EE110B Lab 6

From the lectures, we see the importance of lowpass filters. In this lab exercise, you will learn and test a simple technique to design a digital lowpass filter. Let $h[n]$ be the impulse response of an ideal lowpass filter with the frequency response

$$H(f) = \begin{cases} 1, & |f| \leq 0.2 \\ 0, & 0.2 < |f| \leq 0.5 \end{cases}$$

where the cutoff frequency is chosen to be 0.2.

1) First, determine the analytical form of $h[n]$ by performing the inverse DTFT of $H(f)$.
2) Second, compute $g[n] = h[n - n_0]w[n]$ where
$$w[n] = \begin{cases} n, & 0 \leq n \leq n_0 \\ 2n_0 - n, & n_0 \leq n \leq 2n_0 \end{cases}$$
Unlike $h[n]$, $g[n]$ is a finite casual impulse response.
3) Choose different values of n_0 (such as 20, 30, etc) and compute and plot the amplitude spectrum $|G(f)|$ of $g[n]$ for $-0.5 < f < 0.5$.
4) Compare $|G(f)|$ with $|H(f)|$ and discuss the effect of n_0 on $|G(f)|$. Hint: you can plot $|G(f)|$ on log scale vertically to see details of the small region in $|G(f)|$.
5) Also compute and plot the phase spectrum $\angle G(f)$ of $g[n]$. Is the phase spectrum always a linear function of f within $-0.5 < f < 0.5$? Why?
6) If the input applied to your designed filter is $x[n] = \cos(2\pi 0.1n) + 2\sin(2\pi 0.3n)$, what do you expect at the output of the filter? Can you verify it by computing $y[n] = x[n] * g[n]$?