Experiment 6.1

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Objectives

To verify the effect of pole location upon stability. To verify the effect upon stability of loop gain in a negative feedback system.

Minimum Required Software Packages

MATLAB, Simulink, and the Control System Toolbox.

Prelab

Problem 1

Fiind the equivalent transfer function of the negative feedback system of Figure P6.19 below if $G(s) = \dfrac{K}{s(s+2)^2}$

and $H(s) = 1$.

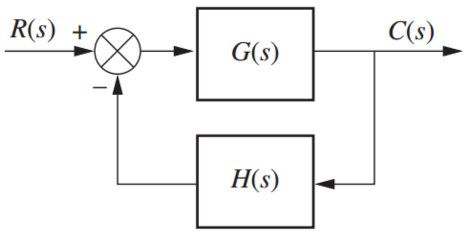


FIGURE P6.19

<u>Answer:</u>

$$G(s) = \frac{G(s)}{1 + G(s)H(s)} = \frac{K}{s^3 + 4s^2 + 4s + K}$$

Problem 2

For the system of Prelab Problem 1, find two values of gain that will yield closed-loop, overdamped, second-order poles. Repeat this for two gains which will produce underdamped poles.

<u>Answer:</u>

Overdamped: $K = \{100, 200\}$

Underdamped: $K = \{1, 2\}$

Problem 3

For the system in Prelab Problem 1, find the value of gain, K, that will make the system critcally damped.

Answer:

Critically Damped: $K = 42.1$

Problem 4

For the system of Prelab Problem 1, find the value of gain, K, that will make the system marginally stable. Also, find the frequency of oscialltion at that value of Kthat makes the system marginally stable.

Answer:

Critically Damped: $K = 24.1, \omega_n = 2$

Problem 5

For each of Prelab Problems 2, 3, and 4, plot on one graph the pole locations for each case and write the corresponding value of gain, K, at each pole.

Answer:

Lab

Problem 1

Using Simulink, set up the negative feedback system of Prelab 1. Plot the step response of the system at each value of gain calculated to yield overdamped, underdamped, critically damped, and marginally stable responses.

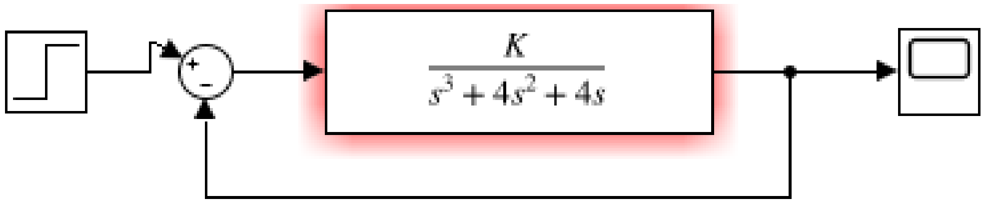
For your Simulink, please provide a screenshot that clearly shows the system.

```
K = 1;

stepinfo(P1);
rlocus(P1)
```

```
Error using rlocus (line 73)
Not enough input arguments.
```

```
print('-sP1','-dpng','P1.png')
```



Problem 2

Plot the step responses for two values of gain, K, above that calculated to yield marginal stability.

```

```

Problem 3

At the output of the negative feedback system, cascade the transfer function $G_1(s) = \frac{1}{s^2+4}$. *Set the gain, K, at a value below that calculated for matginal stability and plot the step response. Repeat for Kcalculated to yield marginal stability.*

For your Simulink, please provide a screenshot that clearly shows the system.

```
% Insert your code here
```

Postlab

Problem 1

From your plots, discuss the conditions that lead to unstable responses.

Instability occurs in higher gains.

Problem 2

Discuss the effect of Gain upon the nature of the step response of a closed-loop system.

Gain will increase the