EE 311 **March 20, 2019**
IIR Problems

1. What advantage do you gain by having a symmetric numerator when you do implementation.

2. Why are most band stop and band pass filters of even order.

3. In class we discussed using the dreviative as a mapping function from s to z. In this case we began with:

$$\frac{dy}{dt} \approx \frac{y(kT) - y[(k-1)T]}{T}$$

This lead to a mapping fuinction given by

$$s \Rightarrow \frac{z-1}{Tz}$$

Use MATLAB® to draw a sketch of the s domain and show how the left half plane and the $j\omega$ axis are mapped to the z-plane using this mapping function. What can you conclude about whether or not stability is preserved by this mapping function?
Hint: Begin by breaking z and s into real and imaginary parts and writing:
Let $z = \alpha + j\beta$ and $s = \sigma + j\omega$. This gives

$$\alpha = \frac{1-\sigma T}{(1-\sigma T)^2 + (\omega T)^2} \text{ and } \beta = \frac{\omega T}{(1-\sigma T)^2 + (\omega T)^2}$$

Allow σ to go to zero in these equations to find the equations for α and β for the jω axis. Allow ω to go from about -10,000 to
+10,000 and find the corresponding values of α and β. Use the **`pol2cart`** function to convert to polar coordinates and plot.

4. The BLT is to be applied to the following analog filter:

$$H(s) = \frac{s+1}{s^2 - 2s + 5}$$

Answer the following questions:

(a) How many poles at z = -1 will there be?

(b) Will the filter in z be stable? Explain.

(c) What will be the order of the numerator and denominator of the resulting filter in z?

(d) If the sample frequency is 50 Hz, where will the analog frequency 10 Hz map to in z?