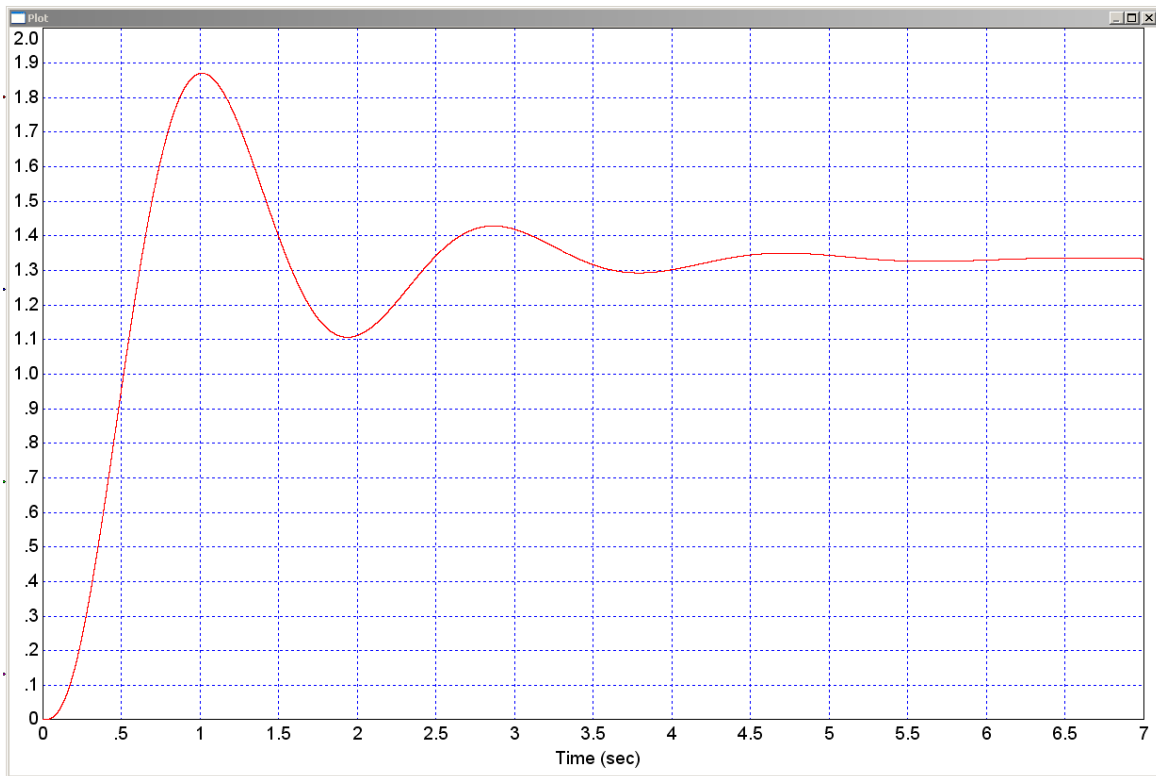


Test #2: ECE 461 / 661

Closed Book. Closed Notes. Calculators Permitted.

1) Give the transfer function for a system with the following step response:

$$G(s) \approx \left(\frac{1.32 \cdot (0.8^2 + 3.39^2)}{(s + 0.8 + j3.39)(s + 0.8 - j3.39)} \right)$$



$T_s = 5$ seconds

$$\text{real}(s) = -0.8$$

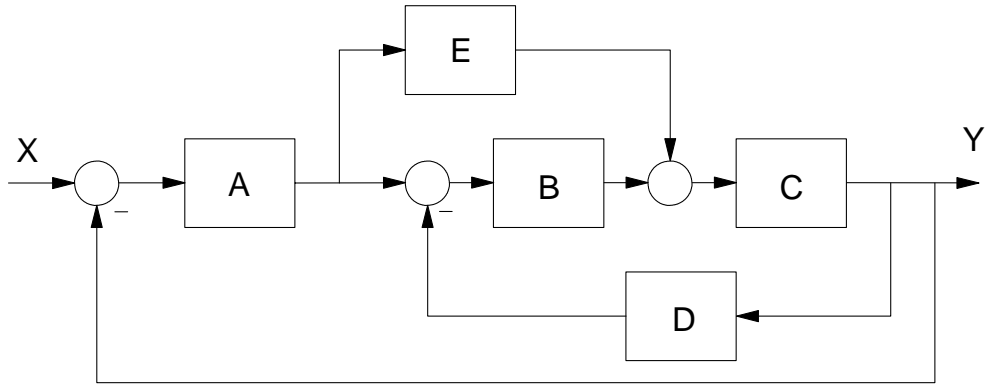
$$\text{Frequency of oscillation} = \left(\frac{2 \text{ cycles}}{3.7 \text{ sec}} \right) 2\pi = 3.39$$

DC gain = 1.32

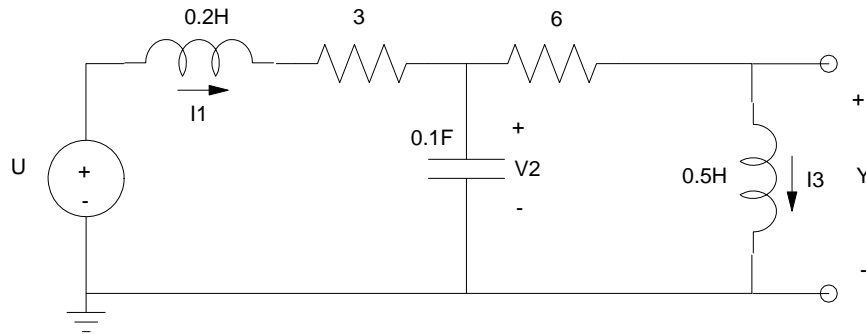
$$G(s) \approx \left(\frac{1.32 \cdot (0.8^2 + 3.39^2)}{(s + 0.8 + j3.39)(s + 0.8 - j3.39)} \right)$$

2) Find the transfer function from X to Y

$$G(s) = \left(\frac{ABC + AEC}{1 + ABC + BCD + ACE} \right)$$



3a) Write the coupled differential equations which describe the following circuit:



$$0.2sI_1 = U - (3I_1 + V_2)$$

$$0.1sV_2 = I_1 - I_3$$

$$0.5sI_3 = V_2 - 6I_3$$

3b) Express these dynamics in state-space form:

$$sX = AX + BU$$

$$Y = CX + DU$$

$$s \begin{bmatrix} I_1 \\ V_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -15 & -5 & 0 \\ 10 & 0 & -10 \\ 0 & 2 & -12 \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \\ I_3 \end{bmatrix} + \begin{bmatrix} 5 \\ 0 \\ 0 \end{bmatrix} U$$

$$Y = 0.5sI_3 = \begin{bmatrix} 0 & 1 & -6 \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \\ I_3 \end{bmatrix} + [0]U$$

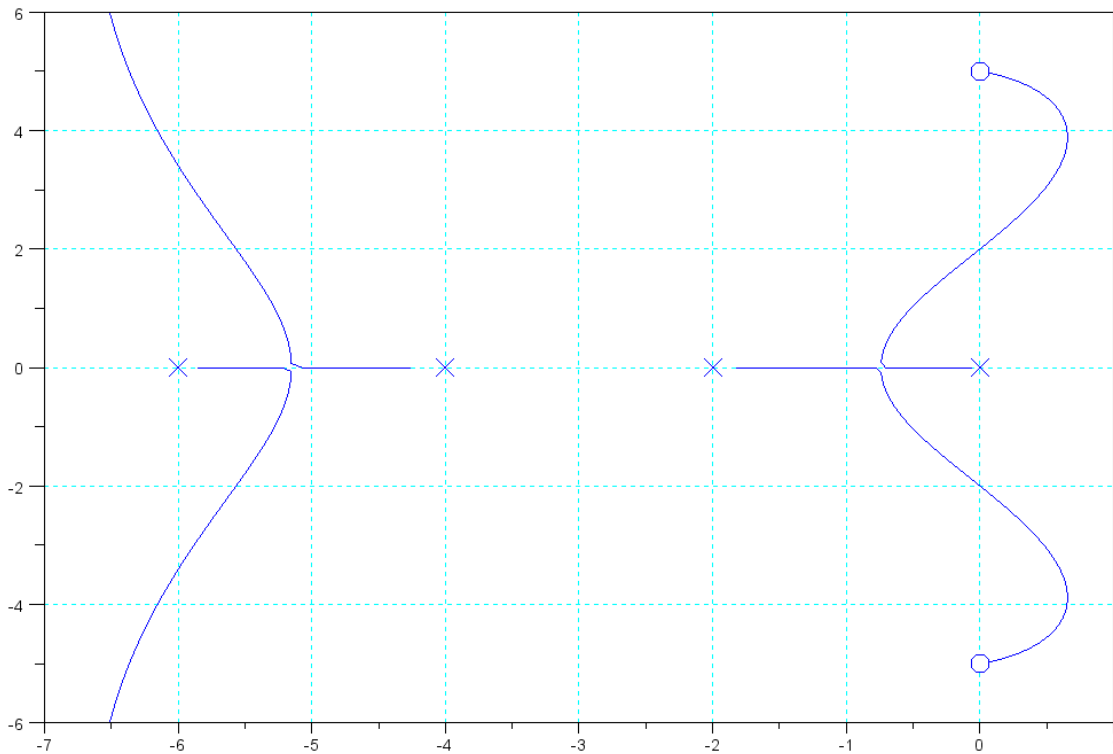
4) The root locus for $G(s)$ is shown below. Determine the following:

$$G(s) = \left(\frac{(s+j5)(s-j5)}{s(s+2)(s+4)(s+6)} \right)$$

# Asymptotes	2
Asymptote Intersect	$\left(\frac{(0-2-4-6)-(0+0)}{2} \right) = -6$
Asymptote Angle	$\pm 90^\circ$
Approach Angle to the Zero at $s = +j5$	-20.65 degrees

$$\left(\frac{(s+j5)}{s(s+2)(s+4)(s+6)} \right)_{s=j5} = 0.0074 \angle -159.3^\circ$$

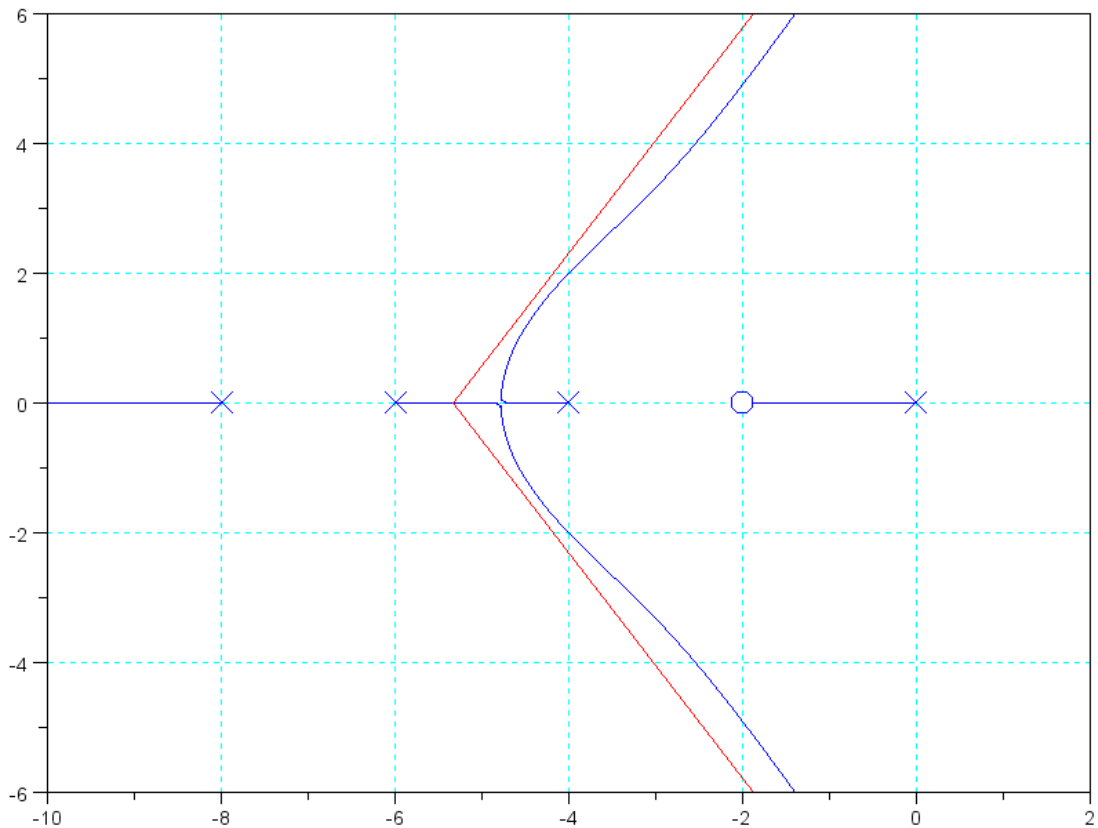
To make the angles add up to 180 degrees, the zero at $+j5$ must add another -20.65 degrees



5) Sketch the root locus for $G(s)$. Also determine the following

$$G(s) = \left(\frac{s+2}{s(s+4)(s+6)(s+8)} \right)$$

Real Axis Loci	(0, -2), (-4, -6), (-8, -infinity)
# Asymptotes	4 poles - 1 zero = 3 asymptotes
Asymptote Intersect	$\left(\frac{(0-4-6-8)-(-2)}{4-1} \right) = -5.333$
Asymptote Angle	$\pm 60^\circ, 180^\circ$
Breakaway Point(s) (approximate)	-4.8
jw Crossing(s) (approximate)	j9.23



Bonus: Name one person other than Donald Trump and Hillary Clinton, who is running for President of the U.S. Jill Stein, Gary Johnson