Homework: Resolution Limit and Fourier Frequency Estimation Bias

You will create a signal consisting of two sinusoids, and will observe 100 points. The signal form is

$$x[n] = \cos(2\pi f_1 n) + \cos\,(2\pi(f_1 + \Delta f)n)$$

and you observe over n= 0, … 99. The lower frequency is $f_1 = 0.2$ and we will try different values of Δf from 0.01, 0.03, 0.05, 0.08, 0.1, 0.15, 0.2. For each value of Δf create $x[n]$, take the FFT (zero-padding to an appropriately large NFFT to get very fine frequency sampling. I recommend something huge like NFFT = 100000) and find the frequency at which the first peak occurs. This peak should correspond to the peak produced by the true value of $f_1 = 0.2$, but there will be some bias with closely spaced sinusoids. Plot the frequency estimate vs Δf. The frequency estimates should be in the normalized frequency f and not ω.

This first analysis above implicitly uses the rectangular window. Redo the analysis using a Hamming window and a Blackman window, producing plots for each.

Turn in the three plots and your Matlab code.