EE 438 Digital Signal Processing with Applications
Homework #2 due 9/7/2007

1. Consider a DT LTI system described by the following equation

$$y(n) = x(n) + 2x(n-1) + 0.5y(n-1).$$

   a. Compute the impulse response $h(n)$ of the system.

   b. Compute the output when $x(n) = u(n)$.

   c. Compute the output when $x(n) = 0.25^n u(n)$.

2. For each of the following C-T signals, compute the CTFT and manually plot the magnitude of the result.

   a) $e^{-t}u(t)$
   b) $e^{j\omega_0 t}$
   c) $\text{rect}(t)e^{j6\pi t}$
   d) $\text{sinc}(t)\cos(2\pi f_0 t)$
   e) $\cos(2\pi f_o t)\,\text{rect}(t)$

3. For each of the following D-T signals,
   i. Compute the DTFT $X(\omega)$. Simplify your answer as much as possible.
   ii. Sketch the magnitude and phase of $X(\omega)$.

   a) $u(n+N) - u(n-N-1)$
   b) $2^n u(-n)$
   c) $a^n \sin(\omega_o n)u(n) \;\; |a| < 1, \;\; |\omega_o| < \pi$
   d) $\cos(18\pi n/7)$
   e) $\dfrac{\sin(\pi n/8)}{\pi n}$

4. Let $x(n)$ and $y(n)$ be D-T signals with DTFT's $X(e^{j\omega})$ and $Y(e^{j\omega})$ respectively. Use the formulas for the DTFT and its inverse to compute the DTFT's of the following signals.

   a) $x(n-N)e^{j\omega_0 n}$
   b) $x^*(-n)$
   c) $x(n)y(n)$
   d) $x(n)^2$

5. Consider the filter described by the difference equation

$$y[n] = \frac{1}{4}\{x[n] - 2x[n-1] + x[n-2]\}$$

a. Find a simple expression for the frequency response $H(\omega)$
b. Find a simple expression for the magnitude response $|H(\omega)|$
c. Sketch $|H(\omega)|$
d. Find a simple expression for the phase response $\arg\{H(\omega)\}$
e. Sketch $\arg\{H(\omega)\}$