ECEN315 - Assignment 2

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1 Question 1

```
clear
clf
figure(1)
subplot(1,2,1)
hold on
aVals = [1 2 4 8];
Legend = cell(length(aVals), 1);
StepInfo = cell(length(aVals), 1);
TimeConstants = cell(length(aVals), 1);
i = 1;

for a = aVals
    sys = tf(a, [1 4 a]);
    step(sys)
    StepInfo{i} = stepinfo(sys);
    Legend{i} = strcat(num2str(a), 'V Step');
    [Wn, Z] = damp(sys);
    TimeConstants{i} = 1./(Wn .* Z);
    i = i + 1;
end
hold off
legend(Legend)

subplot(1,2,2)
hold on
for a = aVals
    sys = tf(a, [1 4 a]);
```

```
    pzmap(sys)
end
legend(Legend)
```

Table 1: Time Constants and Settling Time for Various Step Inputs

Step Size	Time Constants	Settling Time
1	$\begin{pmatrix} 3.7321 \\ 0.2679 \end{pmatrix}$	14.879
2	$\begin{pmatrix} 1.7071 \\ 0.2929 \end{pmatrix}$	6.9996
4	$\begin{pmatrix} 5 \\ 5 \end{pmatrix}$	2.1970
8	$\begin{pmatrix} 5 \\ 5 \end{pmatrix}$	2.1082

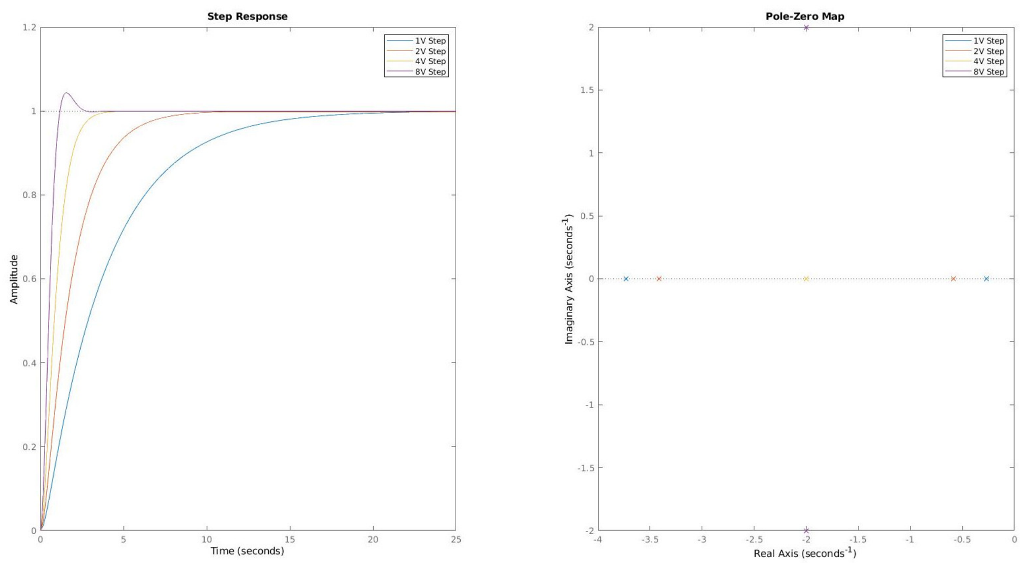

Figure 1: Step Response to various step sizes and PZ Map of those step responses

2 Question 2

```
clear
```

```
clf
%a
sys = tf(0.0425, [1 2.45 0]); % Angular Displacement
step(5 * sys, 10);
%Graph is pretty much a ramp
%This makes sense as the motor shaft will continue to
    spin while powered.
%If we were to plot between -180 and 180 we would see
    this loop around like
%a sawtooth wave
hold on
%b
%Angular Velocity, so have to differentiate the TF i.e.
    multiply by s
sys2 = tf(0.0425, [1 2.45]);
step(5 * sys2);
% steady state is 0.0867 rads/sec
legend("Angular Displacement TF", "Angular Velocity TF
    ")
```

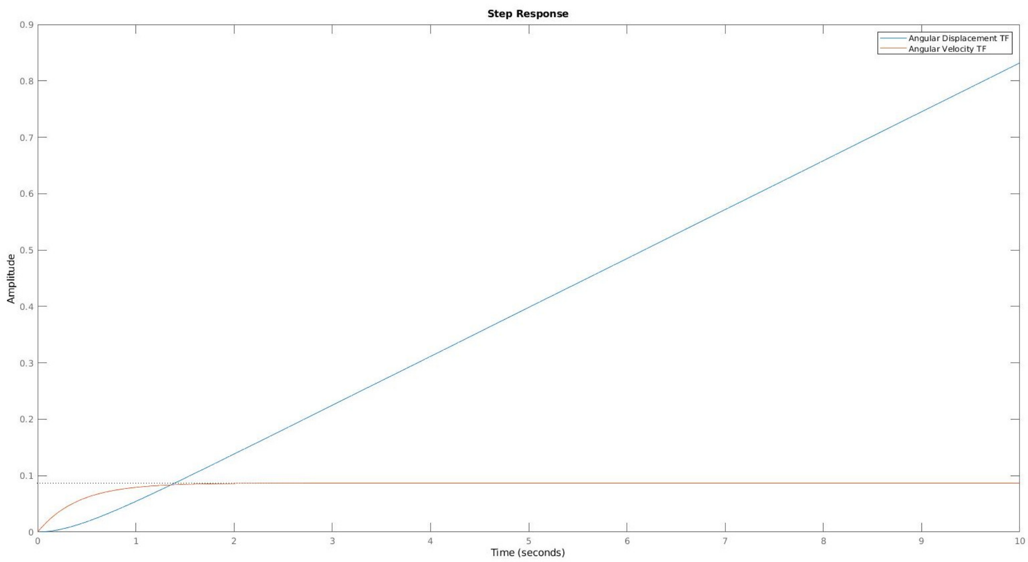

Figure 2: Step Response of $\frac{\Theta_L(s)}{E_a(s)}$ and $\frac{\Omega_L(s)}{E_a(s)}$

3 Question 3

```
sys1 = tf(26, [1 3 16]);
sys2 = tf(0.4, [1 0.02 0.04]);
sys3 = tf(1.07e7, [1 1.6e3 1.07e7]);
linearSystemAnalyzer(sys1, sys2, sys3);

[wn1, zeta1] = damp(sys1)
[wn2, zeta2] = damp(sys2)
[wn3, zeta3] = damp(sys3)
```

Table 2: Relevant values for the systems defined in question 3

System	ω_n	ζ	T_s (s)	T_p (s)	T_R (s)	$OS\%$
$G_1(s)$	4	0.375	2.66	0.86	0.357	28
$G_2(s)$	0.2	0.05	3.8	15.7	5.42	85.4
$G_3(s)$	3.2711×10^3	0.2446	0.00433	0.000979	0.0003864	45.2

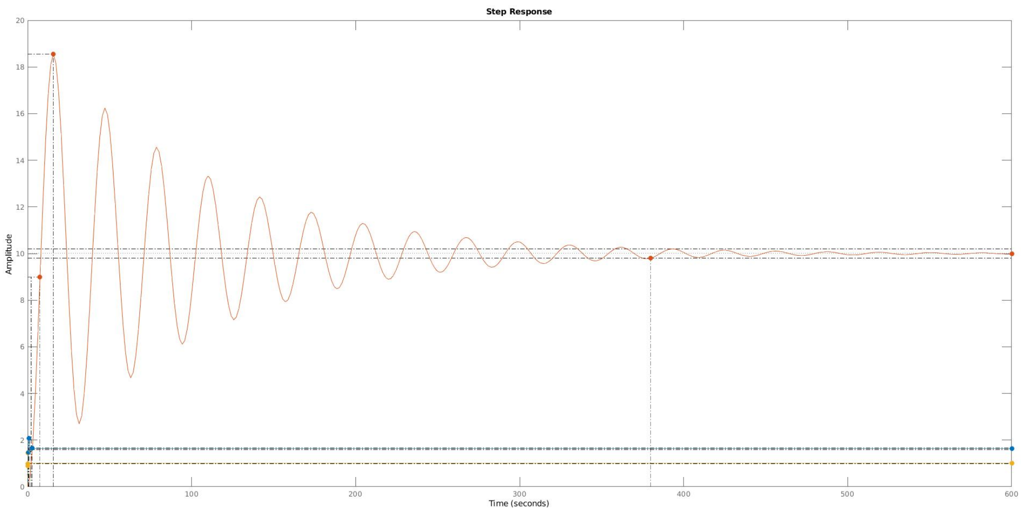

Figure 3: Usage of the LTI Viewer exported to figure

4 Question 4

```
clear
clf

a = 1;
```

```
b = 8;
k = 10.8e8;
J = 10.8e8;

%a
controller = tf([k k*a], [1 b]);
spacecraft = tf(1, [J 0 0]);
sys = feedback(controller * spacecraft, 1);

percentages = [1 0.8 0.5];
i = 1;
figure(1)
hold on
Legend = cell(length(percentages),1);
for p = percentages
    spacecraft = tf(1, [J*p 0 0]);
    sys = feedback(controller * spacecraft, 1);
    step(10 * sys)
    Legend{i} = strcat(num2str(p), ' of J');
    i = i + 1;
end
legend(Legend);
ylabel("Actual Altitude \theta(t)")
```

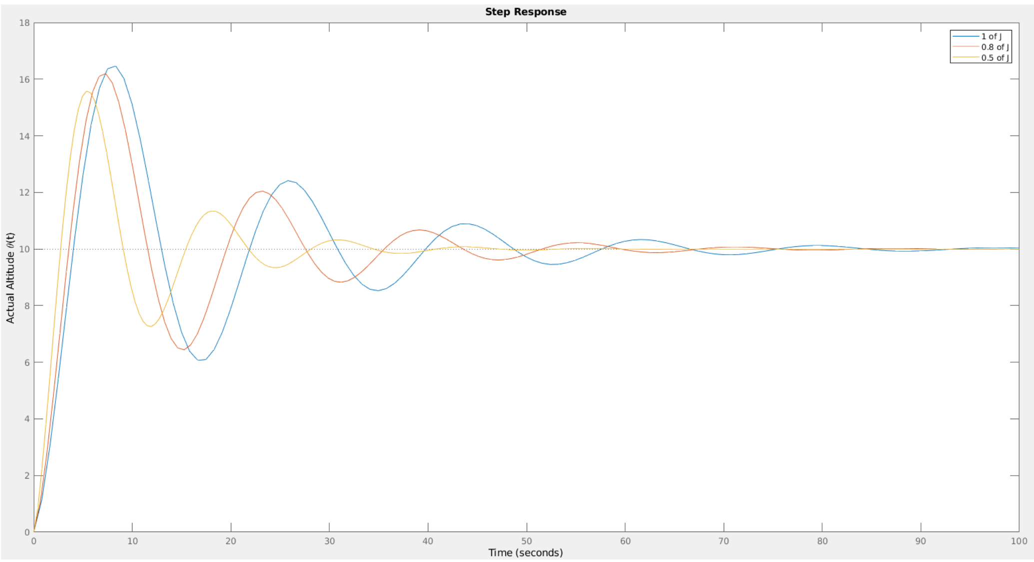

Figure 4: Satellite Step Responses for various moments of inertia

5 Question 5 (6 in the handout)

```
clear
clf

G = tf(6, [1 7 6 0]);
C = [4, 5, 6, 7, 8];

Legend = cell(length(C), 1);
i = 1;
figure(1)
hold on
for a = C
    sys = feedback(series(a, G), 1);
    step(sys, 40);
    Legend{i} = strcat(num2str(a), 'V Step');
    i = i + 1;
end
hold off
legend(Legend)

figure(2)
subplot(1,2,1)
H = feedback(series(tf([0.1 0.1], [1 0]), G), 1);
step(H, 100);
title("Step Response with Controller $$C = 0.1(1+\frac
    {1}{s})$$",'interpreter','latex')
subplot(1,2,2);
pzmap(H);
```

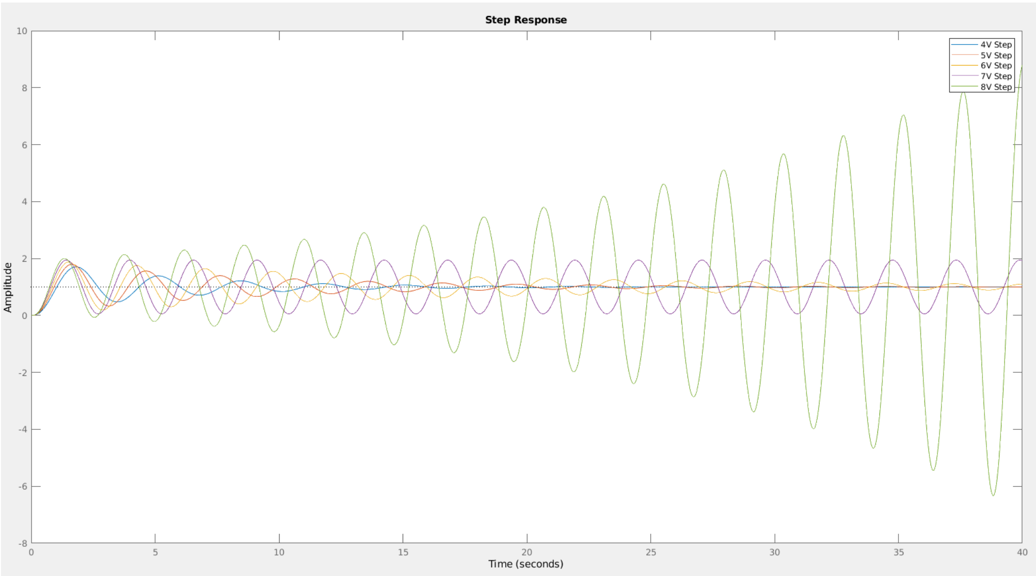

Figure 5: Gain Controller Step Response Stability

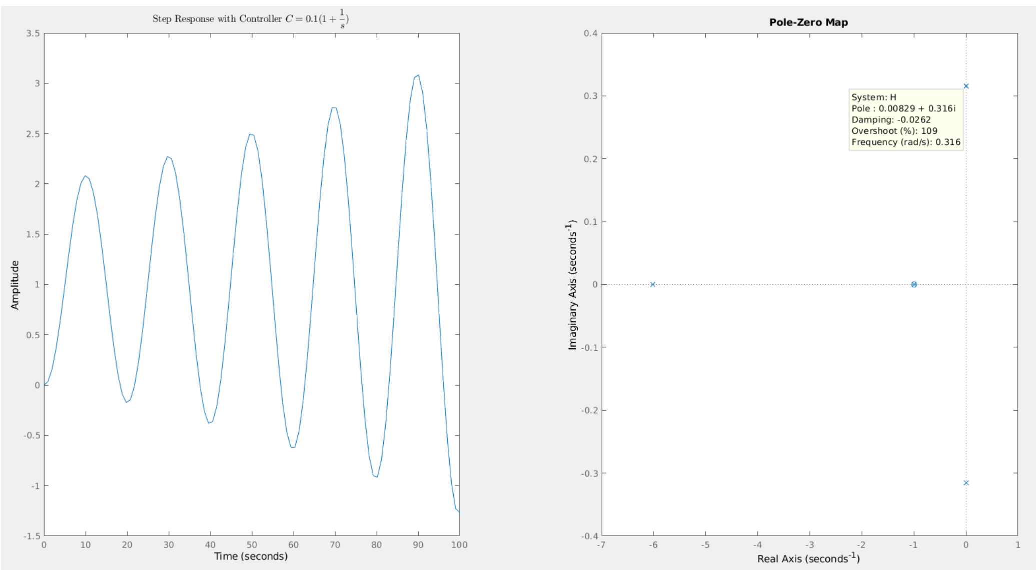

Figure 6: PI Controller Stability with low steady state gain