Experiment 5.1

Name:

Objectives

To verify the equivalency of the basic forms, including cascade, parallel, and feedback forms. To verify the equivalency of the basic moves, including moving blocks past summing junctions, and moving blocks past pickoff points.

Minimum Required Software Packages

MATLAB, Simulink, and the Control System Toolbox.

Prelab

Problem 1

Find the equivalent transfer function of three cascaded blocks, $G_1(s) = \frac{1}{s+1}$, $G_2(s) = \frac{1}{s+4}$, *and* $G_3(s) = \frac{s+1}{s+5}$.

Answer:

$$G_{eq}(s) = G_1(s)G_2(s)G_3(s) = \frac{s+1}{(s+1)(s+4)(s+5)}$$

Problem 2

Find the equivalent transfer function of three parallel blocks, $G_1(s) = \frac{1}{s+4}$, $G_2(s) = \frac{1}{s+4}$, *and* $G_3(s) = \frac{s+3}{s+5}$.

Answer:

$$G_{eq}(s) = G_1(s) + G_2(s) + G_3(s) = \frac{1}{s+1} + \frac{1}{s+4} + \frac{s+1}{s+5}$$

Problem 3

Find the equivalent transfer funciton of the negative feedback system of Figure P5.55 (picture below) if $G(s) = \frac{s+1}{s(s+2)}$, *and* $H(s) = \frac{s+3}{s+4}$.

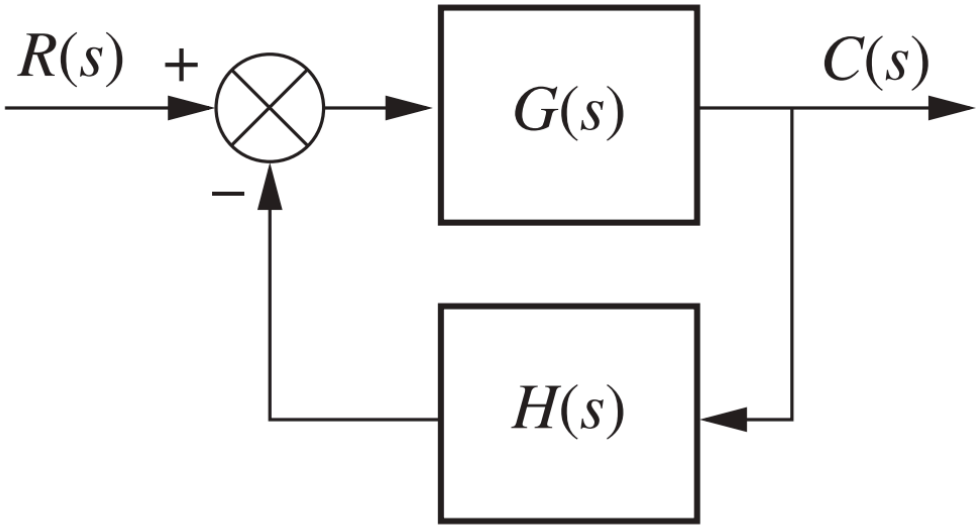


FIGURE P5.55

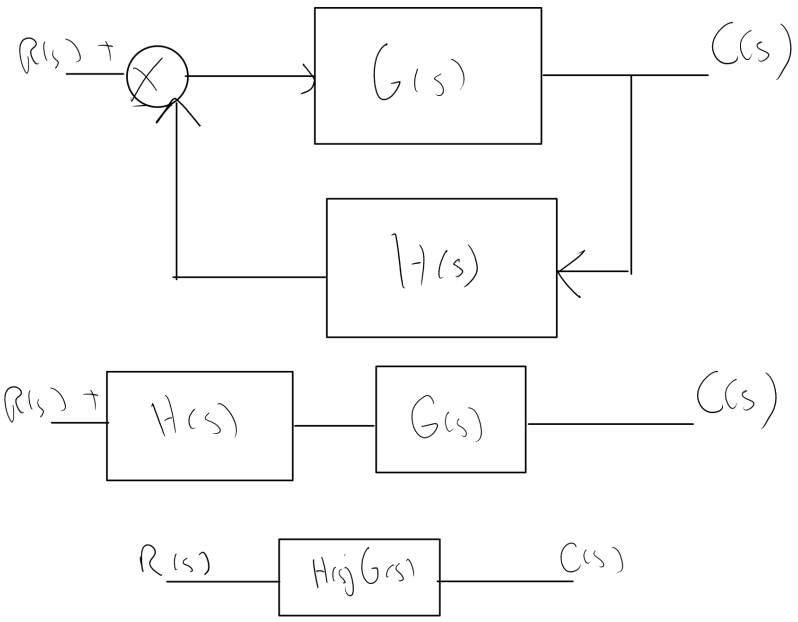
Answer:

$$G_{eq}(s) = \frac{G(s)}{1 + G(s)H(s)} = \frac{(s+1)(s+4)}{s^3 + 7s^2 + 12s + 3}$$

Problem 4

For the system of Prelab 3, push $H(s)$ *to the left past the summing junction and draw the equivalent system.*

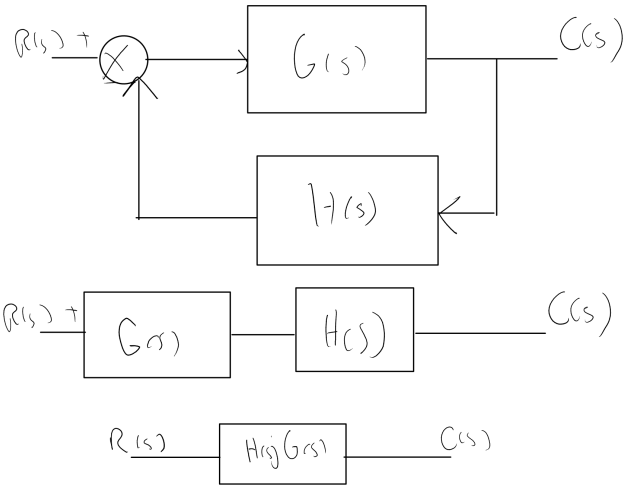
Answer:



Problem 5

For the system of Prelab 3, push $H(s)$ to the right past the pickoff point and draw the equivalent system.

Answer:



Lab

Problem 1

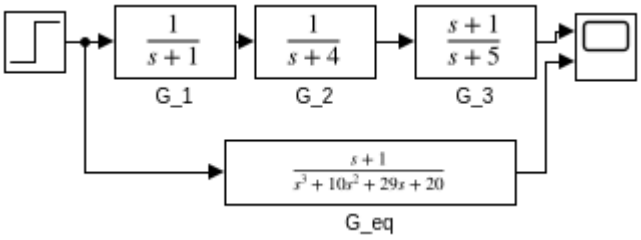
Using Simulink, set up the cascade system of Prelab 1 and the equivalent single block. Make separate plots of the step response of the cascaded system and its equivalent single block. Record the values of settling time and rise time for each step response.

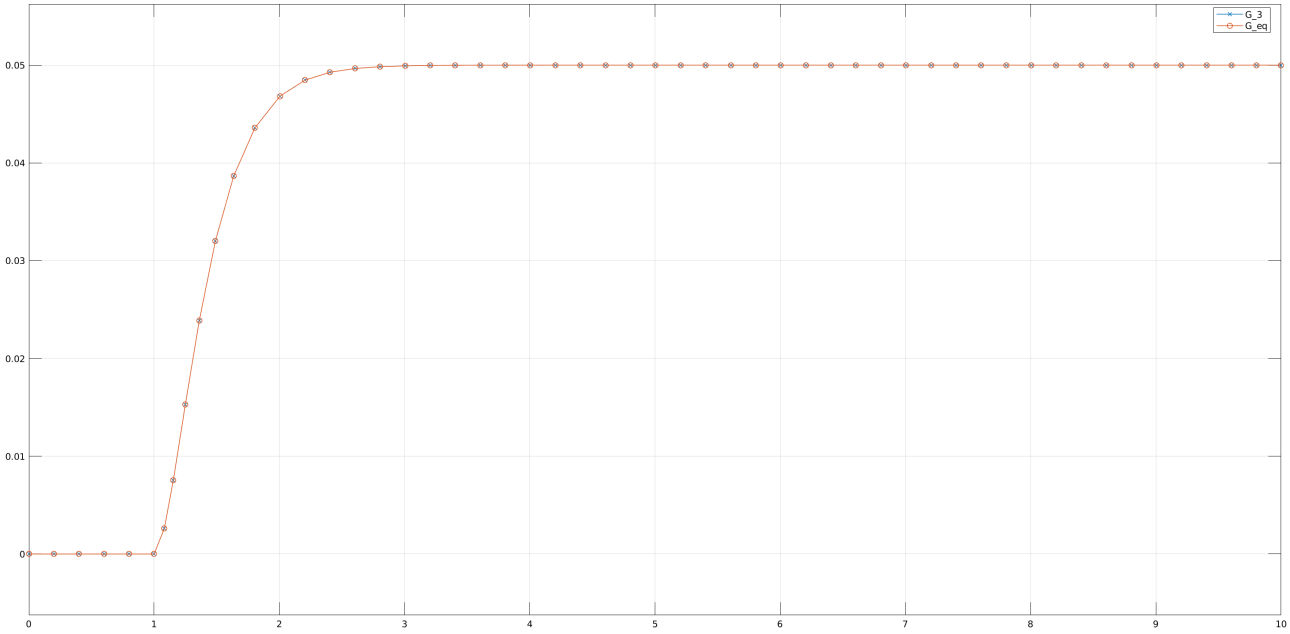
For your Simulink, please provide a screenshot that clearly shows the syste

```
stepinfo(P_1)
```

```
ans = struct with fields:
         RiseTime: 0.5333
     SettlingTime: 6.9600
      SettlingMin: 0
      SettlingMax: 2
        Overshoot: 200
       Undershoot: 0
             Peak: 6
         PeakTime: 1
```

```
%P_1  % to open the model
%print('-sP_1','-dpng','p_1.png')
```





Problem 2

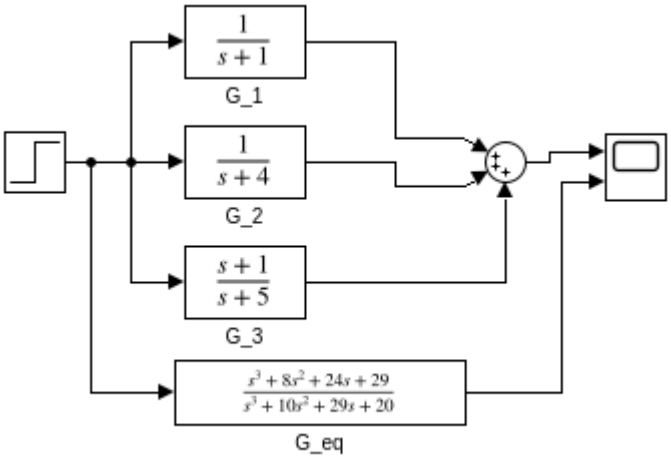
Using Simulink, set up the parallel system of Prelab 2 and the equivalent single block. Make separate plots of the step response of the parallel system and its equivalent single block. Record the values of settling time and rise time for each step response.

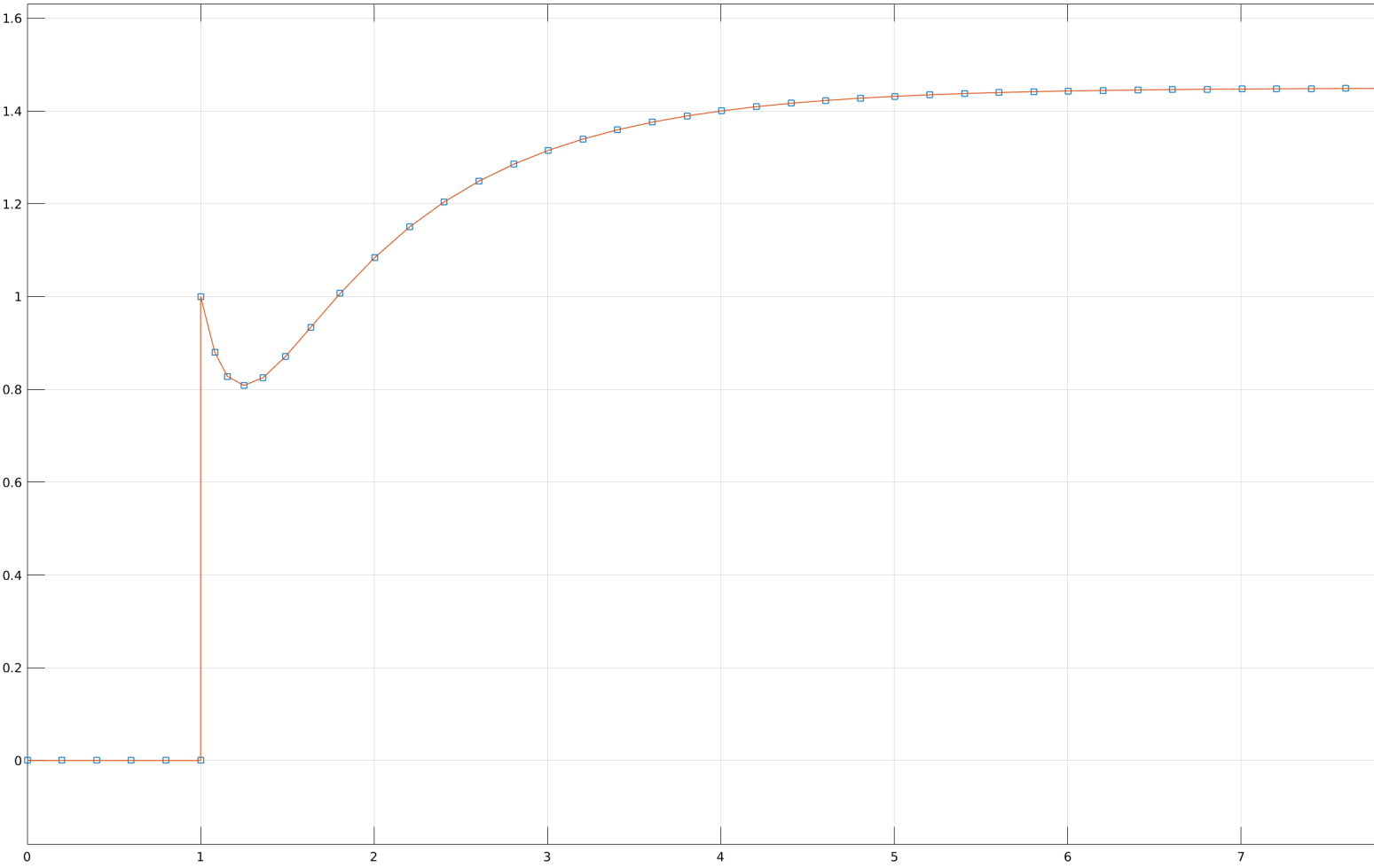
For your Simulink, please provide a screenshot that clearly shows the system.

```
stepinfo(P_2)  % to open the model
```

```
ans = struct with fields:
        RiseTime: 0.5333
    SettlingTime: 6.9600
     SettlingMin: 0
     SettlingMax: 2
       Overshoot: 200
      Undershoot: 0
            Peak: 6
        PeakTime: 1
```

```
%print('-sP_2','-dpng','P_2.png')
```





Problem 3

Using Simulink, set up the negatvie feedback system of Prelab 3 and the equivalent single block. Make separate plots of the step response of the negative feedback system and its equivalent single block. Record the values of settling time and rise time for each step response.

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

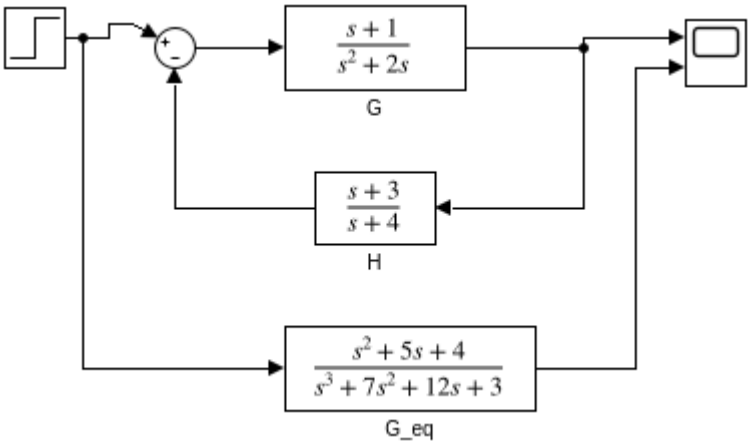
```
stepinfo(P_3)
```

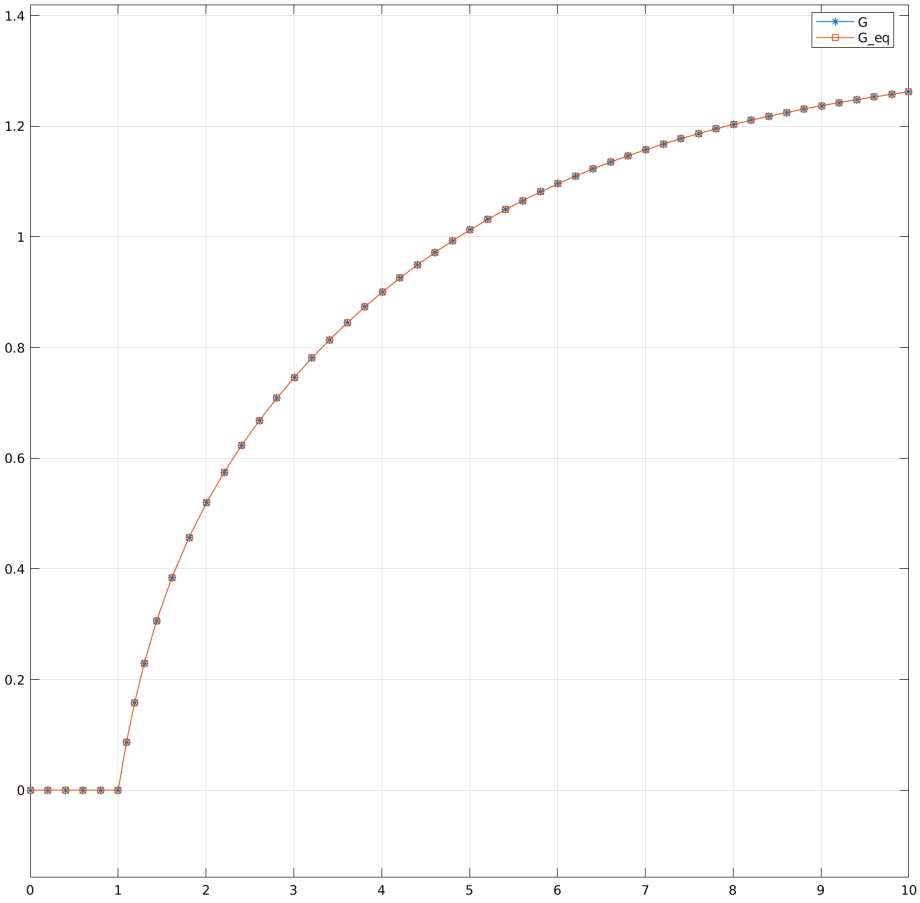
```
ans = struct with fields:
         RiseTime: 0.5333
     SettlingTime: 6.9600
      SettlingMin: 0
      SettlingMax: 2
        Overshoot: 200
       Undershoot: 0
             Peak: 6
         PeakTime: 1
```

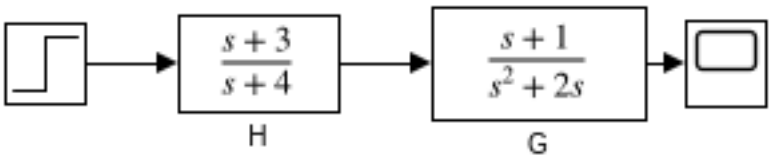
```
stepinfo(P_4)
```

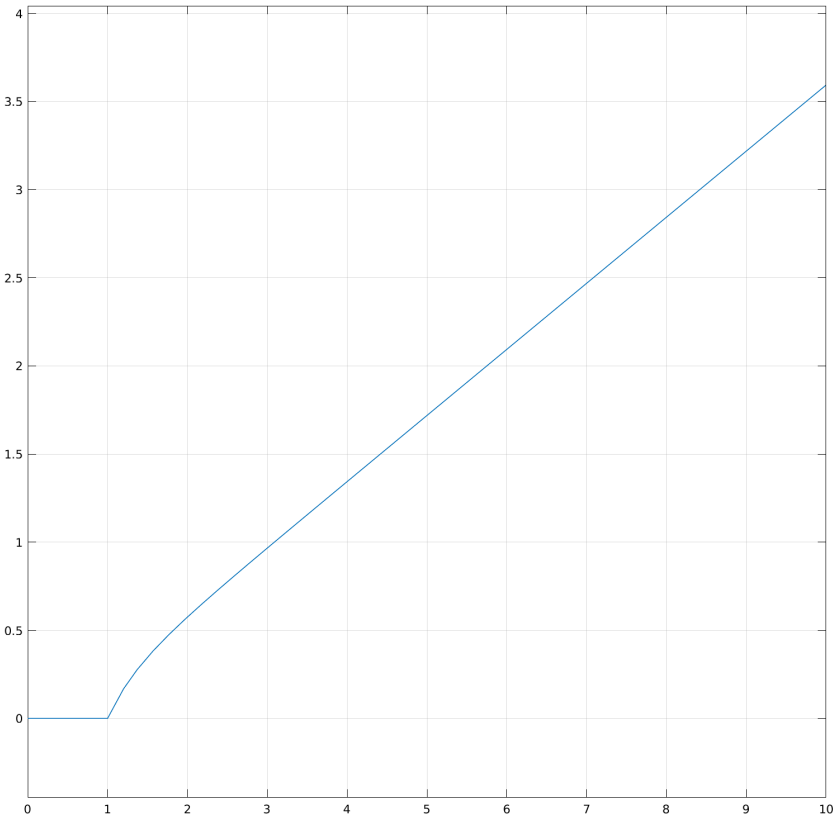
```
ans = struct with fields:
         RiseTime: 0.2667
     SettlingTime: 6.9800
      SettlingMin: 0
      SettlingMax: 2
        Overshoot: 50
       Undershoot: 0
             Peak: 3
         PeakTime: 1
```

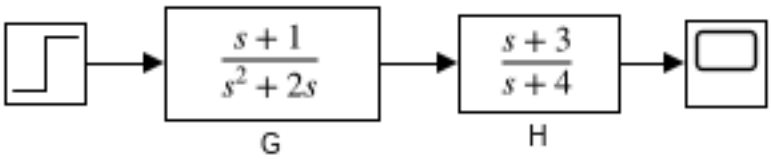
```
stepinfo(P_5)
%P_4
%print('-sP_4','-dpng','P_4.png')
%P_5
%print('-sP_5','-dpng','P_5.png')
```

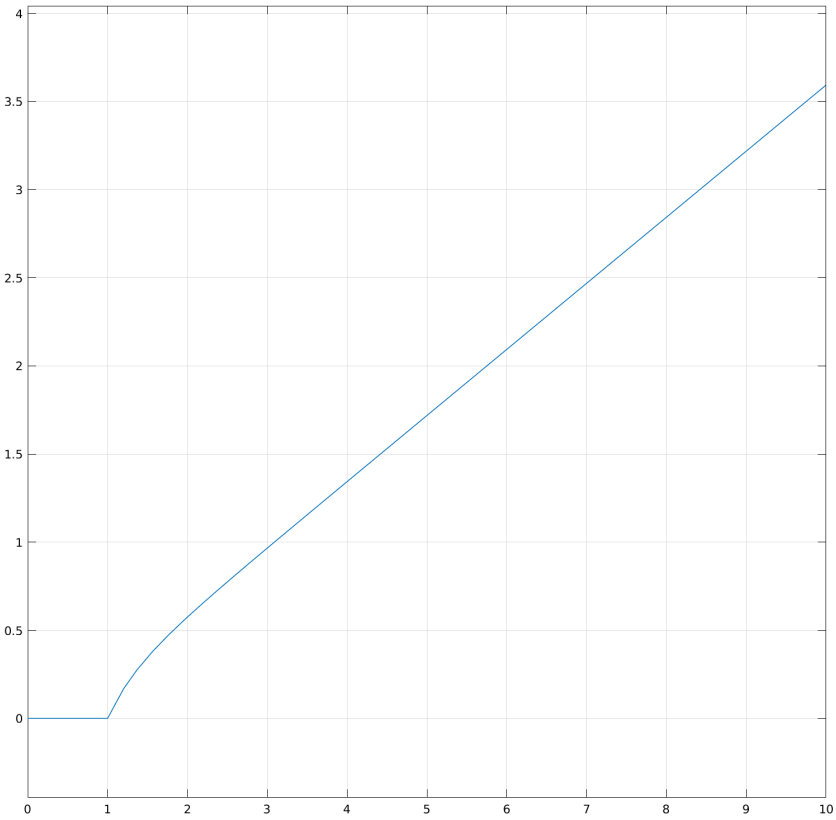



G
G_eq
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9
10


$\frac{s+3}{s+4}$
H
$\frac{s+1}{s^2+2s}$
G


4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
7
8
9
10


$\frac{s+1}{s^2+2s}$
G
$\frac{s+3}{s+4}$
H



Problem 4

Using Simulink, set up the negative feeback systems of Prelab 3, Prelab 4, and Prelab 5. Make separate plots of the step response of each of the systems. Record the values of settling time and rise time for each step response.

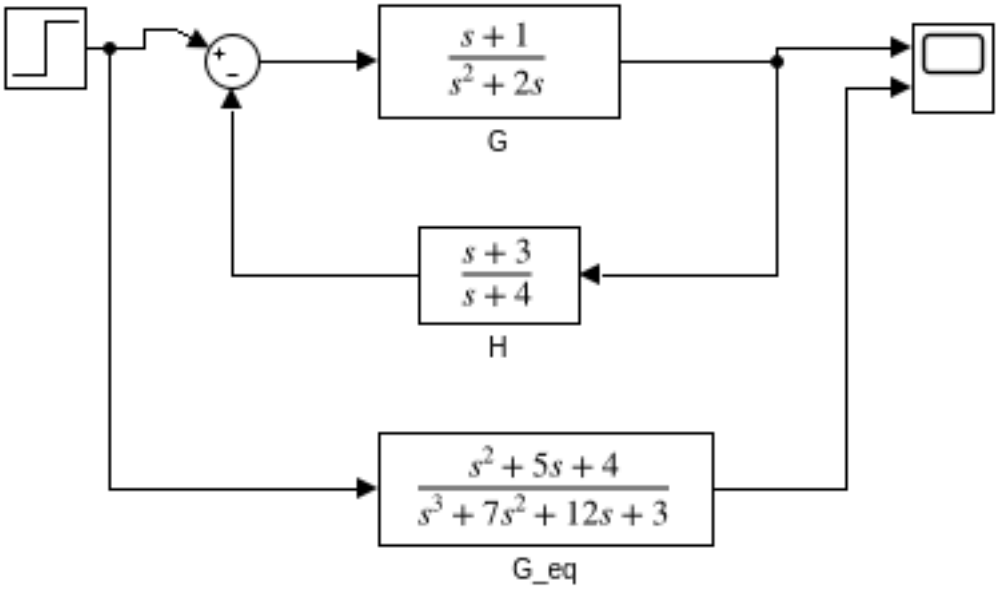
For your Simulink, please provide a screenshot that clearly shows the system.

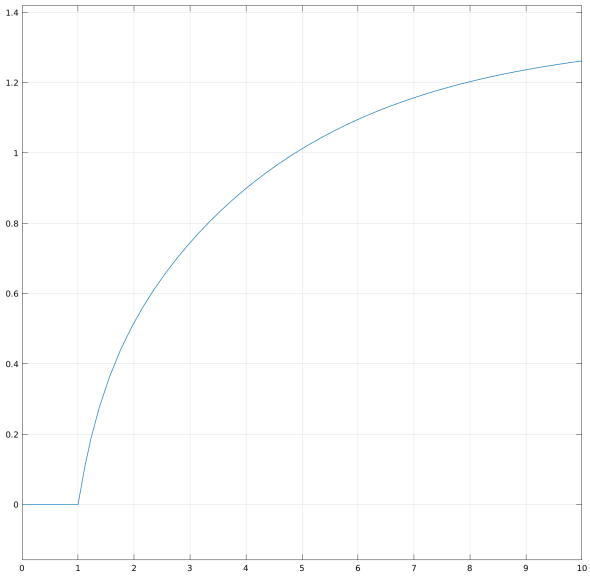
```
stepinfo(P_3)
```

```
'P3' is not found in the current folder or on the MATLAB path, but exists in:
    /home/john/Documents/School_Docs/systems_and_control_i/labs/Chapter 6

Change the MATLAB current folder or add its folder to the MATLAB path.
```

```
print('-sP_3','-dpng','P_3.png');
```





Postlab

Problem 1

Using your lab data, verify the equivalent transfer function of blocks in cascade.

The equivalent transfer block matched the calculations in the pre lab. Both systems had identical step reponses.

Problem 2

Using your lab data, verify the equivalent transfer function of block in parallel.

The equivalent transfer block matched the calculations in the pre lab. Both systems had identical step reponses.

Problem 3

Using your lab data, verify the equivalent transfer function of negative feedback systems.

The equivalent transfer block matched the calculations in the pre lab. Both systems had identical step reponses.

Problem 4

Using your lab data, verify the moving of blocks past summing junctions and pickoff points.

The equivalent transfer block matched the calculations in the pre lab. Both systems had identical step reponses.

Problem 5

Discuss your results. Were the equivalencies verified?

All equivalencies were verified, the step responses of the equivlent systems matched.