

ECE 486: Control Systems

Lecture 6A: Effects of Extra Poles and Zeros

Key Takeaways

This lecture considers the effect of extra poles and zeros on the step response.

LHP Poles: Increase settling time.

The effects are small if the pole is far in the LHP.

LHP Zeros: Increase overshoot, decrease rise time, and have no effect on settling time.

The effects are small if the zero is far in the LHP.

RHP Zeros: Cause undershoot but no effect on settling time.

The effects are small if the zero is far in the RHP.

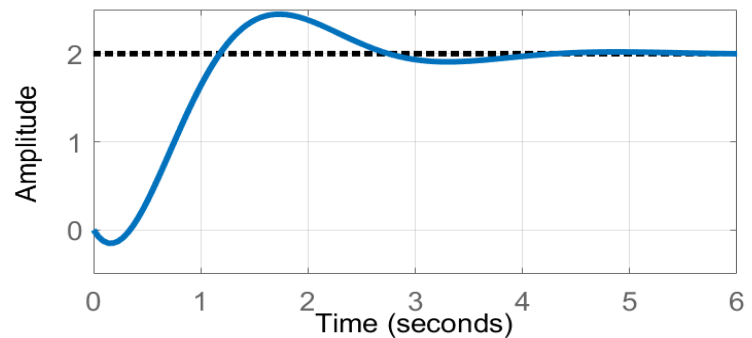
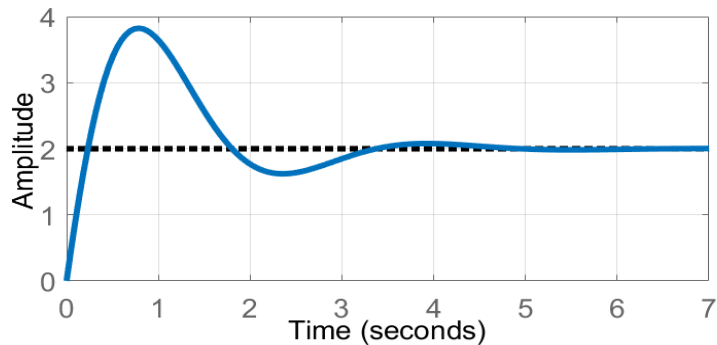
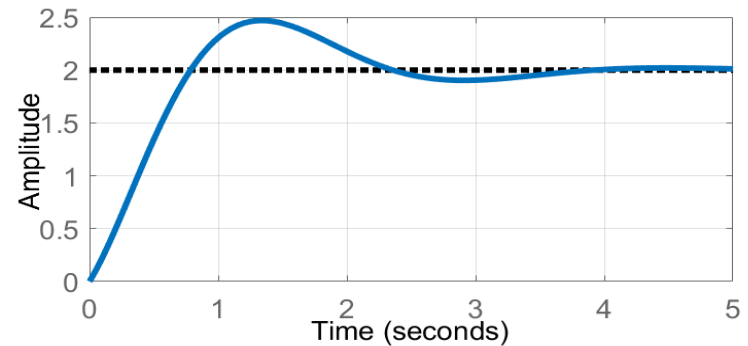
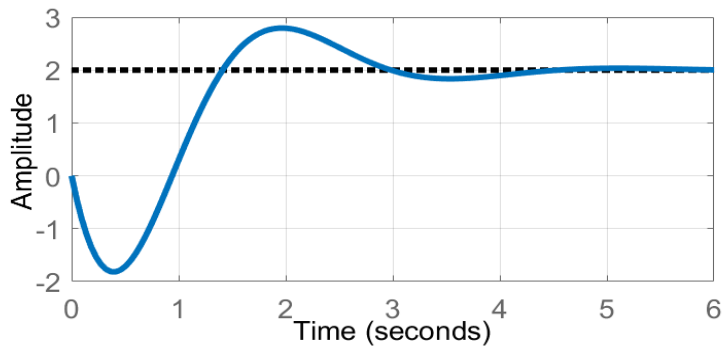
Problem 1

Four systems and four unit step responses are given below. Match each system to its unit step response.

$$G_A = \frac{-2s+10}{s^2+2s+5} \quad G_C = \frac{2s+10}{s^2+2s+5}$$

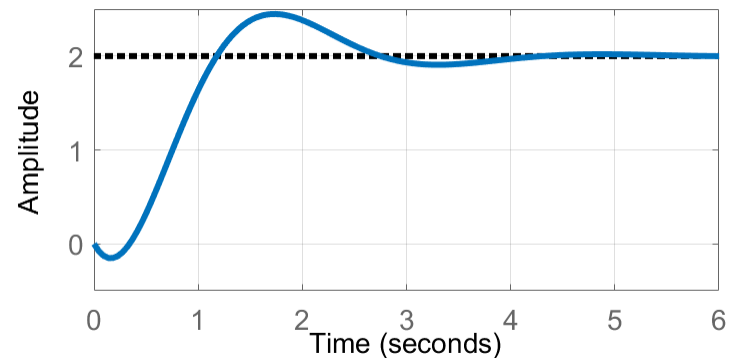
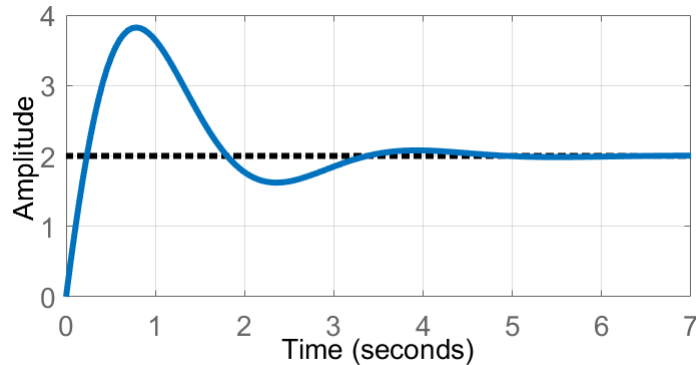
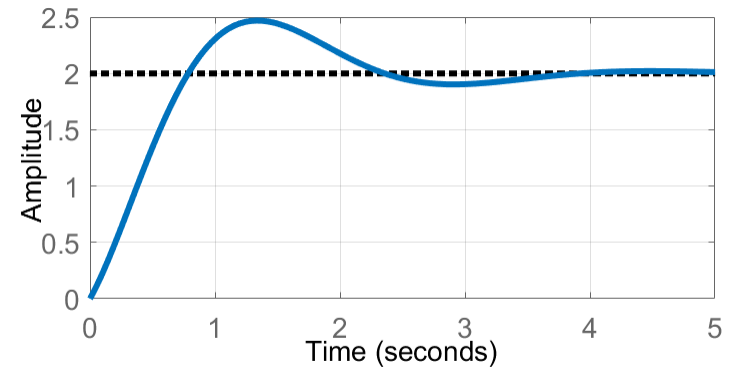
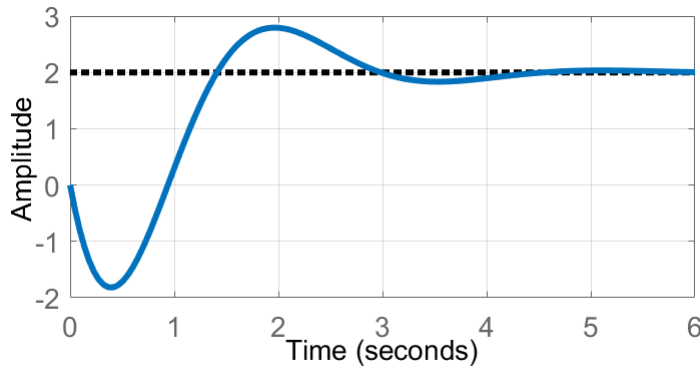
$$G_B = \frac{-10s+10}{s^2+2s+5} \quad G_D = \frac{10s+10}{s^2+2s+5}$$

What happens if adding a pole at -20?



Solution 1

$$G_A = \frac{-2s+10}{s^2+2s+5}, \quad G_B = \frac{-10s+10}{s^2+2s+5}, \quad G_C = \frac{2s+10}{s^2+2s+5}, \quad G_D = \frac{10s+10}{s^2+2s+5}$$



Solution 1-Extra Space

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Lecture 6B: Stability

Key Takeaways

We study the properties exponential terms e^{st} that appear in the free and forced response.

The lecture covers the following:

1. Response characteristics for real and complex roots
2. Time Constants
3. Internal Stability
4. Bounded-Input, Bounded-Output Stability

Problem 2

For each of the systems below:

- What are the poles? Is the system stable?

$$G_A(s) = \frac{s-2}{s+7}$$

$$G_B(s) = \frac{s+2}{s-7}$$

$$G_C(s) = \frac{-9}{s^2+2s-8}$$

$$G_D(s) = \frac{5}{(s^2+4s+13)(s-5)}$$

Solution 2A

- What are the poles? Is the system stable?

$$G_A(s) = \frac{s-2}{s+7}$$

Solution 2B

- What are the poles? Is the system stable?

$$G_B(s) = \frac{s+2}{s-7}$$

Solution 2C

- What are the poles? Is the system stable?

$$G_C(s) = \frac{-9}{s^2 + 2s - 8}$$

Solution 2D

- What are the poles? Is the system stable?

$$G_D(s) = \frac{5}{(s^2 + 4s + 13)(s - 5)}$$

Solution 2-Extra Space

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Lecture 6C: Routh-Hurwitz Criterion

Problem 3

Without a computer, determine whether or not the following polynomial have any RHP roots:

$$s^4 + 10s^3 + 40s^2 + 20s + 1$$

Solution 3-Extra Space
