PROJECT 1

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1. The objective of this exercise is to deduce the effect of location of pole and zero on the time-domain response of a system.

   a. First-order systems: Consider $G_1(s) = \frac{1}{s+p}$. Compare in terms of rise time and steady-state value the step responses of this system for different values of *p*. Choose p = 0.5, 1, 2, and 10. (For purposes of this experiment, assume the following definition of rise time: the time taken for the output to reach 90% of the final steady-state value.) Based on this, where should one locate the pole if the requirement is a fast response? Where should one locate the pole if the steady-state value of the output is expected to be equal to the input value? Can one independently satisfy both requirements?

   b. Second-order systems: Consider $G_2(s) = \frac{10}{s^2+as+10}$. Compare in terms of rise time, the settling time, the peak overshoot, and steady-state value the step responses of this system for different values of *a*: Choose a = 0.1, 2.5, 5, 7.5, 10. (Use the definitions in the prescribed text-book.) Ask questions similar to that in 4.a, and discuss the results.

   c. The effect of an additional pole: Consider $G_3(s) = \frac{10}{s^2+2s+10}$ in cascade with a first order system $G_4(s) = \frac{p}{s+p}$. Repeat the experiment 4.b for different values of *p*. Choose p = 5, 10, 20. In your discussions, include as well a comparison of these results with those obtained in 4.b.

   d. The effect of an additional zero: Consider $G_4(s) = \frac{10(\frac{s}{a}+1)}{s^2+2s+10}$. Repeat the experiment 4.b for different values of *a*. Choose a = 0.1, 1, 10, 100. In your discussion, include as well a comparison of these results with those obtained in 4.b.

2. The objective of this exercise is to compare the response of systems to different kinds of inputs. Consider the two systems $G_3(s) = \frac{10}{s^2+2s+10}$ and $G_3(s) = \frac{10(s+1)}{s^3+10s^2+10s+10}$. Compare the responses of these systems to a step input and a unit-ramp input. Do the outputs follow or track the input? If so, why? If not, why not? Can one theoretically deduce these results?

Codes:

Question 1:

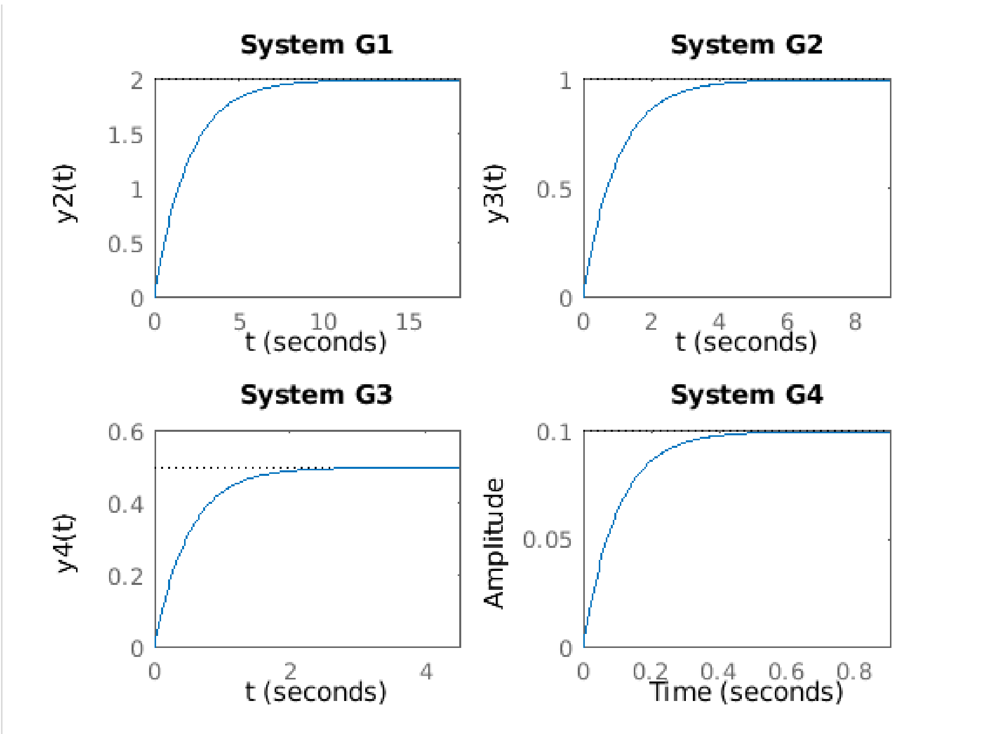
```
clc;

p1 = 0.5;

p2 = 1;

p3 = 2;

p4 = 10;

G1 = tf([0 1], [1 p1]);

G2 = tf([0 1], [1 p2]);

G3 = tf([0 1], [1 p3]);

G4 = tf([0 1], [1 p4]);

%plot the step response

xlabel('t');

ylabel('y1(t)')
```

```
subplot(2, 2, 1)

step(G1);

title('System G1');
```

```
xlabel('t');

ylabel('y2(t)')

subplot(2, 2, 2)

step(G2);

title('System G2');
```

```
xlabel('t');

ylabel('y3(t)')

subplot(2, 2, 3)

step(G3);

title('System G3');
```

```
xlabel('t');

ylabel('y4(t)')

subplot(2, 2, 4)

step(G4);

title('System G4');
```



rise time for p=0.5 is 4.39

rise time for p=1 is 2.2

rise time for p=2 is 1.1

rise time for p=10 is 0.22

steady state for p=0.5 is 2

steady state for p=1 is 1

steady state for p=2 is 0.5

steady state for p=10 is 0.1

THE INFERENCE:- *For fast response the pole has to be at s=-10 i.e a value of 0.22*

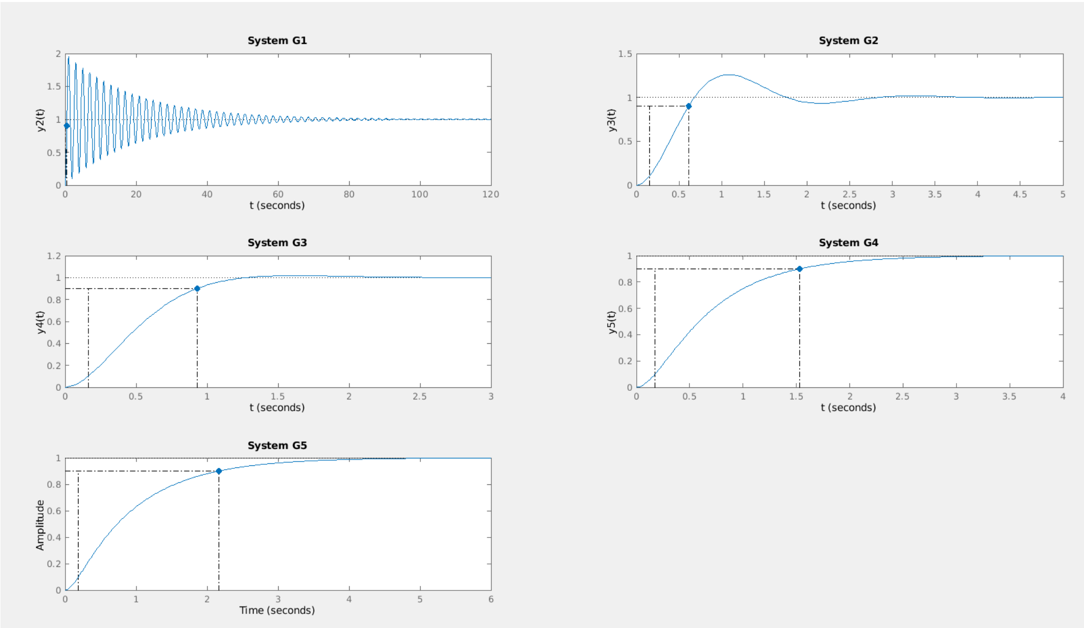
For steady state response the pole has to be at s=-1

satisfying both conditions is not possible.

Question 2:

```
G1 = tf([0 0 10], [1 0.1 10]);

G2 = tf([0 0 10], [1 2.5 10]);

G3 = tf([0 0 10], [1 5 10]);

G4 = tf([0 0 10], [1 7.5 10]);

G5 = tf([0 0 10], [1 10 10]);

%plot the step response

xlabel('t');

ylabel('y1(t)')

subplot(3, 2, 1)

step(G1);

title('System G1');

xlabel('t');

ylabel('y2(t)')

subplot(3, 2, 2)

step(G2);

title('System G2');

xlabel('t');

ylabel('y3(t)')

subplot(3, 2, 3)

step(G3);
```

```
title('System G3');

xlabel('t');

ylabel('y4(t)')

subplot(3, 2, 4)

step(G4);

title('System G4');

xlabel('t');

ylabel('y5(t)')

subplot(3, 2, 5)

step(G5);

title('System G5');
```



rise time for p=0.1 is 0.334

rise time for p=2.5 is 0.461

rise time for p=5 is 0.769

rise time for p=7.5 is 1.36

rise time for p=10 is 1.98

steady state for p=0.1 is 1

steady state for p=2.5 is 1

steady state for p=5 is 1

steady state for p=7.5 is 1

steady state for p=10 is 1

settling for p=0.1 is 77.6

settling for p=2.5 is 2.66

settling for p=5 is 1.16

settling for p=7.5 is 2.46

settling for p=10 is 3.59

peak amplitude for p=0.1 is 1.95

peak amplitude for p=2.5 is 1.26

peak amplitude for p=5 is 1.02

peak amplitude for p=7.5 is

peak amplitude for p=10 is

Inference as 'a' value increases the overshoot value rapidly decreases

G1 has the least rise time 95.2% over shoot it also has the highest peak amplitude so it's the fastest

all the systems are suitable for steady state response(G1 G2 G3 G4 G5)

settling time is the highest for g1

G1 SATISFIES BOTH THE CONDITIONS