Solution of Homework # 5

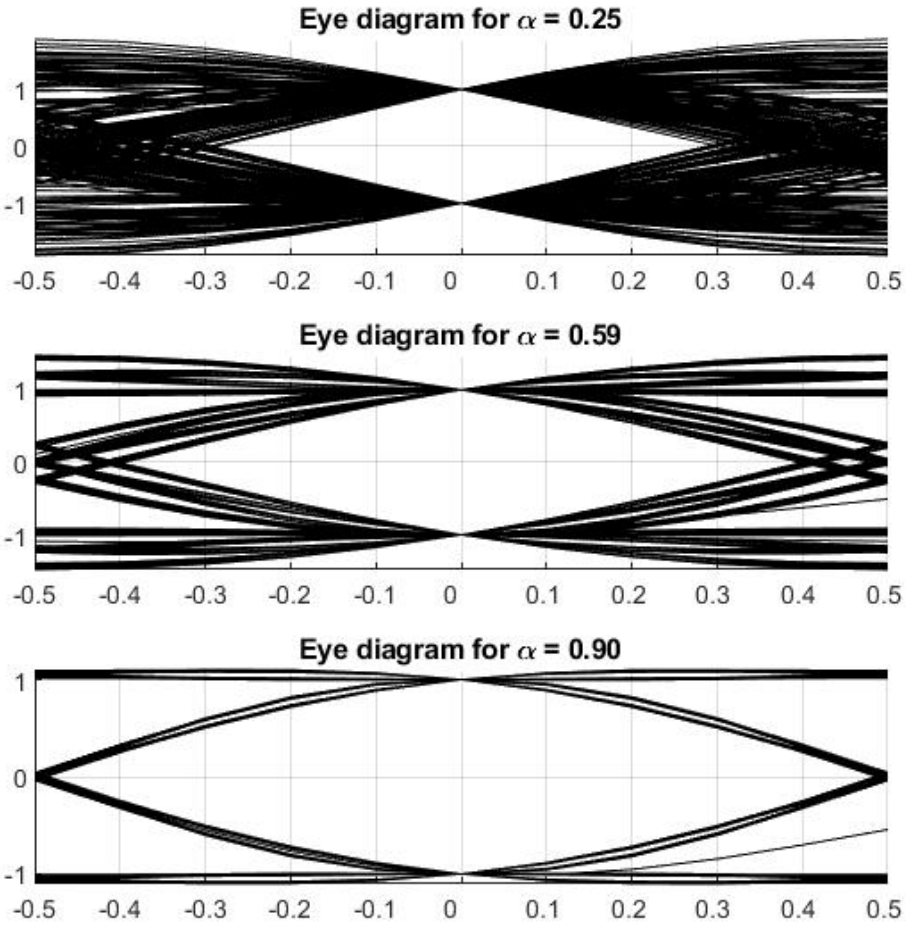
1. For an RF (bandpass) channel the bandwidth is $B = 2W = 20$ kHz and $W = 10$ kHz. We have

$$W = \frac{1+\alpha}{2T} = \frac{1+\alpha}{2}R \qquad \longrightarrow \qquad R = \frac{2W}{1+\alpha}.$$

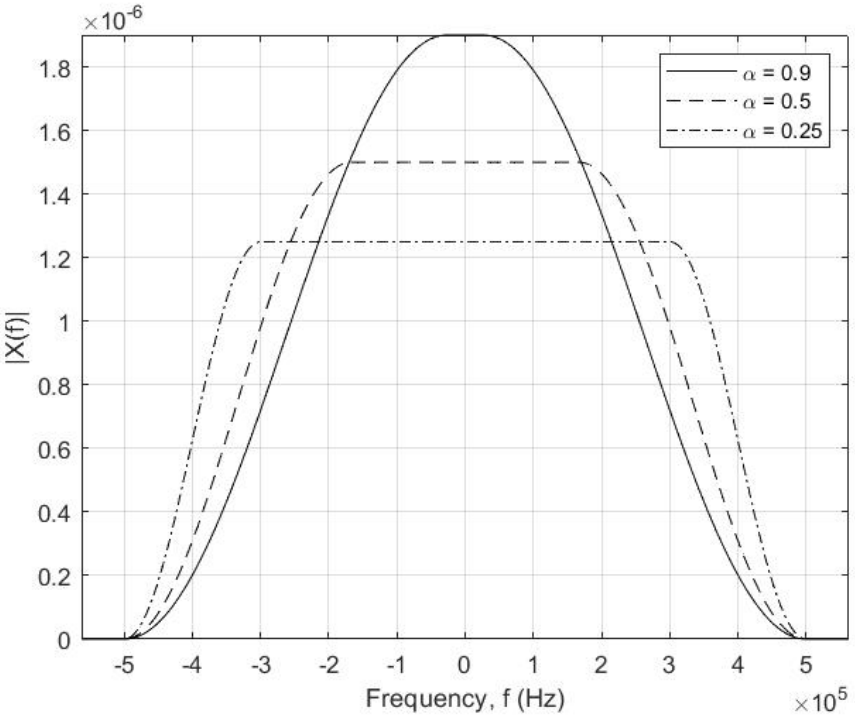
Symbol rate values for different excess bandwidths:

α	R (symbol/s or baud)
0.25	16000.0
0.33	15037.6
0.50	13333.3
0.75	11428.6
1.00	10000.0

2. Eye diagrams:



3. (a) The lowpass equivalent channel has bandwidth $W = B/2 = 500$ kHz. The raised-cosine spectra are plotted below:



(b) Note that $\dfrac{R}{W} = \dfrac{2}{1+\alpha}$. and as explained in lecture: $\left(\dfrac{S}{N}\right) = \dfrac{E_s}{N_0}\dfrac{R}{W}$. The required E_s/N_0 to obtain $P_b = 10^{-3}$ with QPSK is obtained as

$$\frac{E_s}{N_0} = \left[Q^{-1}(P_b)\right]^2 = \left[Q^{-1}(10^{-3})\right]^2 = \underline{9.54} \text{ (or 9.8 dB).}$$

Therefore, the SNR is given by

$$\left(\frac{S}{N}\right) = \frac{E_s}{N_0}\frac{R}{W} = \frac{E_s}{N_0}\frac{2}{1+\alpha} = \frac{19.1}{1+\alpha}, \text{ and } \left(\frac{S}{N}\right) \text{(dB)} = 10\log_{10}\left(\frac{S}{N}\right).$$

Symbol rates, bit rates and SNRs:

α	R (baud)	R_b (bps)	SNR (dB)
0.90	526,315.79	1,052,631.58	10.02
0.50	666,666.67	1,333,333.33	11.05
0.25	800,000.00	1,600,000.00	11.84