

Homework 1

Due Date: Sept. 6, 2023

Problem 1 (Raised-cosine pulse)

Suppose a raised-cosine pulse with the roll-off factor $\beta = 0.3$ is used for ISI-free transmission over the channel with $W = 1000$ Hz. The sampling receiver is used at the receiver side. Find the largest possible symbol rate.

Problem 2 (Fourier Transform and RC pulse)

The raised cosine pulse is given by

$$g(t) = \text{sinc}\left(\frac{t}{T}\right) \frac{\cos(\pi\alpha t/T)}{1 - 4\alpha^2 t^2/T^2}$$

Verify that this expression does indeed represent a raised-cosine pulse by calculating the Fourier transform for the special case $\alpha = 1$. Hint: as an intermediate step, verify that $g(t) = \text{sinc}(2t/T) + 0.5\text{sinc}(2t/T + 1) + 0.5\text{sinc}(2t/T - 1)$.

Problem 3 (Nyquist Pulse)

The pulses are defined in frequency domain and their spectra are shown in Figure 1 (frequency is in MHz).

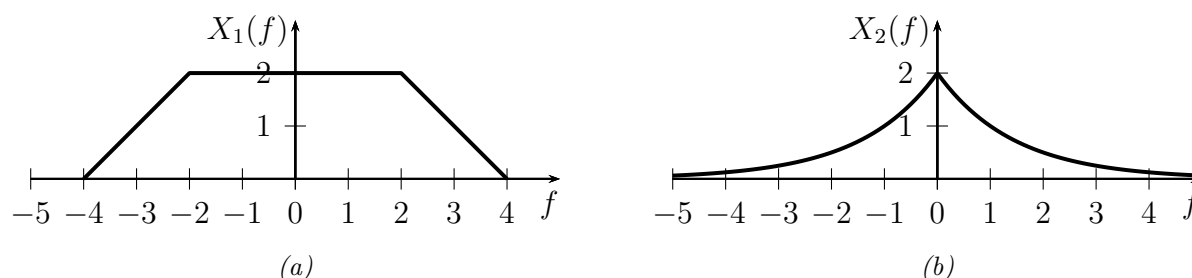


Figure 1: Problem 3

$$X_1(f) = \begin{cases} 2 & \text{if } |f| < 2 \\ 4 - |f| & \text{if } 2 \leq |f| \leq 4 \end{cases} \quad X_2(f) = 2^{-|f|+1}, f \in \mathcal{R}$$

1. Which pulses satisfy the Nyquist criterion and for which symbol rate?
2. Find the value at $t = 0$ and the energy for these signals.