LAB #1 System Response using MATLAB Control Toolbox

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Contents

Figure

1. INTRODUCTION

Firstly, in this hereby lab, we utilized MATLAB to observes the poles, zeros, and various responses from four transfer functions. Simulink was also used to analyze graphs.

2. QUESTION 1.1

In question 1 there were 4 parts, that we will tend to. This first one is the first transfer function, G1. From the graph we can see that it is an overdamped system since there are no positive poles and no values in the $j\omega$ domain. Furthermore, all the inputs in question 1 are step inputs.

```
clc;
clear all;
close all;

fprintf("G1") %Print G1
num=[3 8]; %Numerator
den=[1 6 5]; %Denominator
G1=tf(num,den); %Transfer Function
fprintf("Pole(s):") %print Pole(s):
pole(G1) %returns poles of transafer function
fprintf("Zero(s):") %print Zero(s):
zero(G1) %returns zeros of transfer function

subplot(1,2,1) %plot on left side of figure
pzmap(G1) %plot pole-zero map
subplot(1,2,2) %plot on right side of figure
step(G1) %plot step input to the transfer function
axis([0 10 0 inf]) %forcing axis range to 0 to 10
```

```
G1Pole(s):
ans =
-5
-1
Zero(s):
ans =
-2.6667
```

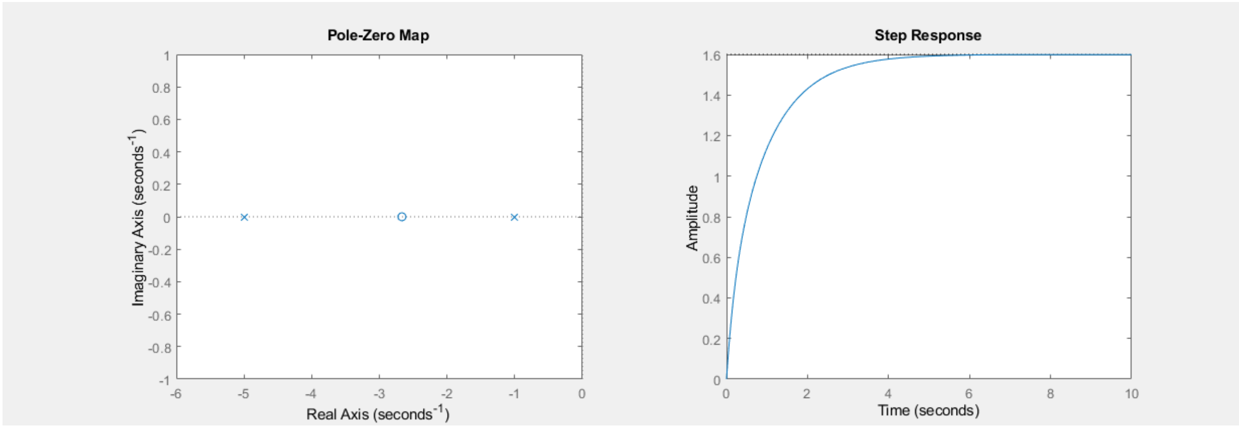

Figure A

3. QUESTION 1.2

G2 in this analysis produced an undamped response. This is due to the poles have no real part only on the imaginary domain.

```
clc;
clear all;
close all;

fprintf("G2") %Print G2
num=[3 8]; %Numerator
den=[1 0 9]; %Denominator
G2=tf(num,den); %Transfer Function
fprintf("Pole(s):") %print Pole(s):
pole(G2) %returns poles of transafer function
fprintf("Zero(s):") %print Zero(s):
zero(G2) %returns zeros of transfer function
subplot(1,2,1) %plot on left side of figure

pzmap(G2) %plot pole-zero map
subplot(1,2,2) %plot on right side of figure
step(G2) %plot step input to the transfer function
axis([0 10 0 inf]) %forcing axis range to 0 to 10
```

```
G2Pole(s):
ans =
0.0000 + 3.0000i
0.0000 - 3.0000i
Zero(s):
ans =
-2.6667
```

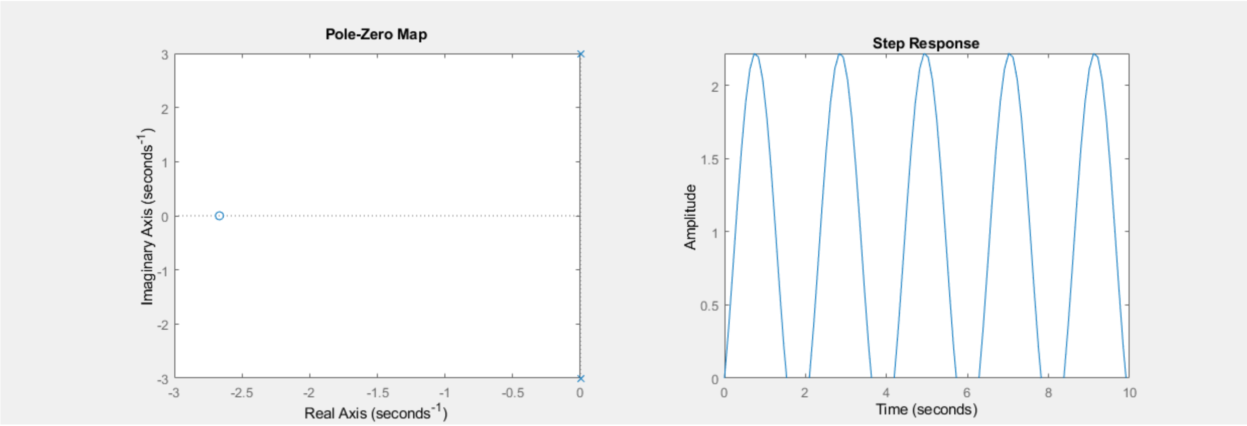

Figure B

4. QUESTION 1.3

The response in G3 is an underdamped system since it overshoots the steady state value and then does eventually converge there.

```
clc;
clear all;
close all;

fprintf("G3") %Print G3
num=[3 8]; %Numerator
den=[1 2 8]; %Denominator
G3=tf(num,den); %Transfer Function
fprintf("Pole(s):") %print Pole(s):
pole(G3) %returns poles of transafer function
fprintf("Zero(s):") %print Zero(s):
zero(G3) %returns zeros of transfer function

subplot(1,2,1) %plot on left side of figure
pzmap(G3) %plot pole-zero map
subplot(1,2,2) %plot on right side of figure
step(G3) %plot step input to the transfer function
axis([0 10 0 inf]) %forcing axis range to 0 to 10
```

```
G3Pole(s):
ans =
-1.0000 + 2.6458i
-1.0000 - 2.6458i
Zero(s):
ans =
 -2.6667
```

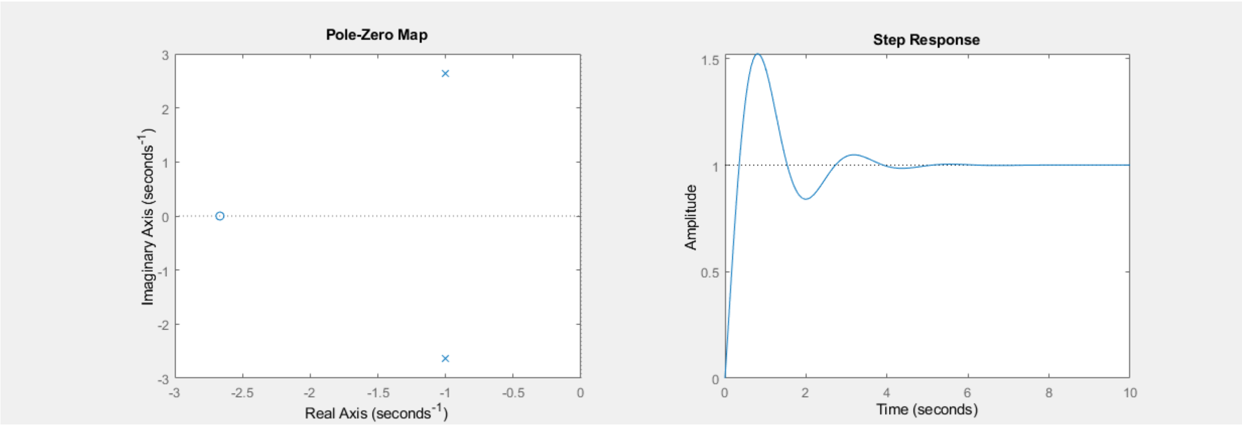

Figure C

5. QUESTION 1.4

In this response by G4 we have an unstable system since it goes out of the bounds of the plot and more importantly the poles are positive.

```
clc;
clear all;
close all;

fprintf("G4") %Print G4
num=[3 8]; %Numerator
den=[1 -6 8]; %Denominator
G4=tf(num,den); %Transfer Function
fprintf("Pole(s):") %print Pole(s):
pole(G4) %returns poles of transafer function
fprintf("Zero(s):") %print Zero(s):
zero(G4) %returns zeros of transfer function

subplot(1,2,1) %plot on left side of figure
pzmap(G4) %plot pole-zero map
subplot(1,2,2) %plot on right side of figure
step(G4) %plot step input to the transfer function
```

```
G4Pole(s):
ans =
4
2
Zero(s):
ans =
-2.6667
```

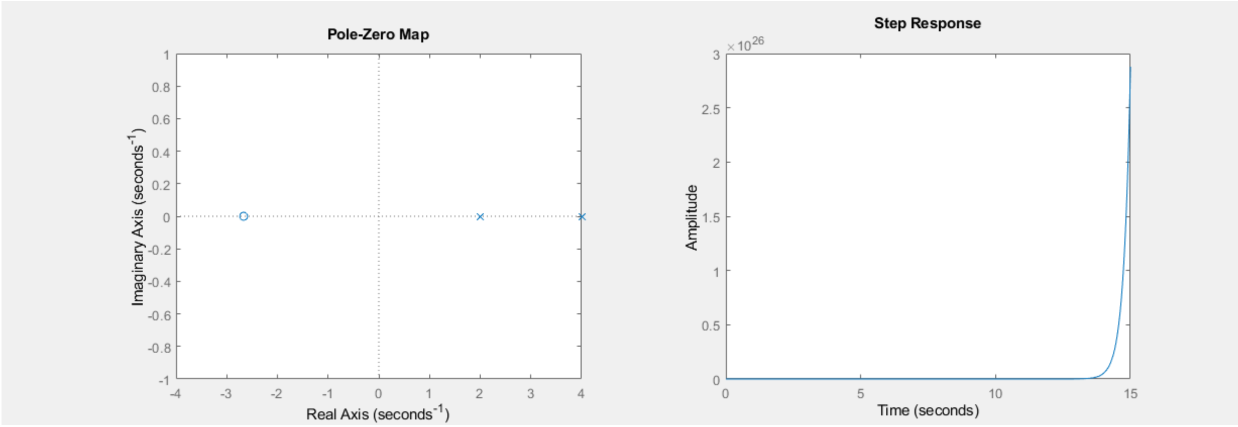

Figure D

6. QUESTION 2

Now onto question 2 which takes G3 and a modified sine wave input. The response can be seen in Figure E.

```
clc; %initial clean up lines
clear all;
close all;

num=[3 8]; %Numerator
den=[1 2 8]; %Denominator
G3=tf(num,den); %Transfer Function

t=0:0.1:10; %time interval
r=sin(2*t+0.8); %time input
c=lsim(G3,r,t); %return Transfer function output

plot(t,r) %plot Sine Wave Input vs. Time

hold on %hold to plot two wave on one plot

plot(t,c) %plot Transfer Function Output vs. Time
legend('Sine Wave Input','Transfer Function Output') %legend
xlabel('Time (s)','FontSize',12,'FontWeight','bold','Color','b')
ylabel('Y Value','FontSize',12,'FontWeight','bold','Color','b')
title('Transfer Function','FontSize',12,'FontWeight','bold')
```

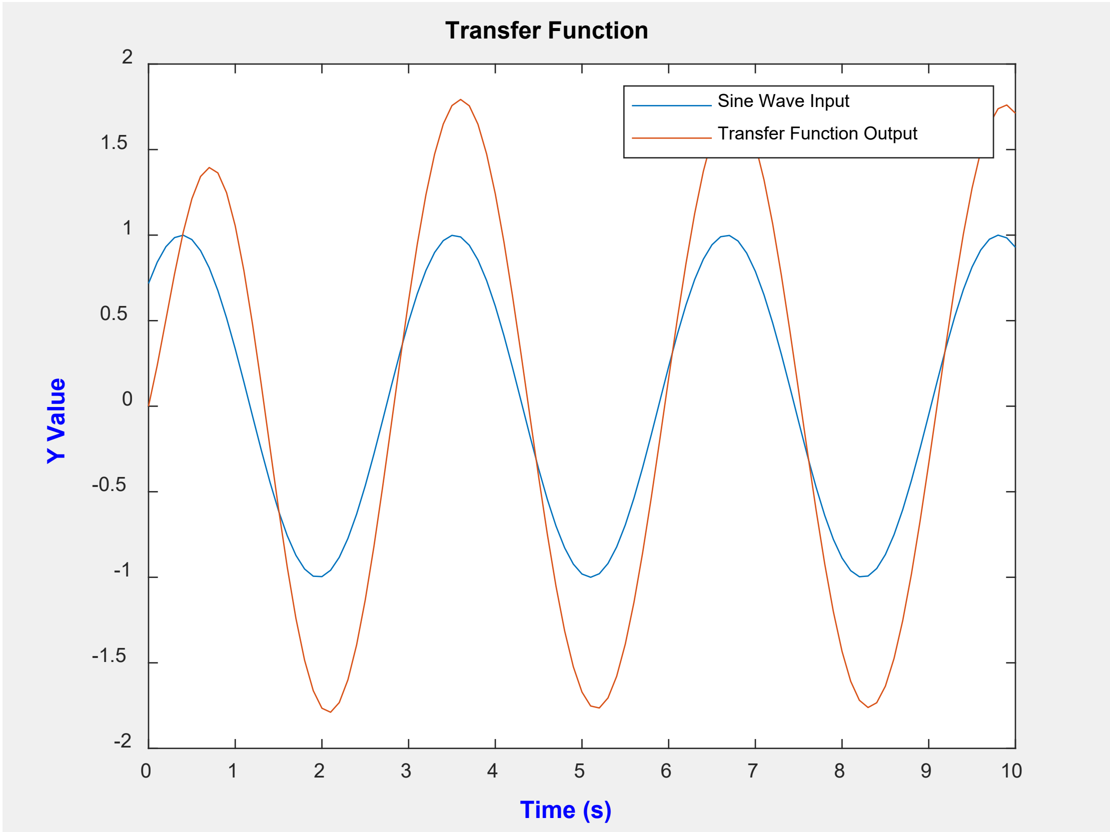

Figure E

7. QUESTION 3

Nextly, question 3 used G1 as the transfer function and a square wave as the input which produced the result in Figure F.

```
clc;
clear all;
close all;

num=[3 8]; %Numerator
den=[1 6 5]; %Denominator
G1=tf(num,den); %Transfer Function
[r,t]=gensig('square',10,100,1); %Generate Square wave input
lsim(G1,r,t); %Plot transfer function output and square wave input vs. time
```

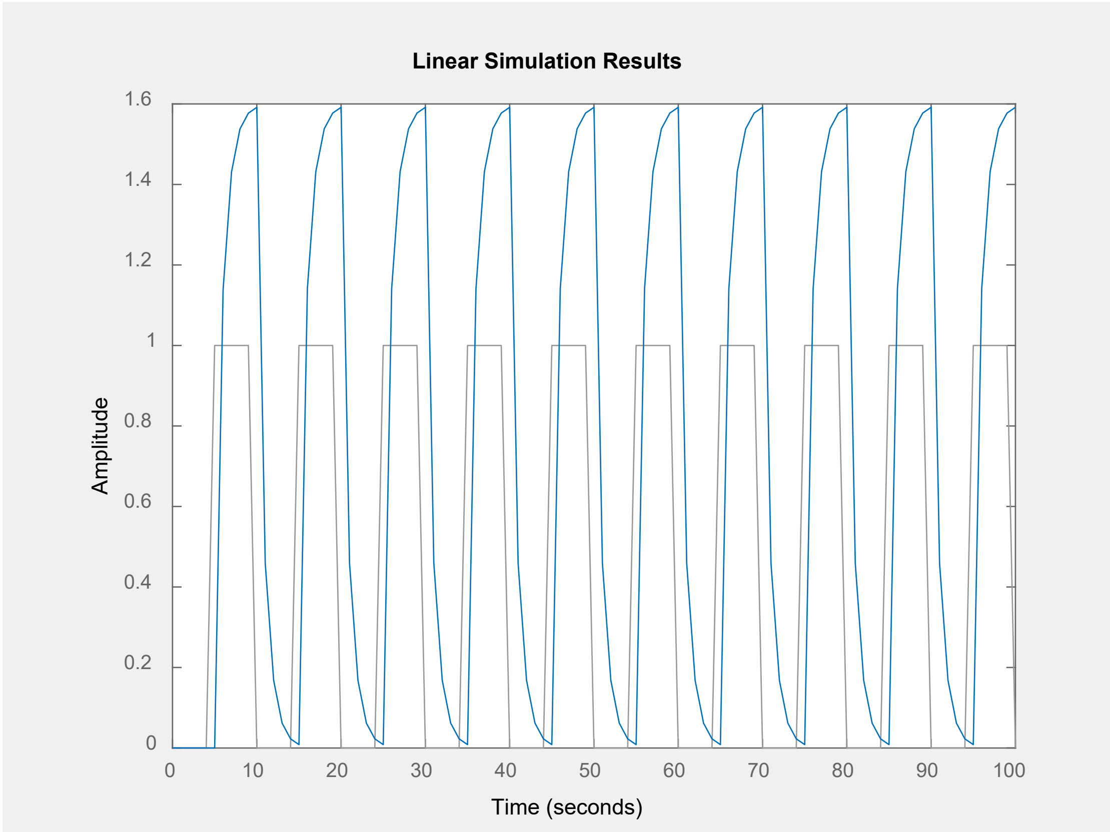

Figure F

8. QUESTION 4

Lastly, G3 was modeled in Simulink and produced the response in Figure H.

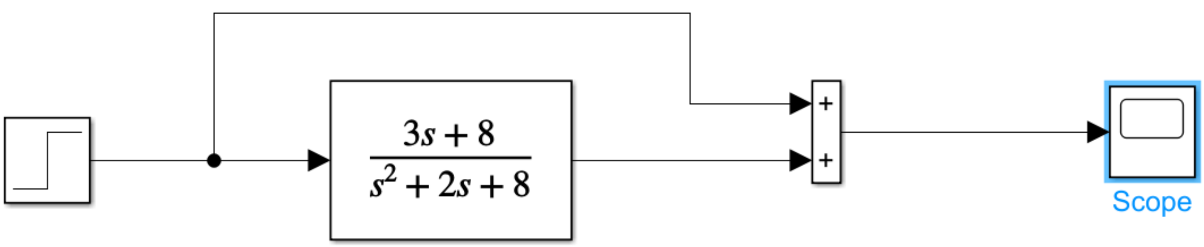

Figure G

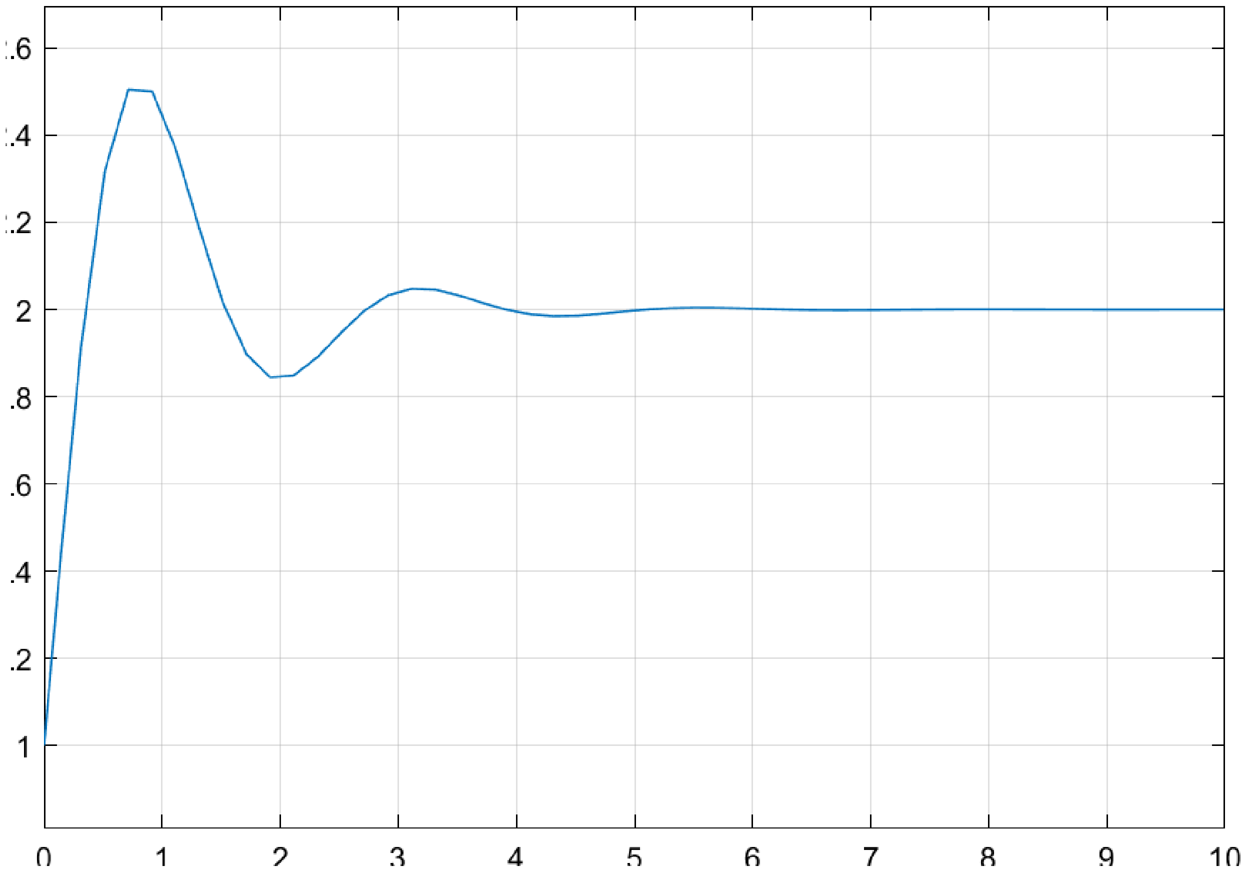

Figure H

9. CONCLUSION

In conclusion, this lab further displayed the power of graphing transfer functions in an incredibly easy to use and readable format. Theses figures produced were especially insightful for analyzing the characteristics of transfer functions.