DSP Homework for Monday Nov 6

1) 7.21 in Proakis and Manolakis

2) Problem 10.12 from Oppenheim and Schafer, copied below.

   Note there is a difference in notation between the texts: in P&M, the DTFT of x(n) is denoted as X(ω), while in O&S it is X($e^{j\omega}$).

   10.12. Let $x[n]$ be a signal with a single sinusoidal component. The signal $x[n]$ is windowed with an L-point Hamming window $w[n]$ to obtain $v_1[n]$ before computing $V_1(e^{j\omega})$. The signal $x[n]$ is also windowed with an L-point rectangular window to obtain $v_2[n]$, which is used to compute $V_2(e^{j\omega})$. Will the peaks in $|V_2(e^{j\omega})|$ and $|V_1(e^{j\omega})|$ have the same height? If so, justify your answer. If not, which should have a larger peak?

3) Problem 10.5 from O & S. For this problem, 'the width of the mainlobe' means the zero-to-zero definition.

10.5. Consider estimating the spectrum of a discrete-time signal $x[n]$ using the DFT with a Hamming window applied to $x[n]$. A conservative rule of thumb for the frequency resolution of windowed DFT analysis is that the frequency resolution is equal to the width of the main lobe of $W(e^{j\omega})$. You wish to be able to resolve sinusoidal signals that are separated by as little as $\pi/100$ in ω. In addition, your window length L is constrained to be a power of 2. What is the minimum length $L = 2^{\nu}$ that will meet your resolution requirement?

4) Rework 10.5, but instead of using the zero-to-zero definition of mainlobe width, use the results in Harris:
   a. Use the -3 dB and -6 dB bandwidths tabulated in Harris's Table 1 to find two new minimum window lengths. Again, for each, also find the power-of-two length L that meets the requirements.
   b. If Fs = 1000 Hz, how does your resolution in ω (i.e. $\pi/100$) map to resolution in Hz?