EE110B - Signals and Systems
Winter 2025

Lab 5

The ideal low-pass filter

$$H_0(e^{j\omega}) = \begin{cases} 1 & -\pi/10 \leq \omega \leq \pi/10 \\ 0 & \text{otherwise} \end{cases}$$

has a time-domain signal

$$h_0[n] = \frac{1}{10}\text{sinc}\left(\frac{\pi n}{10}\right) = \begin{cases} \frac{\sin(\frac{\pi n}{10})}{\pi n} & n \neq 0 \\ \frac{1}{10} & n = 0 \end{cases}$$

which is neither causal nor finite. So for practical purposes, it should be truncated and shifted to the right until it becomes causal. The purpose of this lab is to observe the effects on this operation on the magnitude and the phase of the filter.

Task 1: Let the rectangular pulse be defined as

$$r[n] = \begin{cases} 1 & -n_0 \leq n \leq n_0 \\ 0 & \text{otherwise} \end{cases}$$

and

$$h_1[n] = h_0[n - n_0]r[n - n_0]$$

with $n_0 = 10$. Compute and plot $h_1[n]$, $|H_1(e^{j\omega})|$, and $\angle H_1(e^{j\omega})$. Discuss how the truncation and shifting affected the filter in terms of magnitude and phase. Repeat with $n_0 = 20$ and $n_0 = 50$. What do you observe? A higher or lower fidelity in shape to the original filter magnitude $|H_0(e^{j\omega})|$ as n_0 increases? What is happening to $\angle H_1(e^{j\omega})$ as n_0 increases?

Task 2: This time, perform the truncation using a triangular pulse

$$t[n] = \begin{cases} 1 + \frac{n}{n_0} & -n_0 \leq n \leq 0 \\ 1 - \frac{n}{n_0} & 0 \leq n \leq n_0 \\ 0 & \text{otherwise} \end{cases}$$

and let

$$h_2[n] = h_0[n - n_0]t[n - n_0] \ .$$

Repeat all the steps of Task 1. Which one seems to better approximate $|H_0(e^{j\omega})|$? Rectangular or triangular pulses?