The Hashemite University
Faculty of Engineering

Control system

Control’s project

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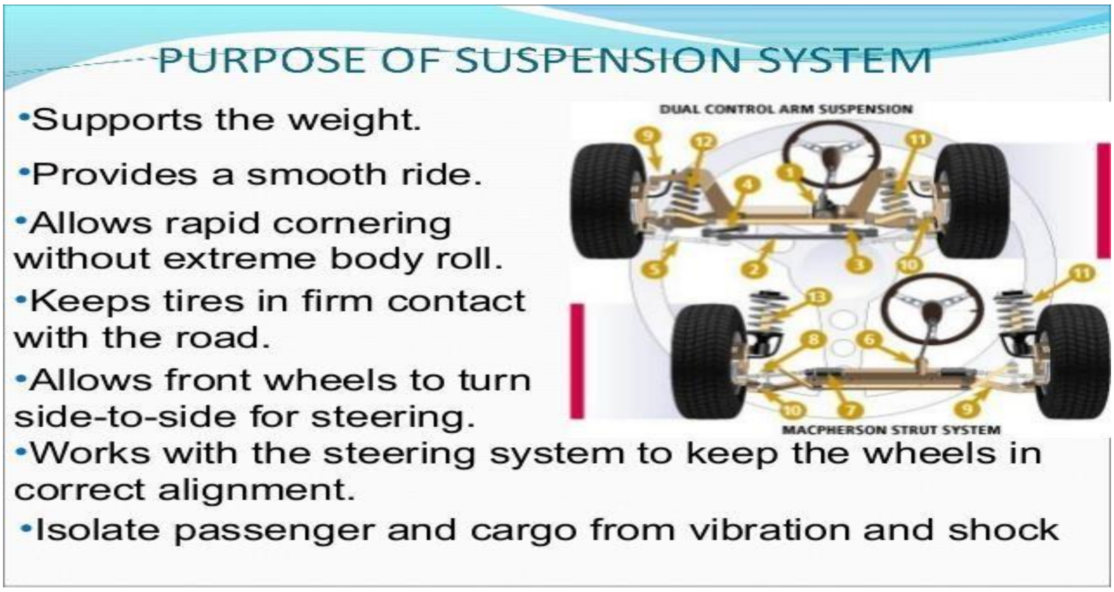
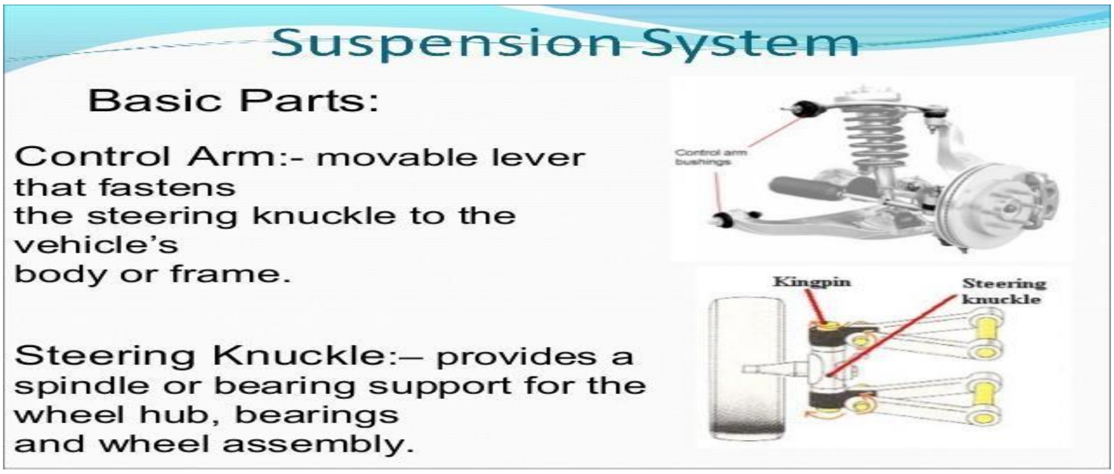
Introduction:

We suggested a suspension system as system that we modeled and simulated it :





Suspension System

Basic Parts:

Ball Joints:– swivel joints that allow control arm and steering knuckle to move up and down and side to side.

Today's complex import suspension systems aren't tolerant of excessive wear.

Springs:– supports the weight of the vehicle; permits the control arm and Wheel to move up and down.

Suspension System

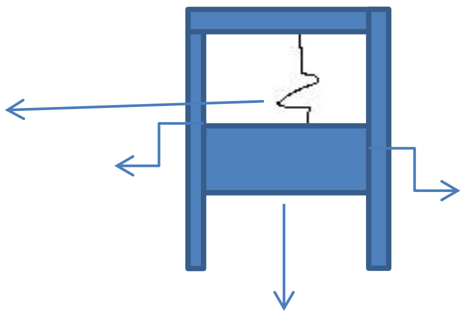
Basic Parts:

Shock absorbers or dampeners:- keeps the suspension from continuing to bounce after spring compression and extension.

Control arm bushing :– sleeves that allows the control arm to swing
up and down on the frame.

Modeling analysis :

k
b
y



F(t)

$\sum f = M\ddot{y}$

$F(t) - ky - b\dot{y} = M\ddot{y}$

$M\ddot{y} + b\dot{y} + ky = f(t)$

Take a lapalcian to find transfer function :

Ms^2y(s)+bsy(s)+ky(s)=f(s)

We supposed that : input=y(s) , output=f(s)

G(s)=y(s)/f(s)=1/ms^2+bs+k

And we supposed M=3 , b=1.5 , k=1

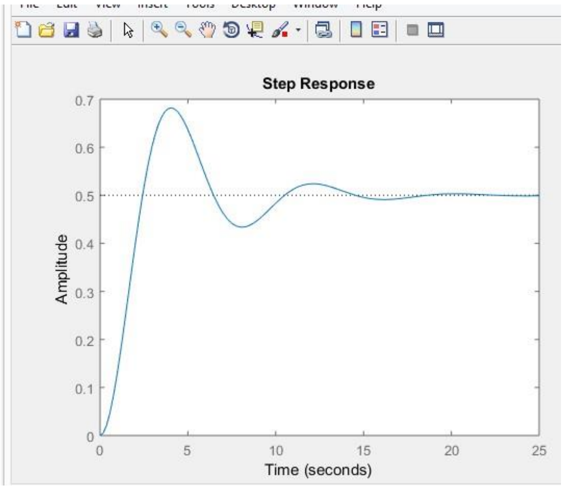
We have a unit feedback signal H(s)=1

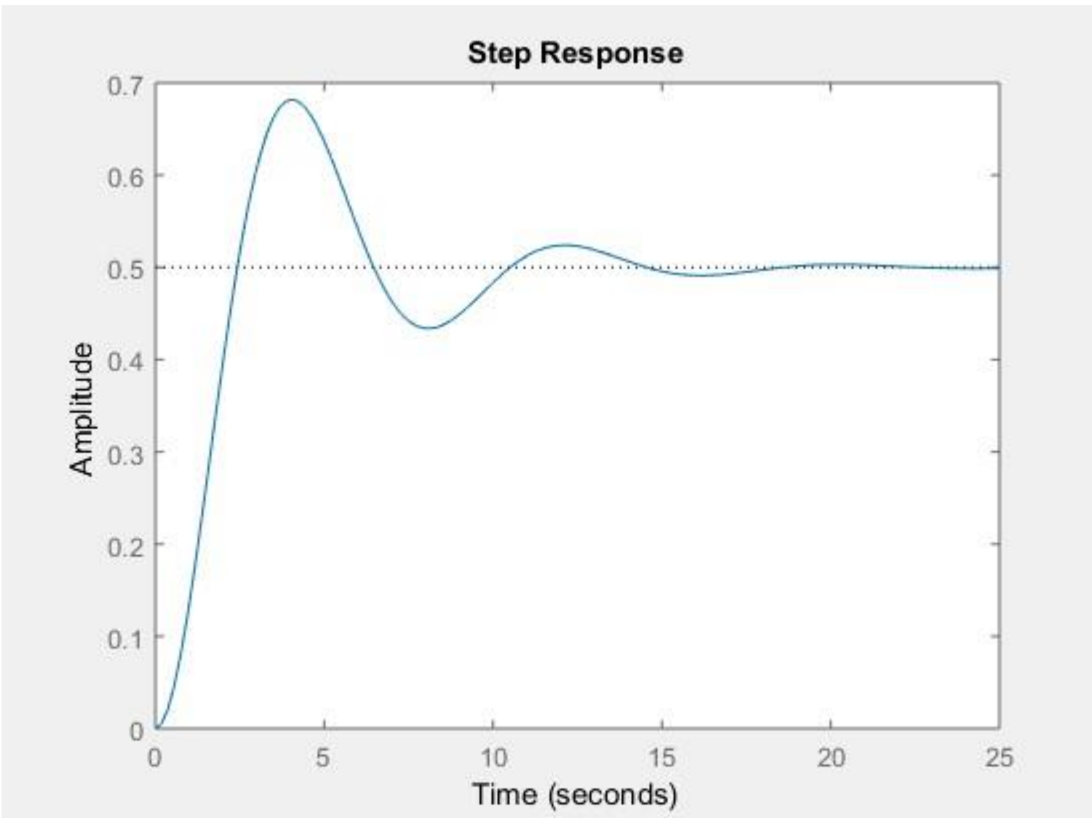
Simulation part :

after we enter the transfer function to MatLab to get response step of the transfer function , we have got the next response :

on the work space :

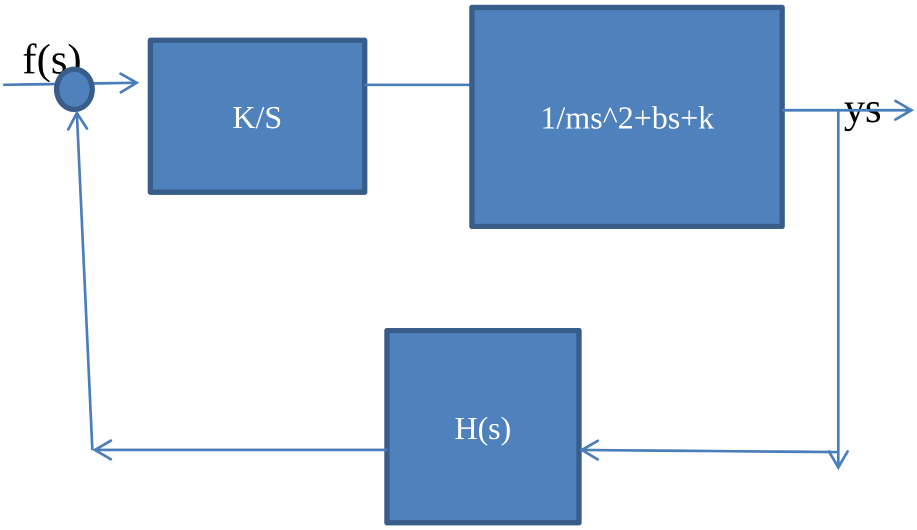
```
clear all
clc

m=3;
b=1.5;
k=1;

syms s

Gnum=1;
Gden=sym2poly(m*s^2+b*s+k);


G=tf(Gnum,Gden)

H=1;

T=feedback(G,H)

step(T)
```



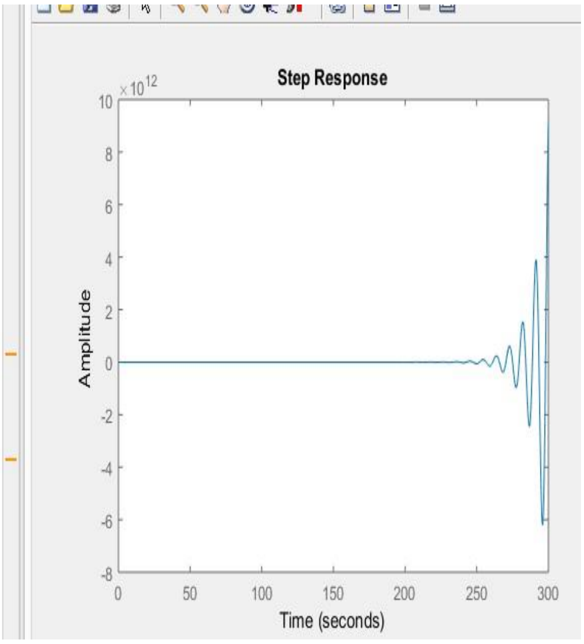


- We can see that the response is not stable as good as we hope so we should find a control to make much more stable.

- **<u>Selected controller :</u>**




```
clc

m=3;
b=1.5;
k=1;
K=1;

syms s

Gnum=1;
Gden=sym2poly(m*s^3+b*s^2+k*s);


G=tf(Gnum,Gden)

H=1;

T=feedback(G,H)

step(T)
```

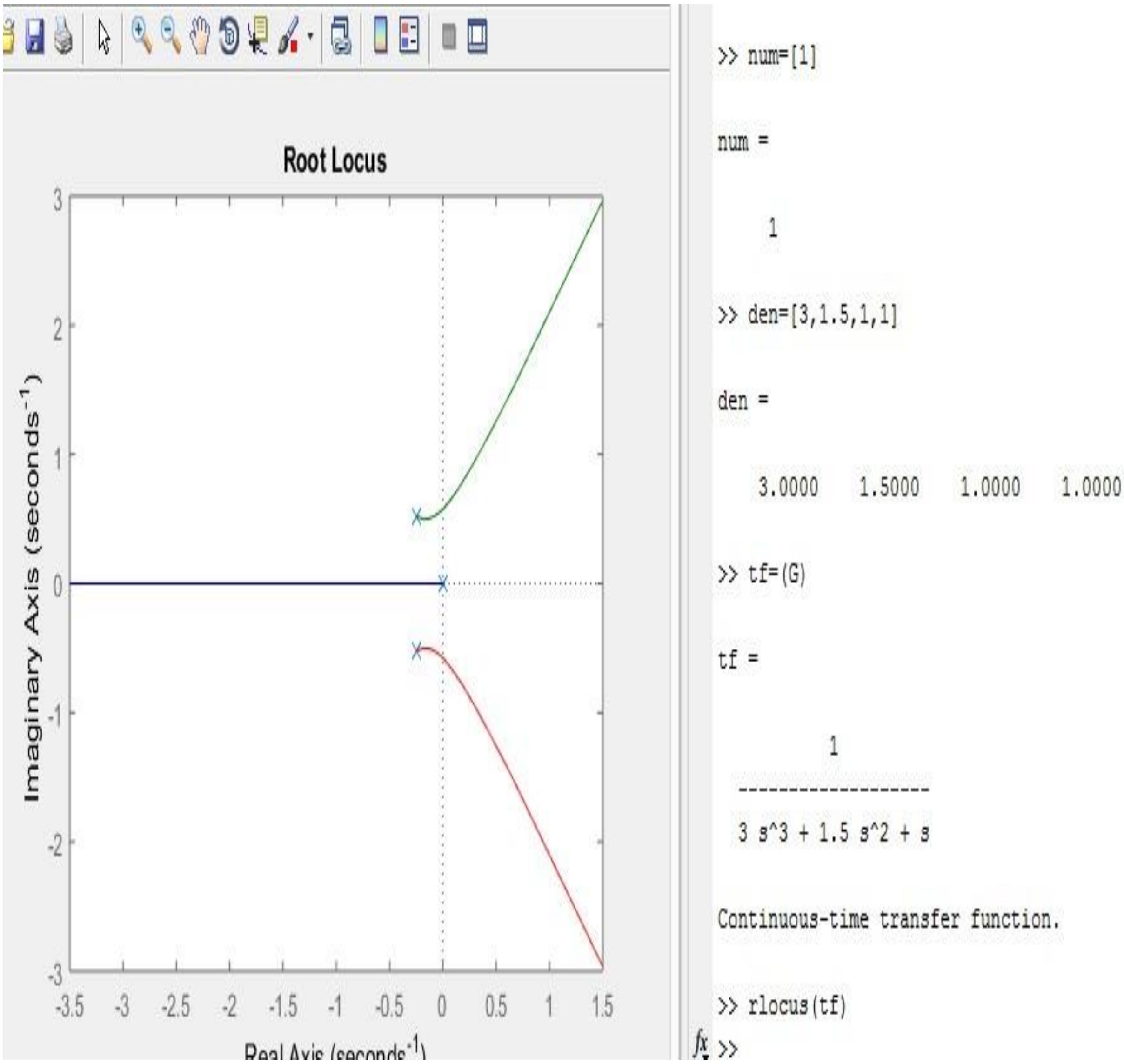


-So the control will be (K/s)

gain K =0.0175

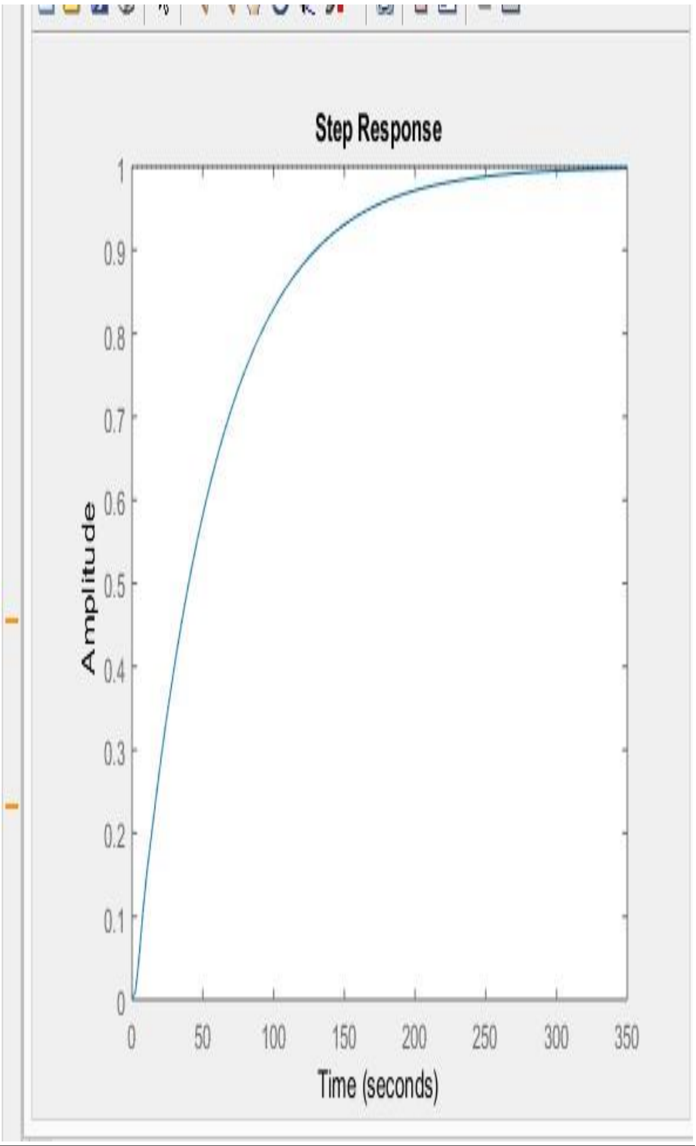
-We found gain(K) by using root locus on MatLab , by search about the values that they have the lowest overshoot .

Let us watch the next graph :



Now we have got the new response :

```
clc

m=3;
b=1.5;
k=1;
K=0.0175;

syms s

Gnum=1*K;
Gden=sym2poly(m*s^3+b*s^2+k*s);


G=tf(Gnum,Gden)

H=1;

T=feedback(G,H)

step(T)
```



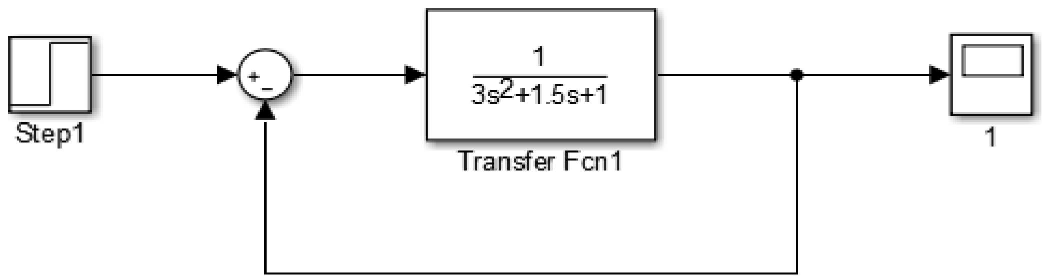
Discussion :

- We can see that in the first paragraph the response was not stable enough .
- So we used a control to help us to have a much more stable response .
- The control was (gain (K)/s).
- Gain K was found by using locus root .
- K = 0.0175
- After we enter the controller to the system , we have got a much more stable response .
- We can see that before we entered the control , the time is taking to reach to the steady state value is shorter than after entered the control .
- When we entered the control (K/s) when K = 1 , there was no stable response (worst response stability) , so we used root locus to find a better gain K which it has the lowest overshoot .

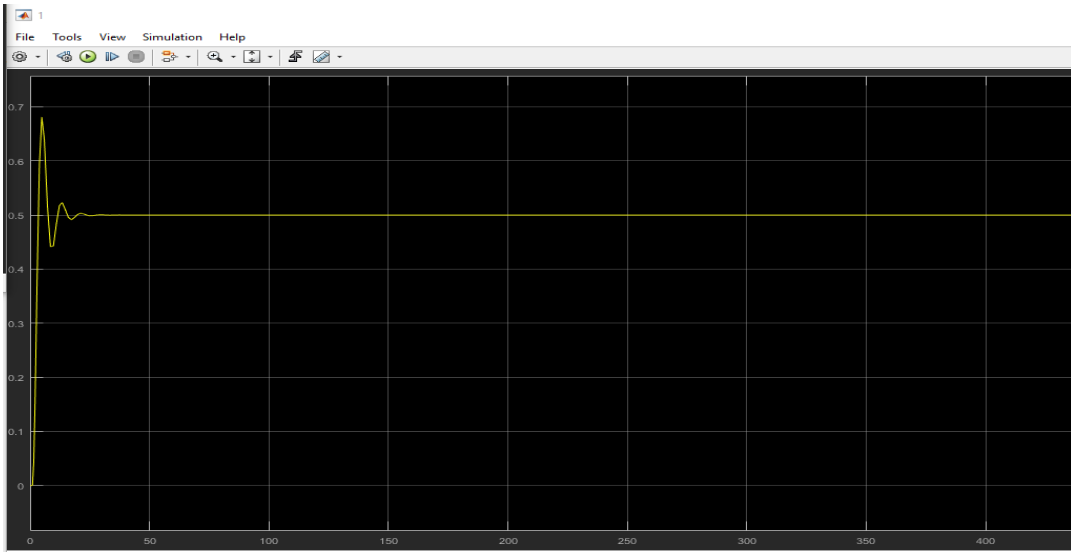
Simulink part :

After we enter the transfer function to MatLab to get response step of the transfer function , we have got the next response :

on the work space :

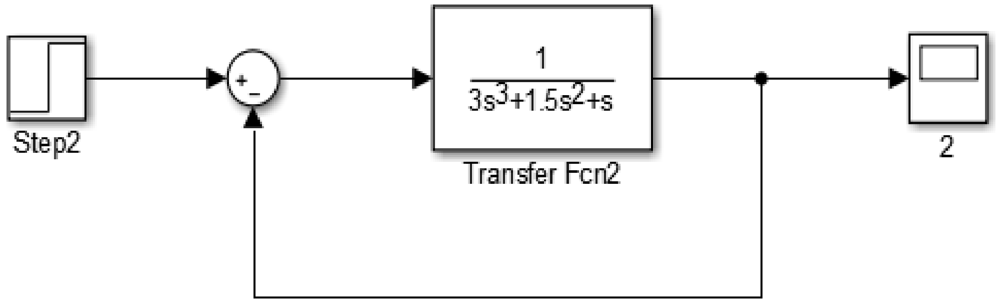


The scope 1 after 550 :

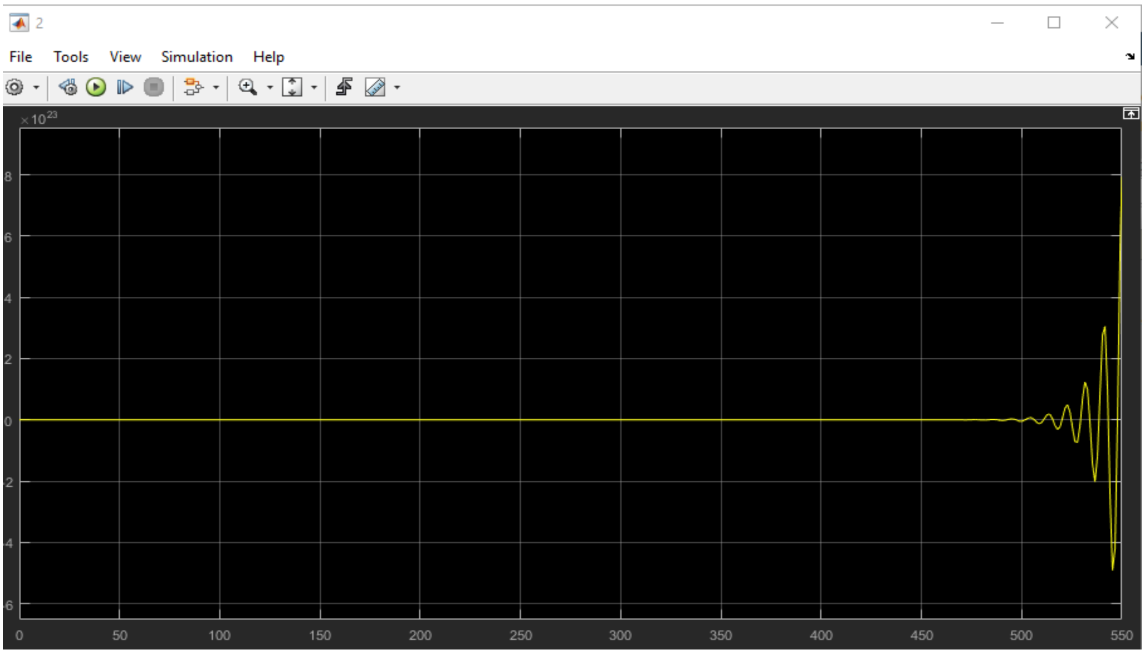


We can see that the response is not stable so we should find a control to make much more stable.

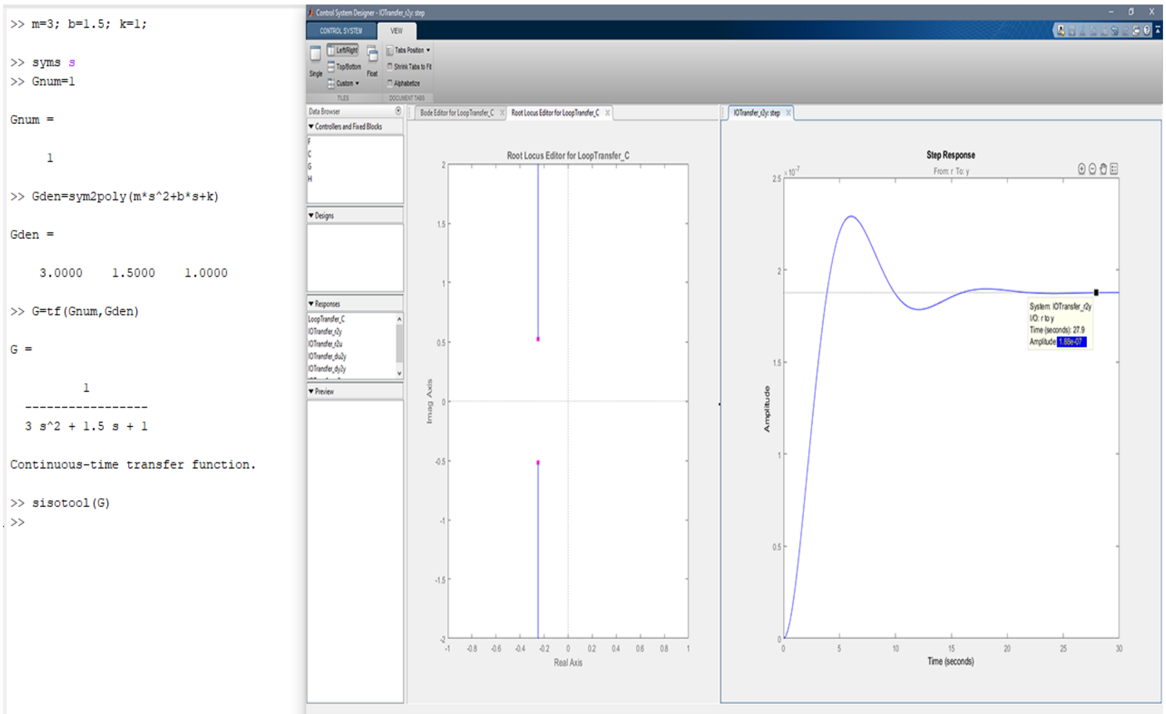
After selected controller :



The scope 2 after 550 :

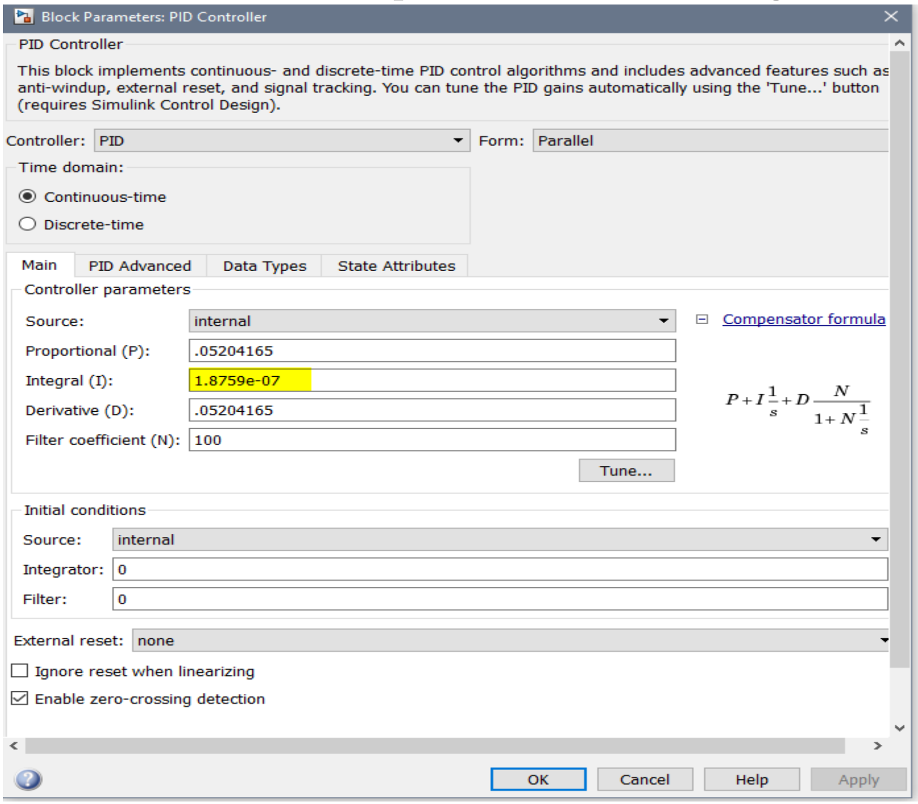


So we must control the system need some value from root locus as

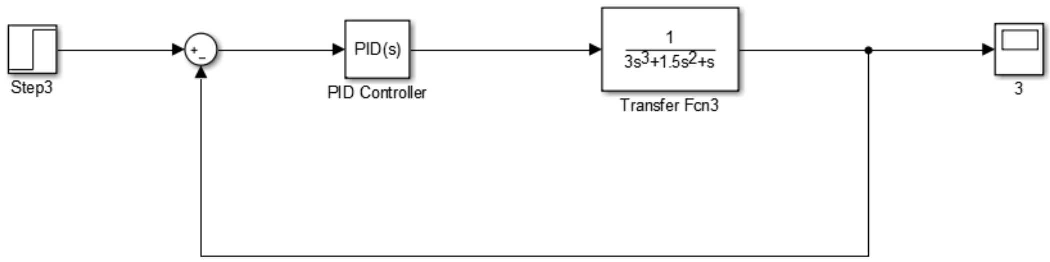


We use sisotool in MatLab to show value we need as show the value we read it's : 1.8759e-7

we take this value and put that in PID in Integral :



The system shape will be :



The scope 3 after 550 :