Problem 4 (20 points)
Three signals, $x_1[n]$, $x_2[n]$, and $x_3[n]$, each consist of the sum of two sinusoids:

$$\begin{aligned} x_1[n] &= \cos\left(\frac{\pi n}{2}\right) + \cos\left(\frac{33\pi n}{64}\right) \\ x_2[n] &= \cos\left(\frac{\pi n}{2}\right) + 0.01\cos\left(\frac{37\pi n}{64}\right) \\ x_3[n] &= \cos\left(\frac{\pi n}{2}\right) + 0.75\cos\left(\frac{37\pi n}{64}\right) \end{aligned}$$

We wish to estimate the spectrum of each of these signals using the system shown in Figure 4.1. The system uses a a 64-point rectangular window ($w[n]$) and a 64-point FFT ($N = 64$).

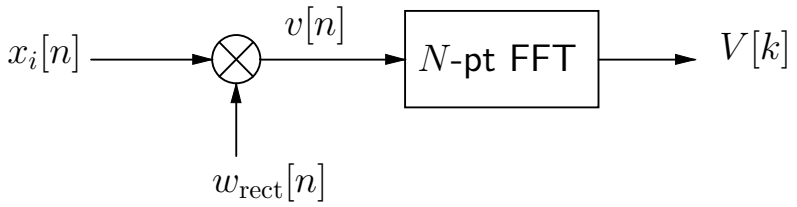

Figure 4.1: Spectral Analysis System

(a) Which of the three signals would you expect to be resolved by the system? That is, for which of the three signals would you expect $|V[k]|$ to show two distinct peaks?

(b) For each of the signals whose sinusoids are not resolved, define a new set of parameters for the system (window type, window length, DFT length) such that they will be resolved. You may find the table of window parameters given below useful.

Note: You just need to specify one set of parameters for each signal that will allow the sinusoids to be resolved. You need not specify all possible parameters that will resolve the sinusoids.

Window Type of Length $M+1$	Approximate Width of Mainlobe	Peak Side-Lobe Amplitude (dB)
Rectangular	$4\pi/(M+1)$	-13
Bartlett	$8\pi/M$	-25
Hanning	$8\pi/M$	-31
Hamming	$8\pi/M$	-41
Blackman	$12\pi/M$	-57

Table 4.1: Commonly Used Windows