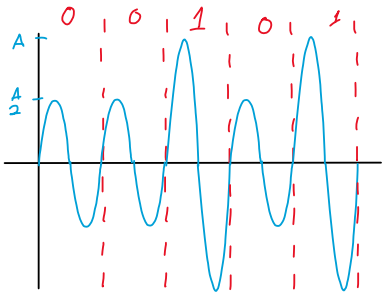
1 a) Binary ASK

Amplitude - 0 : $\frac{R}{R+R} A = \frac{1}{2} A$

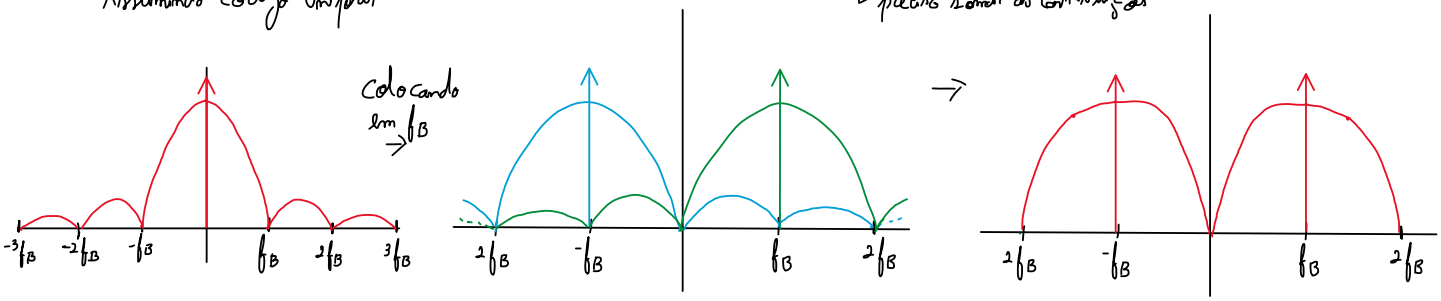
Amplitude - 1 : $\frac{10R}{10R+R} A = \frac{10}{11} A \approx A$

Como $f_C = f_B$

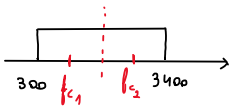


b) Assumindo código Unipolar

É preciso somar os contributos



2 $R = 2400$ bit/s



$f_{c_1} = (3400-300)\frac{1}{4} + 300 = 1075$ Hz

$f_{c_2} = (3400-300)\frac{3}{4} + 300 = 2625$ Hz

$B = \frac{3400-300}{2} = 1550$ $\quad T = \frac{1}{R}\log_2(M)$ $\quad$ Rect $\Rightarrow \alpha = 0$

$B = \frac{1+\alpha}{T} \Leftrightarrow \log_2(M) > (1+\alpha)\frac{R}{B} \Rightarrow M = 4$

4 - ASK
4 - QAM
4 - PSK $\Rightarrow$ QPSK

3 16 - PSK

a) 16 Símbolos (A fase é que muda)

$\log_2(16) = 4$ bits/símbolo

b) Banda Passante $\rightarrow B = \frac{1+\alpha}{T_S} \rightarrow R_S = B = 2$ M símbolos/s $\quad R_B = 4R_S = 8$ Mbit/s //

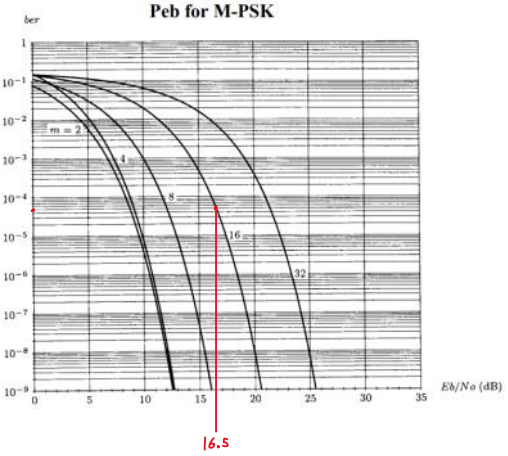
Ideal channel $\rightarrow \alpha = 0$

c) $\alpha = 0.2$

$B = \frac{1+0.2}{T_S} \rightarrow R_S = \frac{B}{1.2} = 1.67$ M símbolos/s $\quad R_B = 4R_S = 6.67$ Mbit/s

d) 16 - PSK

$BER = 6 \times 10^{-5}$



$\frac{E_B}{N_0} = 16.5$ dB

$\frac{C}{N} = \frac{P_S}{P_N} = \frac{E_B \cdot f_B}{N_0 \cdot B_\omega} = \frac{E_B}{N_0} + 10\log_{10}\left(\frac{f_B}{B_\omega}\right) = 22.5$ dB

$f_B = 8$ MHz

$B_\omega = 2$ MHz