
MECA 482 Group ID9

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Team Members

```
"Patrick OKeefe";  
"Alize Hall";  
"Thomas Cunningham";  
"Emily Williams";
```

Ball Balancing Beam Constants

```
clc; clear;  
L = 1; %length of the beam (m)  
d = 0.03; %servo arm length (m)  
m = 0.065; %mass of the ball (kg)  
r = 0.0127; %radius of the ball (m)  
g = -9.8; %gravitational acceleration (m/s^2)  
J = 2/5*m*(r^2); %balls moment of inertia (kg*m^2)  
OS=0.05; %Percent overshoot as a percent of 1  
Ts=1; %Settling time goal  
S = tf('s'); %Transfer function in S-Domain  
Pos_ball = -m*g*d/L/(J/r^2+m)/S^2 %Plant of the system P(s)
```

```
Pos_ball =
```

```
0.21  
----  
s^2
```

```
Continuous-time transfer function.
```

Root Locus for the system

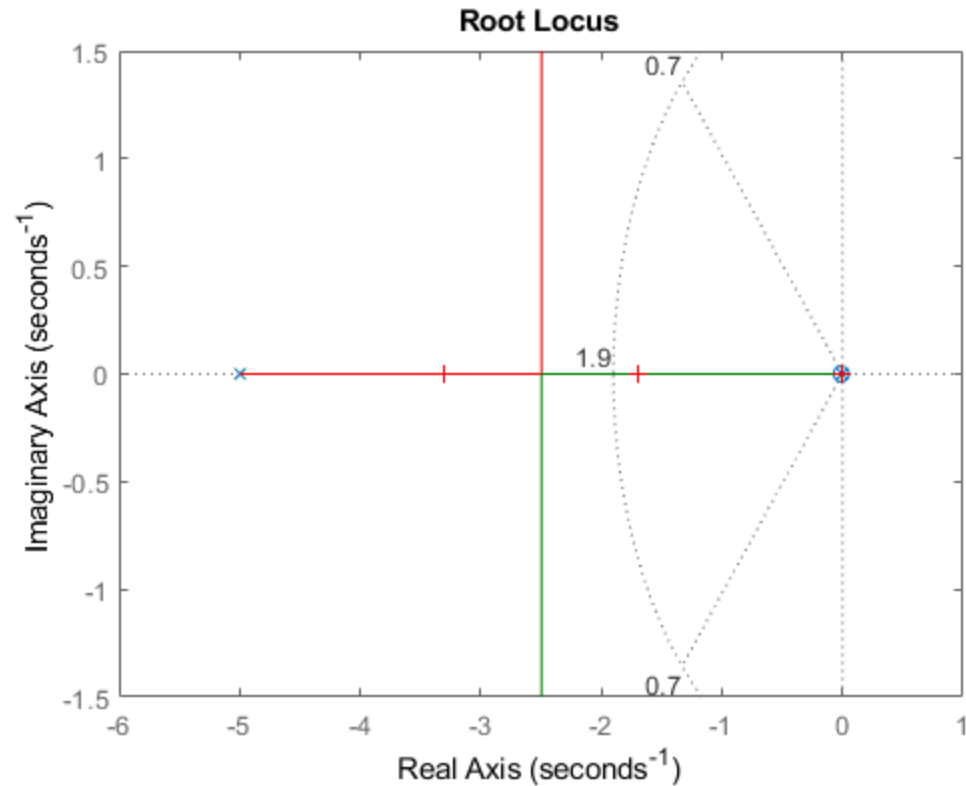
```
rlocus(Pos_ball)  
sgrid(0.7, 1.9)  
axis([-5 5 -2 2])
```

```

Zo=0.01;
Po=5;
C=tf([1 Zo],[1,Po]);
rlocus(C*Pos_ball)
sgrid(0.7,1.9)
[k,poles]=rlocfind(C*Pos_ball)

Select a point in the graphics window
selected_point =
    -3.4040 + 0.3715i
k =
    26.7974
poles =
    -3.2998
    -1.6902
    -0.0101

```

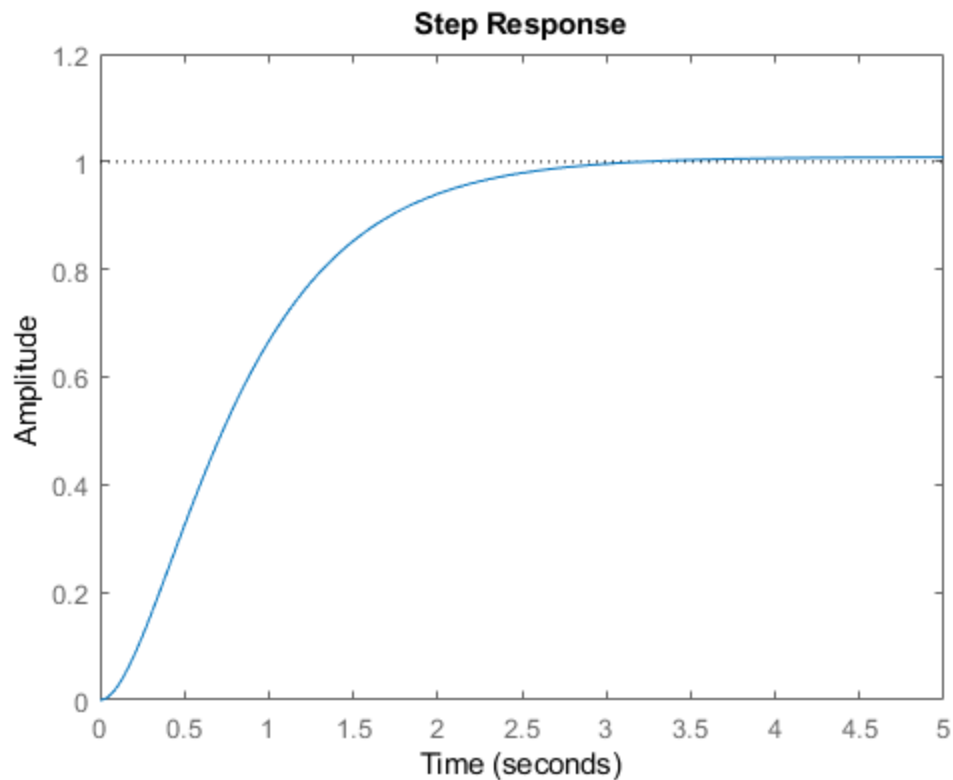


Plotting Root Locus

```

sys_cl=feedback(k*C*Pos_ball,1);
t=0:0.01:5;
figure(2)
step(1*sys_cl,t)

```



Step Response for a PD controller

```

input_step=1; %step for the step response
Kp = 13; %Proportional gain
Kd = 57; %Derivative gain
Ki = 0; %Integral gain (zero because its not needed for this system)
C = pid(Kp,Ki,Kd); %function for PID controller

system=feedback(C*Pos_ball,1);
figure(1);
system_step=input_step*system;
[y]=[(1+OS)*input_step;0.98*input_step;1.02*input_step]; %setting up
the horizontal lines for percent OS and settling time
t=0:0.01:10;
step(system_step) %plots the step response for the system
line([0,t(end)],[y(1),y(1)], 'Color', 'red'); %Percent Overshoot line,
DO NOT CROSS
line([0,t(end)],[y(2),y(2)], 'Color', 'green'); %98 Percent line for
settling time
line([0,t(end)],[y(3),y(3)], 'Color', 'green'); %102 Percent line for
settling time
line([Ts,Ts],[0,10], 'color', 'black', 'LineStyle', ':') %Settling time
goal
axis([0 1.25 0 (1.25*input_step)]); %sets up the axis limits for the
plot

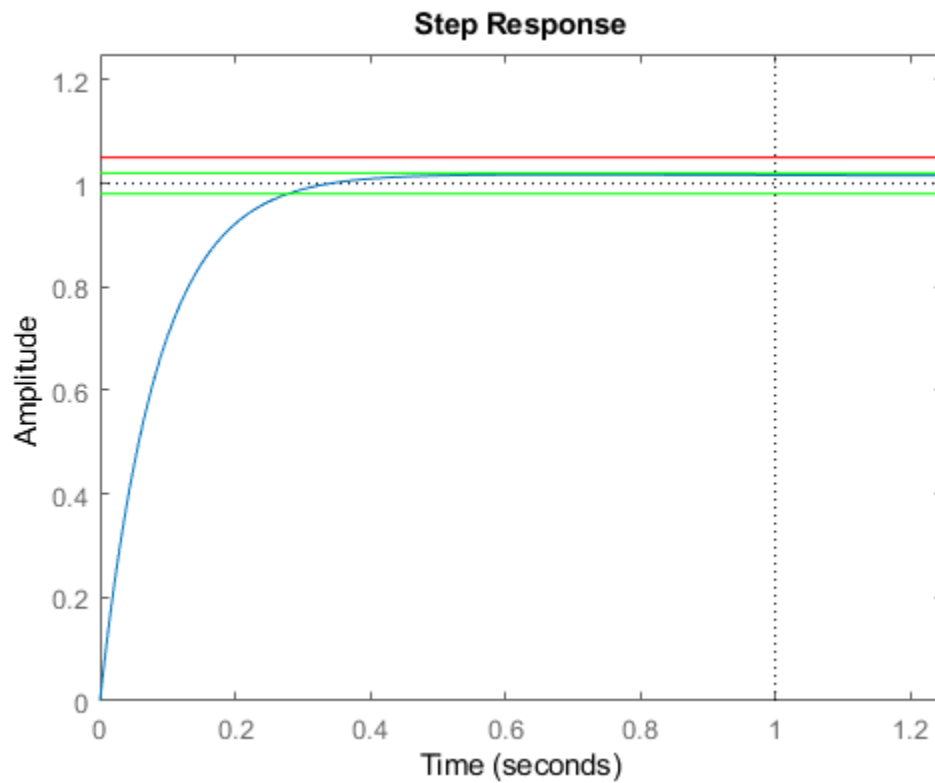
```

```
S=stepinfo(system_step) %system resultant parameters
```

```
S =
```

```
struct with fields:
```

```
    RiseTime: 0.1740  
    SettlingTime: 0.2782  
    SettlingMin: 0.9022  
    SettlingMax: 1.0169  
    Overshoot: 1.6911  
    Undershoot: 0  
    Peak: 1.0169  
    PeakTime: 0.6827
```



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