Homework #9

Due Date: Mar. 28, 2005

1. O&W 7.26

2. O&W 7.27

3. O&W 7.31

4. Matlab. Consider the continuous domain signal $x(t) = \left(\text{sinc}\left(\frac{t}{4}\right)\right)^2$ where 4 has units of sec.

   (a) Determine the critical sampling period and sample this signal for n = -N/2 to N/2-1 samples for N = 256.
   (b) Design a Fourier domain filter to exclude all frequencies above $\omega_c = 2\pi/8$ (this is a continuous domain frequency, e.g. it has units of radians/sec.
   (c) Filter the signal $x_d(n)$ in the Fourier domain to produce $y_d(n)$ by using Matlab's fft and ifft functions.
   (d) Plot the discrete domain signals ($x_d(n)$ and $y_d(n)$) as well as their DTFT's.

5. Matlab problem – please use hw8.m as a template. Consider the discrete domain signal $x(n) = \text{sinc}\left(\frac{n}{8}\right)$. We will sample this with a sampling period of Ns = 5.

   (a) Is this signal adequately sampled?
   (b) Using Matlab, plot the signals and the DTFT of this x and x_s. (I have provided code to do this.)
   (c) Reconstruct the signal using the interp1 function in Matlab. An example is provided. Reconstruct the signal using "nearest", "linear" and "cubic". Plot the reconstructed signals and DTFT of the reconstructed signals. How do they compare to the original signal x/X? Please explain why the constructed signal appears as it does.
   (d) Reconstruct the original signal using a Fourier domain filter $H_r(\omega)$ applied to $X_s(\omega)$. Again, plot reconstructed signal and DTFT of the reconstructed signals. How does it compare to the original signal x/X?
   (e) Now change the sampling rate to Ns = 10 and repeat previous parts.

6. Load the Matlab file ecg1.mat. ecg(2,:) contains an electrocardiogram (ECG) sampled at 0.005 ms per sample.

   (a) Subtract the mean from this signal an plot it and its Fourier transform.
   (b) Determine the frequency of the maximal frequency component in radians/sec.
   (c) Determine (approximately) the peak-to-peak time (T_{pp}) in the ECG and determine the frequency as $2\pi/T_{pp}$ and compare to part (b).