# EECS 644 HW 5: due 11/6/25

1. Sketch the signal flow graph for

$$y(n) = 2x(n) + 3x(n-1) - 0.5y(n-1) + 0.25y(n-2)$$

using Direct Form I and Direct Form II implementations. What is the algorithm for each? Determine the Transposed Form of the Direct Form II and algorithm.

2. <u>Efficiently</u> implement the system function

$$H(z) = \frac{z(z-j)(z+j)}{(z-0.7)^2(z+0.7)^2}$$

in a cascade structure. Show the signal flow graph and the algorithm. *Hint: Which terms can be conveniently combined to <u>reduce the number of multiplies</u>?*

3. Implement the system function from Problem 2 in a parallel structure. Show the signal flow graph and the algorithm.

4. Given the following analog transfer function

$$H(s) = \frac{1}{s+(3+j0.75)} + \frac{1}{s+(3-j0.75)}$$

a) apply <u>impulse invariant filter design</u> to obtain the discrete transfer function and the subsequent discrete-time algorithm

b) plot the designed $|H(\Omega T)|$ vs. $\Omega$ for $T=1$, $T=0.5$, and $T=0.1$ along with the analog $|H(\Omega)|$ for $-5\pi \le \Omega \le 5\pi$ all in the same graph for comparison. Comment on what you observe.

5. Using a Butterworth filter prototype and the <u>bi-linear transform method</u>, design a <u>**highpass**</u> digital filter (obtain the discrete-time algorithm) that meets the following design specs:

$$\kappa_p = -3 \text{ dB} \quad @ \quad \Omega_p = 100\pi$$
$$\kappa_s = -30 \text{ dB} \quad @ \quad \Omega_s = 400\pi$$

Employ a sampling rate of $F_s = 1.2$ kHz with the filter exactly satisfying the $\kappa_s$ requirement. *Note: Use the appropriate analog transformation.*