*Due 21 February 1997 at 5:00 PM*

**EE 438 Assignment No. 4 Spring 1997**

1. For the following signals, find the ZT if it exists, and sketch the ROC, indicating where poles and zeros occur.

   a. $x[n] = 2^{-n} u[n] + 3^{-n} u[n]$

   b. $x[n] = 1, \quad -\infty < n < \infty$

   c. $x[n] = \delta[n-1] + \delta[n+1]$

   d. $x[n] = \cos(\pi n / 4 + \pi / 8)\, u[n]$

   *Hint:* For all parts except c, you should express signals in terms of signals to which known transform pairs or properties may be applied. You should not have to evaluate any of these transforms directly.

2. Consider a causal LTI system with transfer function

$$H(z) = \frac{\left(z - 1/\sqrt{2}\right)}{\left(z^2 + 1/2\right)}$$

   a. Sketch the locations of the poles and zeros.

   b. Use the graphical approach to determine the frequency response $H(\omega)$, for $\omega = 0$ and $\pi / 4$. (Be sure to show your work.)

   c. Is the system stable, Explain why or why not?

   d. Find the difference equation for $y[n]$ in terms of $x[n]$, corresponding to this transfer function $H(z)$.

3. Consider the ZT

$$X(z) = \frac{z+1}{z^2 + z - 2}$$

   Sketch the 3 different ROC's that are possible for this ZT; and for each ROC, find the corresponding signal x[n].

4. Consider a DT LTI system described by the following *nonrecursive* difference equation (moving average filter)

$$y[n] = \frac{1}{5}\{x[n] + x[n-1] + x[n-2] + x[n-3] + x[n-4]\}$$

   a. Find the impulse response $h[n]$ for this filter. Is it of finite or infinite duration?

   b. Find the transfer function $H(z)$ for this filter.

c. Sketch the locations of poles and zeros in the complex $z$-plane.

*Hint:* To factor $H(z)$, use the geometric series and the fact that the roots of the polynomial $z^n - p_0 = 0$ are given by

$$z_k = |p_0|^{1/N} e^{j(\arg p_0)/N + 2\pi k/N},\ k = 0,\ldots,N-1$$

5. Consider a DT LTI system described by the following *recursive* difference equation

$$y[n] = \frac{1}{5}\{x[n] - x[n-5]\} + y[n-1]$$

a. Find the transfer function $H(z)$ for this filter.

b. Sketch the locations of poles and zeros in the complex $z$-plane.

*Hint:* See Part c of Problem 4.

c. Find the impulse response $h[n]$ for this filter by computing the inverse ZT of $H(z)$. Is it of finite or infinite duration?