GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

# ECE 2025 Spring 2003
# Problem Set #9

Assigned: 28-Feb-03
Due Date: Week of 17-March-03

---

**Quiz #2 will be given on 14-March.** One page ($8\frac{1}{2} \times 11$ in.) of **handwritten** notes allowed.

Reading: In *SP First*, 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.
Please follow the format guidelines (cover page, etc.) for homework.

---

## PROBLEM 9.1*:

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

(b) $h[n] = \delta[n] + 2\delta[n-1] + 2\delta[n-3] + \delta[n-4]$

(c) $H(e^{j\hat{\omega}}) = [3 - 2\cos(\hat{\omega})]e^{-j3\hat{\omega}}$

## PROBLEM 9.2*:

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) $H(z) = z^{-3}$

(b) $H(z) = z^{-1} + 3z^{-4} + z^{-7}$

(c) $H(z) = \dfrac{1 + z^{-5}}{1 + z^{-1}}$

## PROBLEM 9.3*:

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) $H(z) = 7$

(b) $H(z) = z^2 - z^{-2}$ *Note:* You will have to allow for noncausal terms in the difference equation.

(c) $H(z) = (1 - z^{-1})(1 - 0.5e^{j\pi/3}z^{-1})(1 - 0.5e^{-j\pi/3}z^{-1})$

## PROBLEM 9.4*:

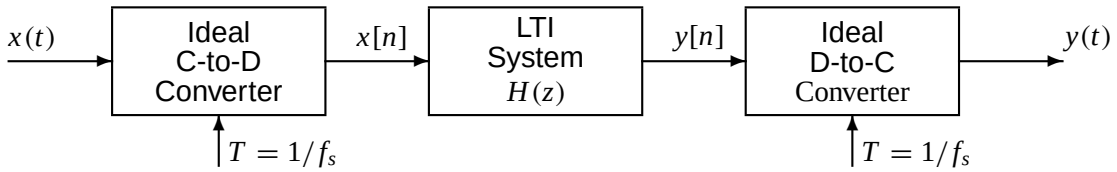
The input to the C-to-D converter in the figure below is

$$x(t) = 2\cos(6000\pi t - \pi/4) + 11\cos(12000\pi t - \pi/3)$$

The system function for the LTI system is

$$H(z) = 1 + z^{-4}$$

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




## PROBLEM 9.5*:

Consider the following MATLAB program:

```
nn = 0:16000;
xx = 2*cos(0.75*pi*nn-pi/4) +  11*cos(1.5*pi*nn-pi/3);
yy = conv([8,0,0,0,8],xx);
soundsc(yy,8000)
```

(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.