Exercises

The signal $s_c(t)$ is defined as: $s_c(t)=\cos(2\pi f_1 t)+0.8\cos(2\pi f_2 t)$, $-\infty<t<\infty$, $f_1=100$ Hz, $f_2=110$ Hz
There is no noise.
The signal is sampled with a frequency of $F_s=400$ Hz

1.a) Is F_s high enough to avoid aliasing?
1.b) From F_s, calculate the sample time T

Sampling of the signal $s_c(t)$ gives discrete values $s_c(nT)=\cos(2\pi f_1 nT)+0.8\cos(2\pi f_2 nT)$, $-\infty<n<\infty$,
or: $x[n]=s_c(nT)=\cos(\omega_1 n)+0.8\cos(\omega_2 n)$, $-\infty<n<\infty$, $\omega_1=2\pi f_1 T$, $\omega_2=2\pi f_2 T$.
Windowing with a rectangular window of length N ($w[n]=1$, for $0\leq n\leq N-1$ and $w[n]=0$ for n otherwise), gives:
$v[n]=x[n]w[n]=\cos(\omega_1 n)+0.8\cos(\omega_2 n)$, $0\leq n\leq N-1$.

2.a) Choose N to obtain a resolution in the frequency domain of at least 5 Hz.
2.b) Use this N for the DFT (FFT) to obtain V[k] and plot (stem) the magnitude | V[k] |.
2.c) Zero-pad v[n] to obtain $v_o[n]$ with a total length of 1024. Calculate $V_o[k]$ and plot the magnitude. Compare the result with the result from 2.b.
2.d) Choose a lower value for N than the one in 2.a and repeat 2.b. Explain the result.
2.e) Choose a higher value for N than the one in 2.a and repeat 2.b. Explain the result.

3.a) Plot the Hann (Hanning) window, $w_h[n]$ of length N (from 2.a).
Note: use MatLab function "hanning(N,'periodic')"
3.b) Plot $v_h[n]=x[n]w_h[n]$
3.c) Repeat exercise 2.b and 2.c. for $v_h[n]$. Explain the differences in the results as compared with exercise 2.
3.d) Now use a Kaiser window and repeat 3a-c. play around with different values for beta.

4) Try to formulate what you have learnt in these exercises.