Homework 3b

EEET–427–01:Controls Systems

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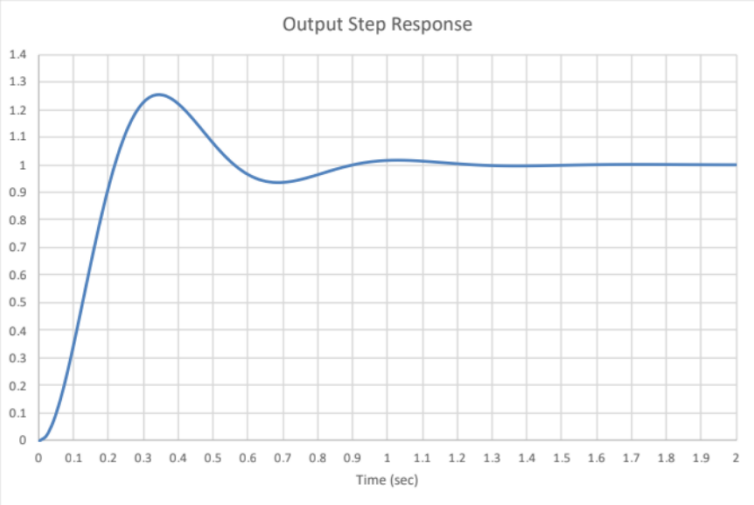
1. Find the root locations for a second order system that has a step response with 4.3% overshoot and a time of peak overshoot of 0.44 seconds.

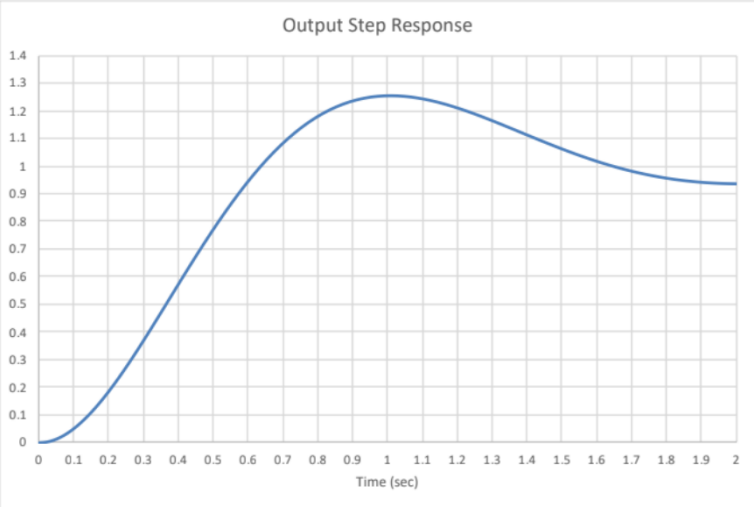
$$Roots = 7.15 \pm 7.140j \tag{1}$$

2. Find the damping ratio, the undamped natural frequency, and root locations for the system which has the following unit step response:



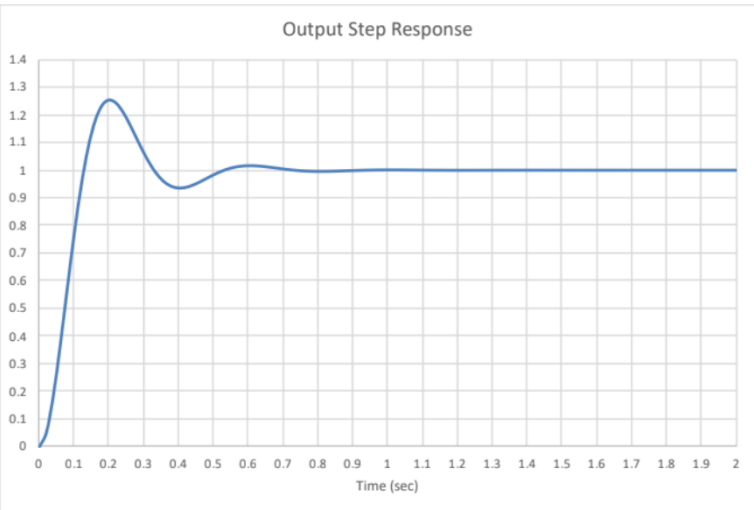
$$\begin{aligned} \zeta &= 0.404 \\ \omega_n &= 9.811 \\ Roots &= 3.961 \pm 8.976j \end{aligned} \tag{2}$$

3. Find the damping ratio, undamped natural frequency, and root locations for the system which has the following unit step response:



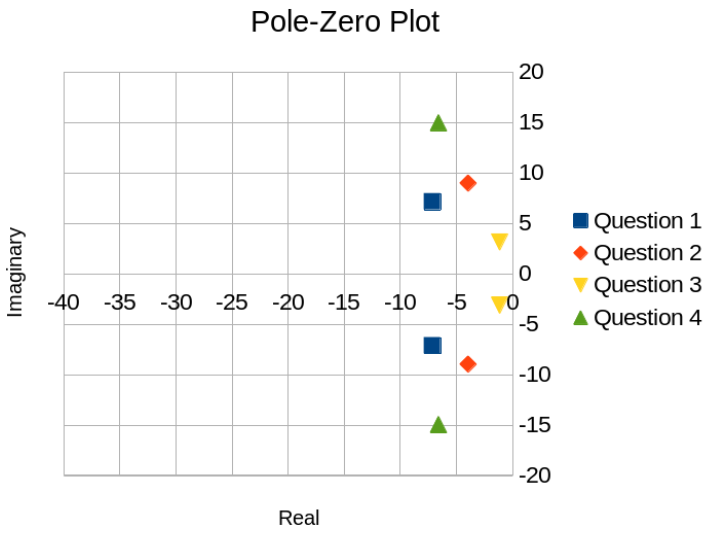
$$\begin{aligned} \zeta &= 0.404 \\ \omega_n &= 3.346 \\ Roots &= 1.153 \pm \pi j \end{aligned} \tag{3}$$

4. Find the damping ratio, undamped natural frequency, and root locations for the system which has the following unit step response:



$$\begin{aligned} \zeta &= 0.404 \\ \omega_n &= 16.35 \\ Roots &= 6.601 \pm 14.96j \end{aligned} \tag{4}$$

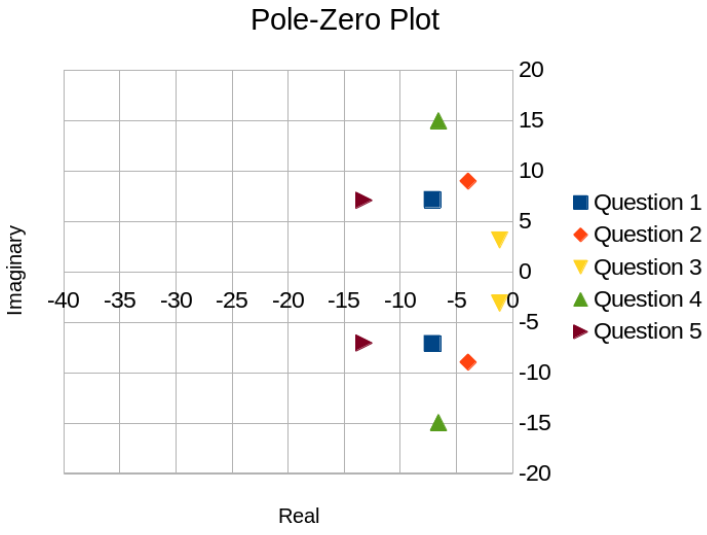
5. Plot the root locations that you calculated for problems 1-4 in the s-plane. Label each pare of poles with its problem number.



What is the same about all 3 of the step responses for these pole locations that lie on the same line?
The ζ values for those 3 are the same.

6. Find the damping ratio, undamped natural frequency, and root locations for the system which has an overshoot of 0.28% and the time of peak response is 0.444 seconds.

$$\begin{aligned} \zeta &= 0.882 \\ \omega_n &= 15.01 \\ Roots &= 13.24 \pm 7.076j \end{aligned} \tag{5}$$



Which pole location has the greatest damping ratio?
Question 5 has the greatest damping ratio.

7. For a system with root locations of $s = -2.3 \pm j11.5$, find the percent overshoot and time to peak response.

$$\begin{aligned} T_p &= 0.273s \\ Overshoot\ \% &= 50.3\% \end{aligned} \tag{6}$$

8. Find the roots of the denominator of the third order polynomial given below:

$$\begin{aligned} \frac{\theta}{\theta_{ref}} &= \frac{aK_p s + aK_i}{s^3 + bs^2 + aK_p s + aK_i} \\ a = 1800;\ b = 6;\ K_p &= 0.08;\ K_i = 0.3 \\ Roots &= -1.0139 \pm 11.6154j;\ -3.9722 + 0j \end{aligned} \tag{7}$$

Then, find the approximate percent overshoot and time to peak response.

$$\begin{aligned} Overshoot\ \% &= 75.13\% \\ T_p &= 0.27 \end{aligned} \tag{8}$$