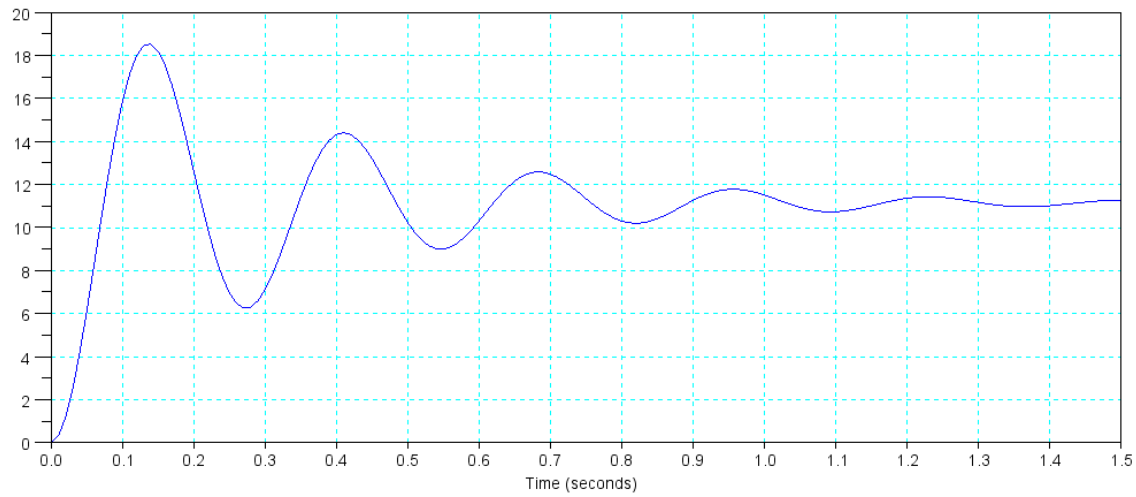
ECE 461 - Final: Name ____________________

Fall - 2020

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

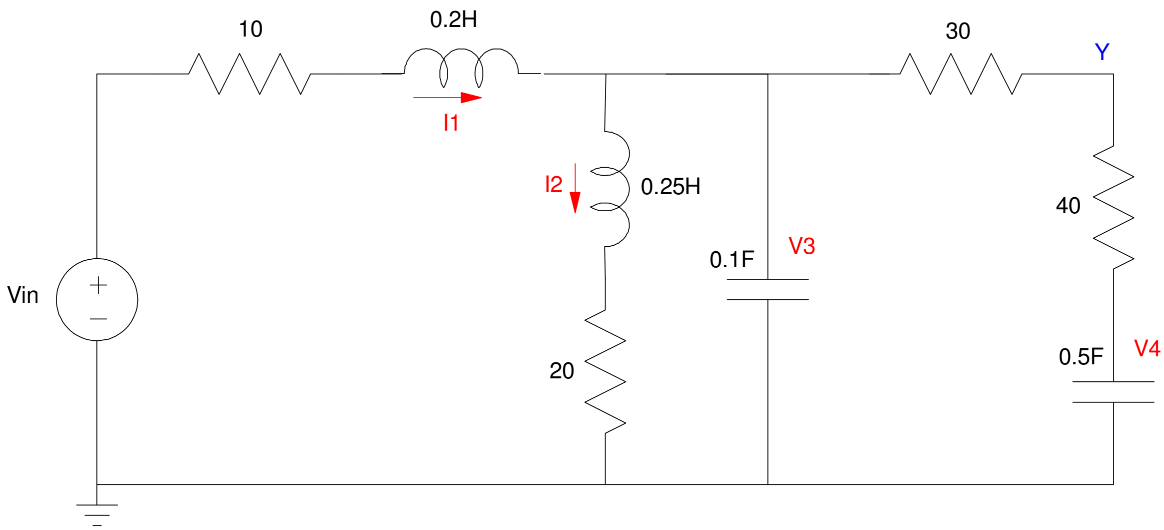


1b) What is the step response for the following system:

$$Y = \left(\frac{2000}{(s+7+j12)(s+7-j12)(s+40)} \right) X$$

DC Gain	2% Settling Time	% Overshoot

2a) Write the differential equations which describe the following circuit (i.e. write the N differential equations which correspond to the voltage node equations)



2b) Express these dynamics in state-space form

$$s\begin{bmatrix} I_1 \\ I_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} - & - & - & - \\ - & - & - & - \\ - & - & - & - \\ - & - & - & - \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ V_3 \\ V_4 \end{bmatrix} + \begin{bmatrix} - \\ - \\ - \\ - \end{bmatrix} V_{in}$$

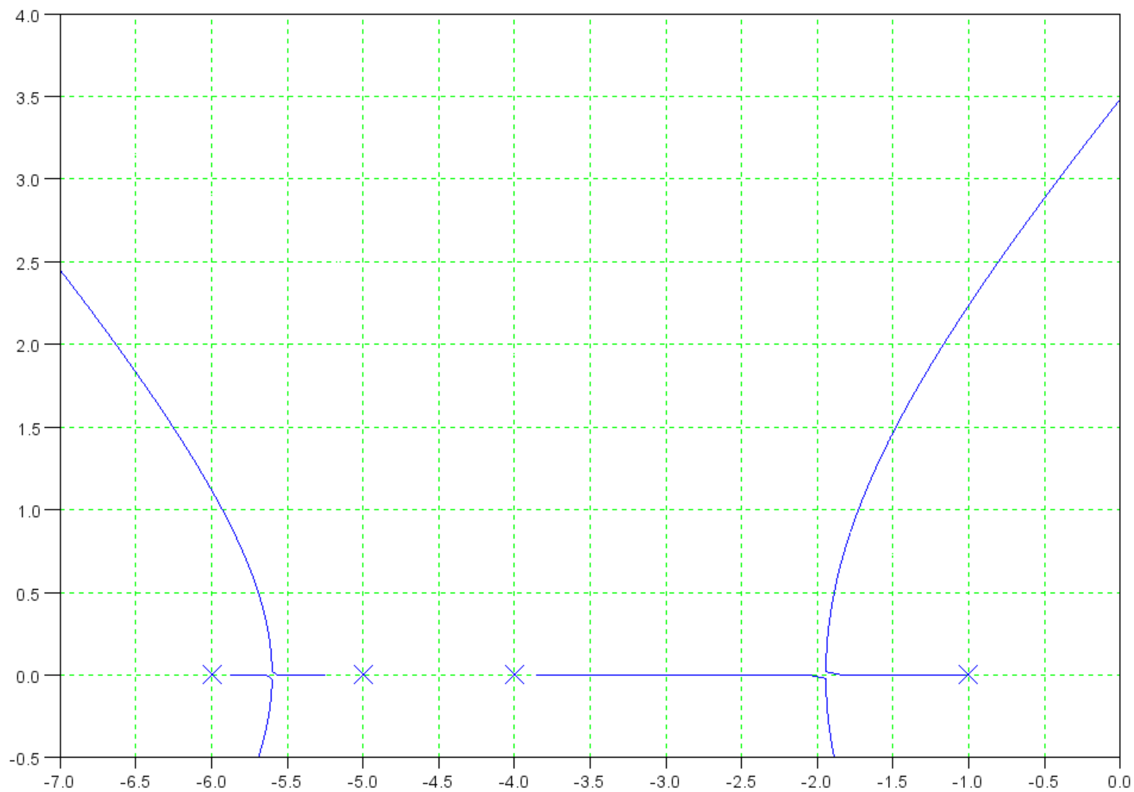
$$Y = \begin{bmatrix} - & - & - & - \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ V_3 \\ V_4 \end{bmatrix}$$

3) Gain Compensation: The root locus for

$$G(s) = \left(\frac{40}{(s+1)(s+4)(s+5)(s+6)}\right)$$

is shown below. Determine the following:

Maximum gain, k, for a stable closed-loop system	
k for a damping ratio of 0.6	
Closed-loop dominant pole(s) for a damping ratio of 0.6	
Closed-Loop DC gain for a damping ratio of 0.6	



4) Given the following stable system

$$G(s) = \left(\frac{100}{(s+0.5)(s+2)(s+6)}\right)$$

Determine a compensator, K(s), which results in the closed-loop system having

- No error for a step input, and
- A closed-loop dominant pole at s = -2 + j5

5) Given the following stable system

$$G(s) = \left(\frac{100}{(s+0.5)(s+2)(s+6)} \right)$$

Determine a digital compensator, K(z), which results in the closed-loop system having

- No error for a step input,
- A closed-loop dominant pole at s = -2 + j5, and
- A sampling rate of T = 0.2

6) Given the following stable system

$$G(s) = \left(\frac{100}{(s+0.5)(s+2)(s+6)}\right)$$

Determine a digital compensator, K(z), which results in the closed-loop system having

- A closed-loop DC gain of 1.000 (i.e. no error for a step input),
- A 0dB gain frequency of 5 rad/sec, and
- Mm = 1.45

7) Determine R and C so that the following compensator has the transfer function of

$$K(s) = 300\left(\frac{(s+2)(s+9)}{s(s+15)}\right)$$