GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Spring 2004
Problem Set #8

Assigned: 14-March-04
Due Date: Week of 22-March-04

Reading: In *SP First*, Chapter 9: *Continuous-Time Signals...*, and Chapter 7: *z-Transform*

$\Longrightarrow$ **Please check the "Bulletin Board" often. All official course announcements are posted there.**

ALL of the **STARRED** problems will have to be turned in for grading. A solution will be posted to the web. Some problems have solutions similar to those found on the CD-ROM.

Your homework is due in recitation at the beginning of class. After the beginning of your assigned recitation time, the homework is considered late and will be given a zero.

PROBLEM 8.1*:

We now have ***four ways*** of describing an LTI system: the difference equation; the impulse response, $h[n]$; the frequency response, $H(e^{j\hat{\omega}})$; and the system function, $H(z)$. In the following, you are given one of these representations and you must find the other three.

(a) $y[n] = \frac{1}{2}\sum_{k=1}^{5} x[n-k]$

(b) $h[n] = u[n-5] - u[n-2]$

(c) $H(e^{j\hat{\omega}}) = [2+\cos(3\hat{\omega})]e^{-j4\hat{\omega}}$

PROBLEM 8.2*:

We now have ***four ways*** of describing an LTI system: the difference equation; the impulse response, $h[n]$; the frequency response, $H(e^{j\hat{\omega}})$; and the system function, $H(z)$. In the following, you are given $H(z)$ and you must find the other three.

(a) $H(z) = 1/z$

(b) $H(z) = 2 + 3z^{-4} - z^{-8}$

(c) $H(z) = \dfrac{1-z^{-6}}{1-z^{-1}}$

(d) $H(z) = (1+z^{-1})(1-\sqrt{2}e^{j\pi/4}z^{-1})(1-\sqrt{2}e^{-j\pi/4}z^{-1})$

PROBLEM 8.3:

Make a concept map that links together terms such as z-Transform, Frequency Response, Impulse Response, Difference Equation, Sinusoidal Response, and LTI System. Use the ***CNT*** software to make the map. Notice that if you add "keywords" to the nodes of the concept map that you can ***connect to many resources*** such as old homeworks from the *SP-First* CDROM. If you create this concept map, please ***save it to the web*** by using that option in ***CNT.*** Include an identifier that refers to Homework #8.3.

PROBLEM 8.4*:

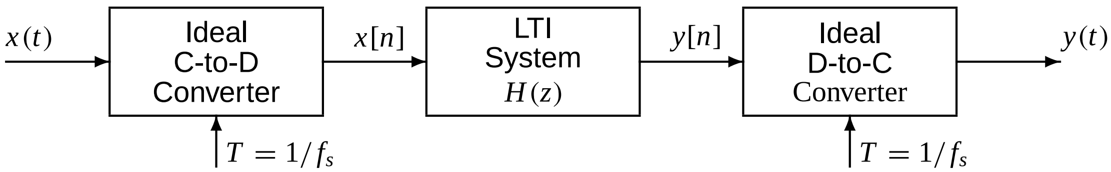
The input to the C-to-D converter in the figure below is

$$x(t) = 8\cos(10000\pi t - 5\pi/2) + 7\cos(22400\pi t)$$

The system function for the LTI system is

$$H(z) = 1 - z^{-5}$$

If $f_s = 8000$ samples/second, determine an expression for $y(t)$, the output of the D-to-C converter.



PROBLEM 8.5*:

Consider the following MATLAB program:

```
nn = 0:16000;
xx =  8*cos(5*pi*(nn-1)/2) + 7*cos(14*pi*nn/5);
yy = conv([1,0,0,0,0,-1],xx);
soundsc(yy,11025)
```

(a) After making the usual correspondence between `xx` and $x[n]$, and between `yy` and $y[n]$, determine the system function $H(z)$ of the FIR filter that is implemented by the `conv( )` statement.

(b) Determine the frequency response of the FIR filter.

(c) Neglecting the end effects in the convolution, determine $y(t)$ that describes the signal produced by the `soundsc( )` statement.
Hint: The result of the previous problem might be useful here.

PROBLEM 8.6*:

Try your hand at expressing each of the following ***continuous-time*** signals into a simpler form:

(a) $[\delta(t-2) + u(t+2)] * \delta(t-3) =$

(b) $[e^{-4t}u(t-0.5) + 3\sin(5\pi t)u(t)]\delta(t-0.1) =$

(c) $\displaystyle\int_{-\infty}^{t-3} \delta(\tau-2)e^{-\pi\tau}u(\tau)d\tau =$

(d) $\displaystyle\frac{d}{dt}\{\cos(5t)[u(t) - u(t-4)]\} =$

Note: use properties of the impulse signal $\delta(t)$ and the unit-step signal $u(t)$ to perform the simplifications. For example, recall

$$\delta(t) = \frac{d}{dt}u(t) \qquad \text{where} \qquad u(t) = \int_{-\infty}^{t} \delta(\tau)d\tau = \begin{cases} 1 & \text{for } t \geq 0 \\ 0 & \text{for } t < 0 \end{cases}$$

Be careful to distinguish between multiplication and convolution. Convolution is denoted by a "star", as in $x(t) * \delta(t-2) = x(t-2)$ and multiplication is usually indicated as in $x(t)\delta(t-2) = x(2)\delta(t-2)$.