

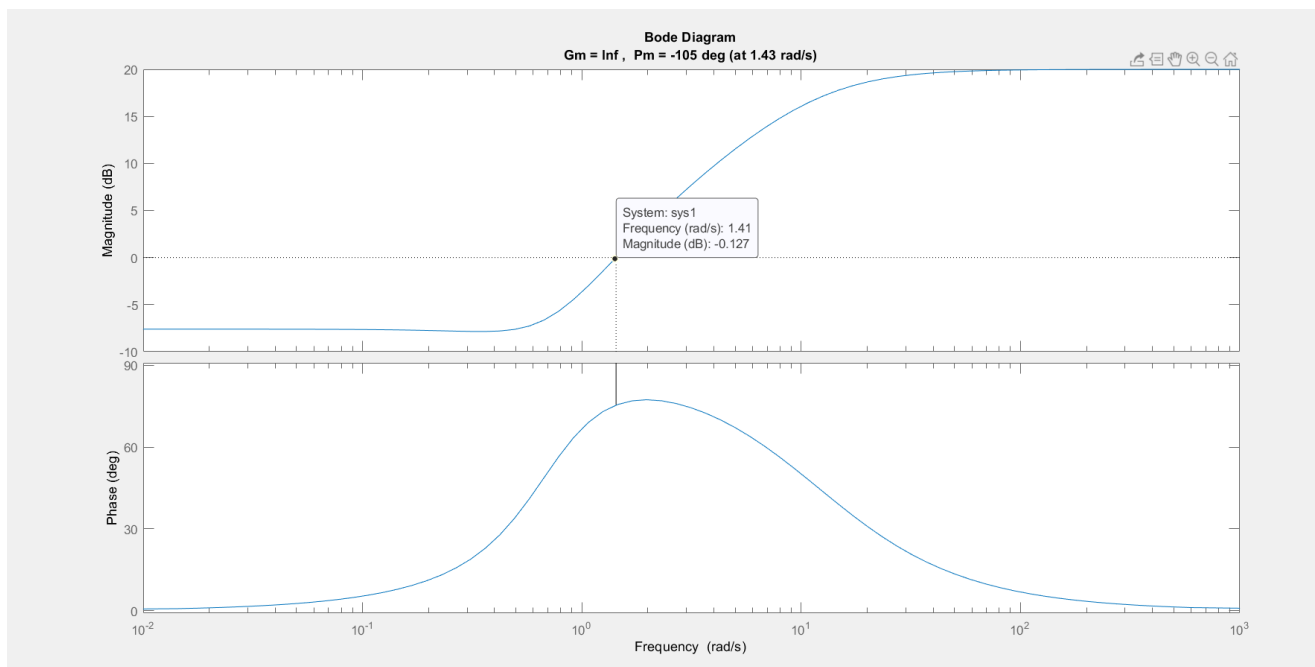
Analysis of Bode plot of given system:

$$G(s)H(s) = \frac{10(s^2 + s + 0.5)}{s(s+1)(s+12)}$$

MATLAB Code for the system is :

```
clc
clear all
num=[10 10 5]
den=conv([1 1],[1 12])
sys1=tf(num,den)
ltiview(sys1)
grid
[Gm, Pm, pcf, gcf]=margin(sys1)
mag=20*log10(Gm)
margin(sys1)
```

Plot of the system is :



Observing the graph:

Gain margin = inf

Phase margin = -105. Deg

Phase cross over frequency = inf

Gain cross over frequency = 1.41 rad/s

Here, phase cross over frequency is greater than gain cross over frequency , system is stable.

Analyzing stability by Nyquist plot and Nichols chart for the following system of open loop transfer function.

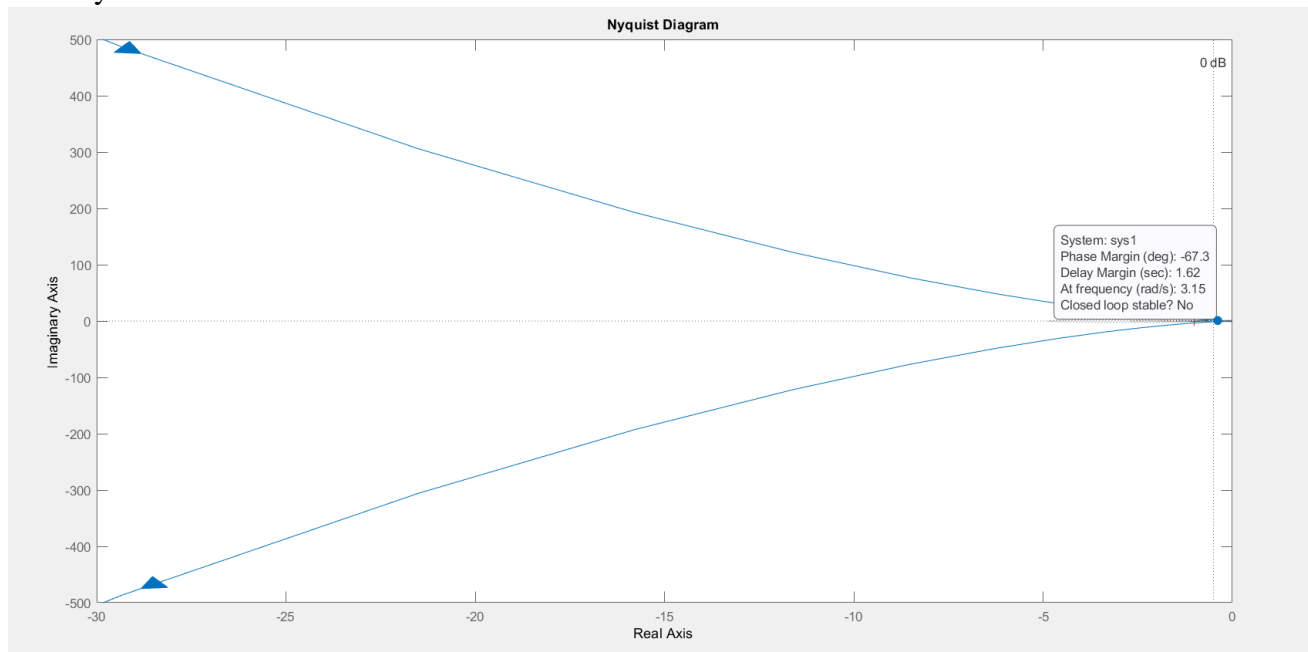
$$G(s) = \frac{100(s+4)(s+32)}{s^3(s+50)(s+10)}$$

MATLAB Code for the system is:

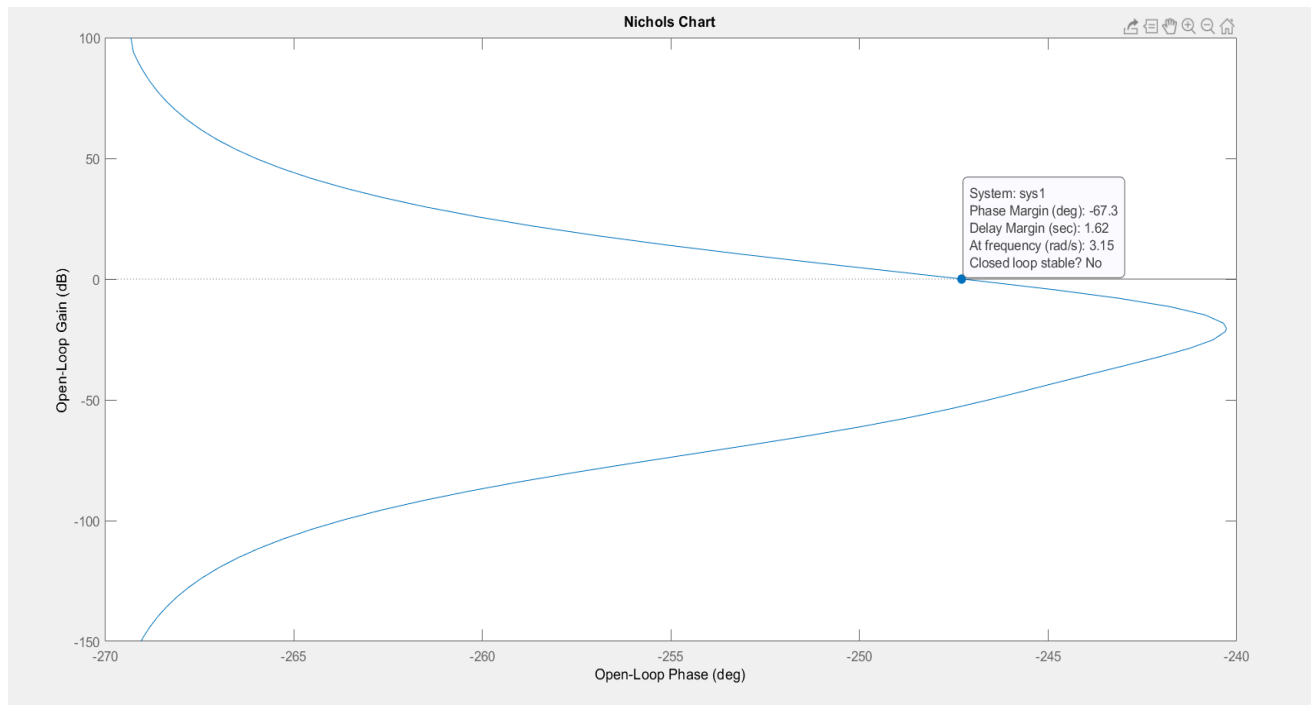
```
clc
clear all
num=conv([100 400],[1 32])
den=conv([1 50 0 0 0],[0 0 0 1 10])
sys1=tf(num,den)
figure
nyquist(sys1);
grid
figure
nichols(sys1);
```

Nyquist Chart

The system is found to be unstable.

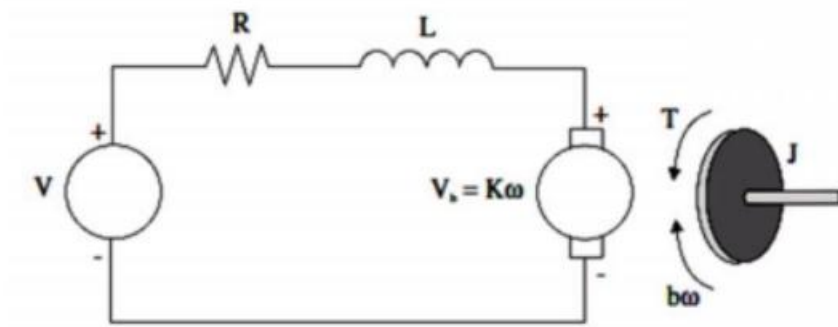


Nichols Chart



Interesting problem :

The electric circuit for an armature-controlled DC motor is as shown below:

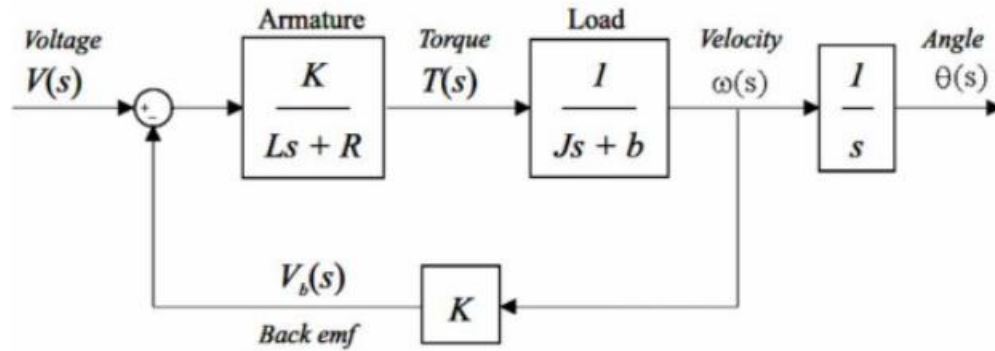


Consider the following values for the motor parameters:

moment of inertia of the rotor $J = 0.01 \text{ kg} \cdot \text{m}^2$, damping friction of the mechanical system $b = 0.1 \text{ Nms}$, back electro motive force constant $K = 0.01 \text{ Nm/A}$, electric resistance $R = 1 \Omega$, electric inductance $L = 0.5 \text{ H}$

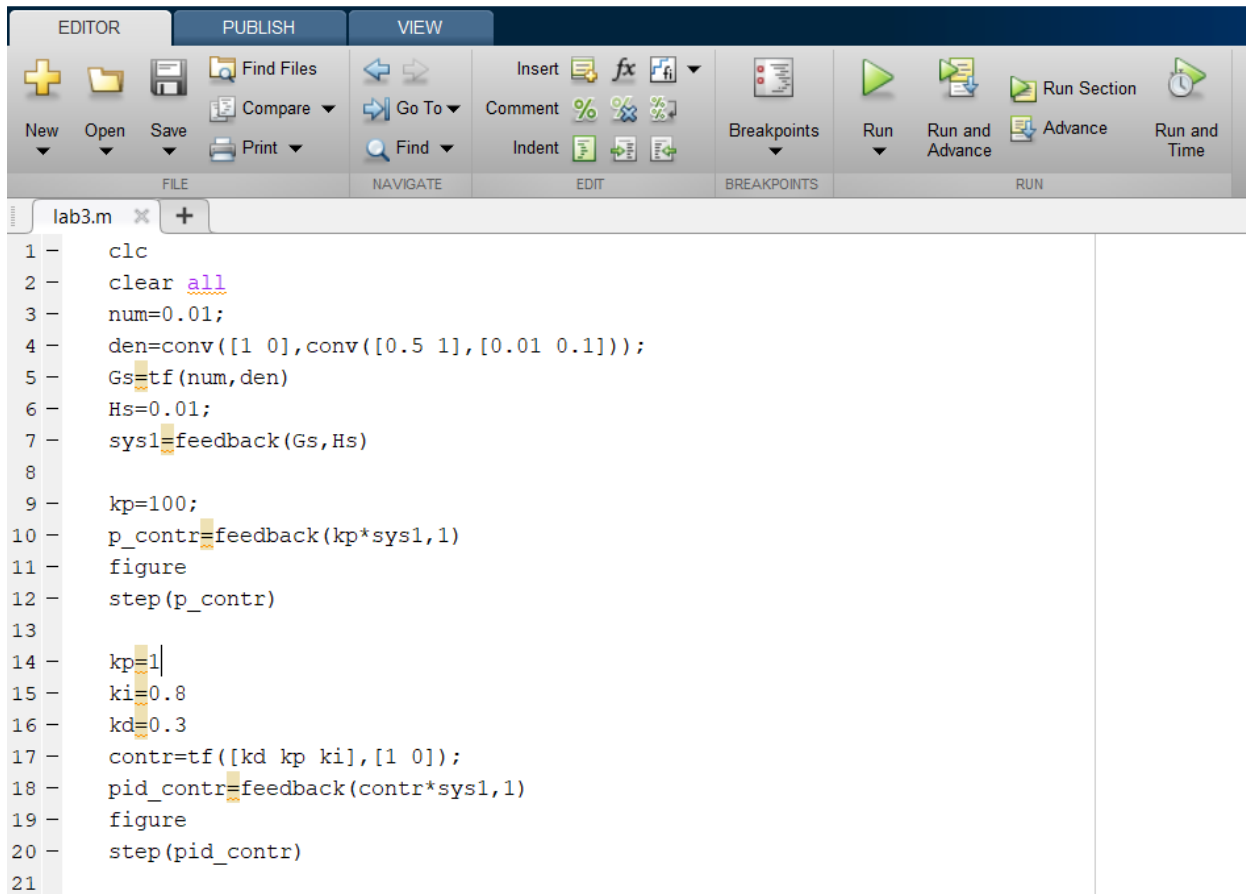
The input is the armature voltage V in volts and the measured variables are angular

velocity of the shaft ω in rad/s, and shaft angle θ in radians. The block diagram for the system is as shown below:



Designing a PID controller to control the position angle of the DC motor. Using Matlab codes as well as Simulink block diagram with a P-controller, assuming $K_p = 100$, then use PID controller with $K_p = 1$, $K_i = 0.8$, and $K_d = 0.3$. Comment on the changes in the output response with the P or PID controller.

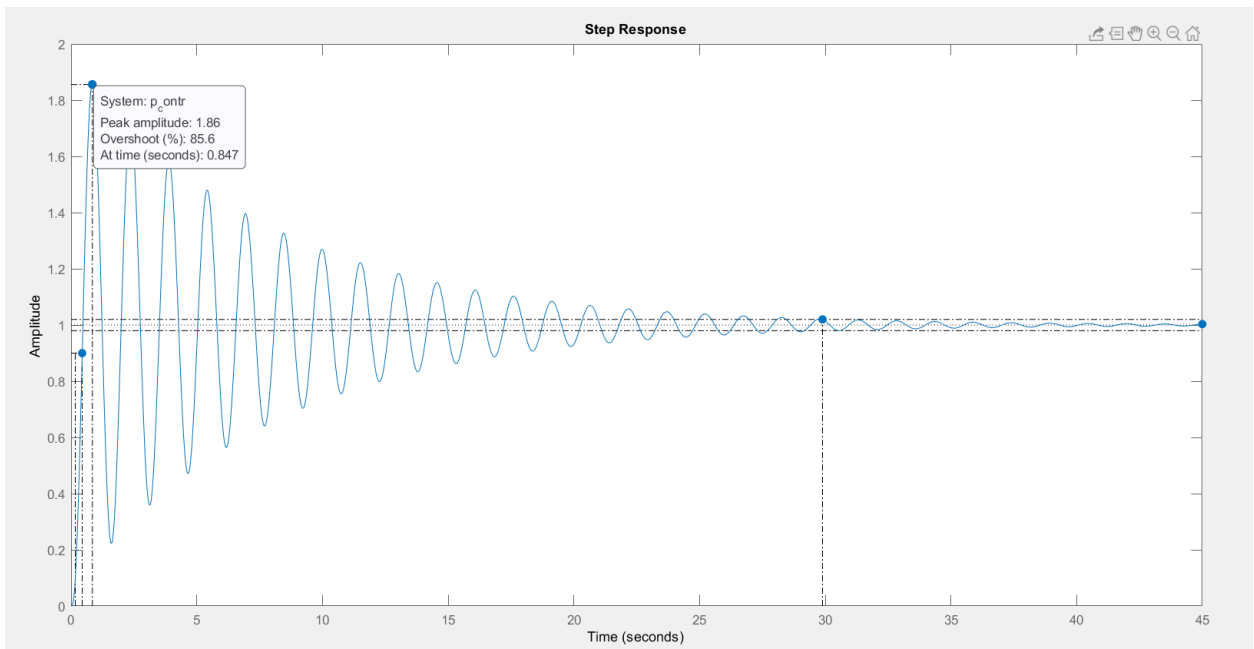
Code for the system is



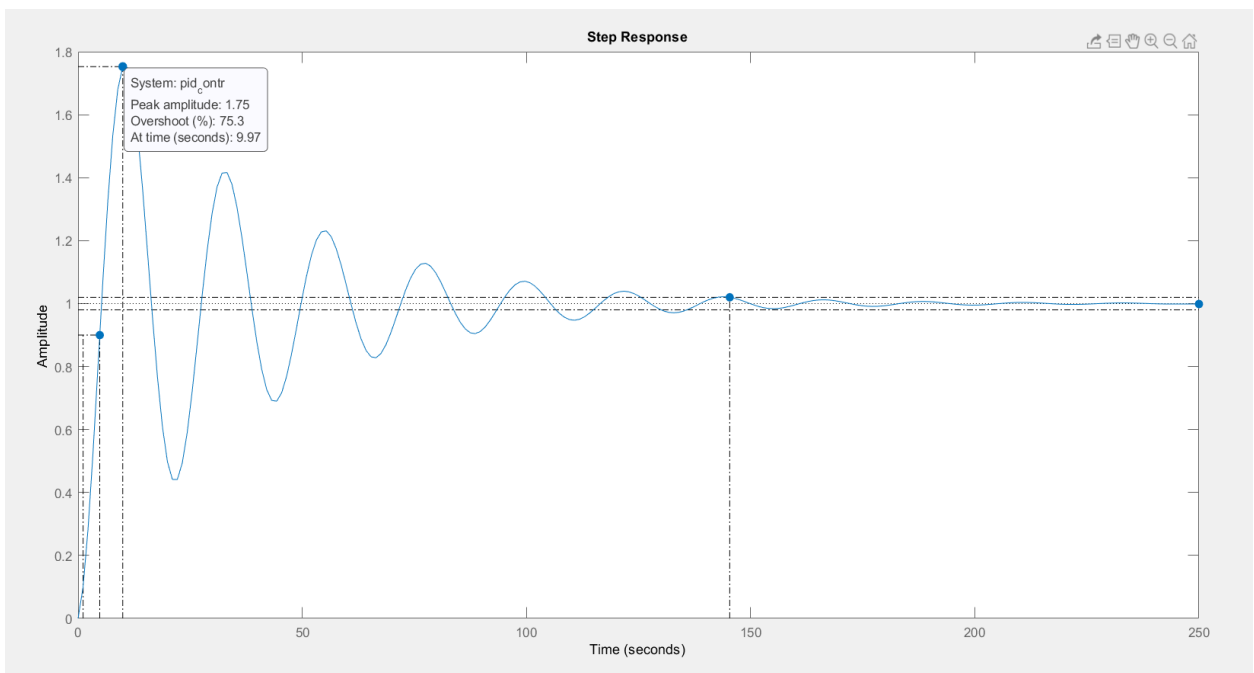
The image shows the MATLAB Editor window with a script named 'lab3.m'. The script implements a PID control system simulation. It starts by clearing the workspace and defining the plant transfer function G_s . A feedback loop is formed with a gain H_s . The system is simulated with a step input for a proportional controller with gain $K_p = 100$. Then, the gain is set to $K_p = 1$, and a PID controller is designed with $K_i = 0.8$ and $K_d = 0.3$. The system is simulated again with a step input for the PID controller. The interface includes a toolbar with various editing and execution tools, and a command window on the right.

```
1 - clc
2 - clear all
3 - num=0.01;
4 - den=conv([1 0],conv([0.5 1],[0.01 0.1]));
5 - Gs=tf(num,den)
6 - Hs=0.01;
7 - sys1=feedback(Gs,Hs)
8 -
9 - kp=100;
10 - p_contr=feedback(kp*sys1,1)
11 - figure
12 - step(p_contr)
13 -
14 - kp=1
15 - ki=0.8
16 - kd=0.3
17 - contr=tf([kd kp ki],[1 0]);
18 - pid_contr=feedback(contr*sys1,1)
19 - figure
20 - step(pid_contr)
21 -
```

a) P controller



b) PID controller



Observing the graph :

P controller

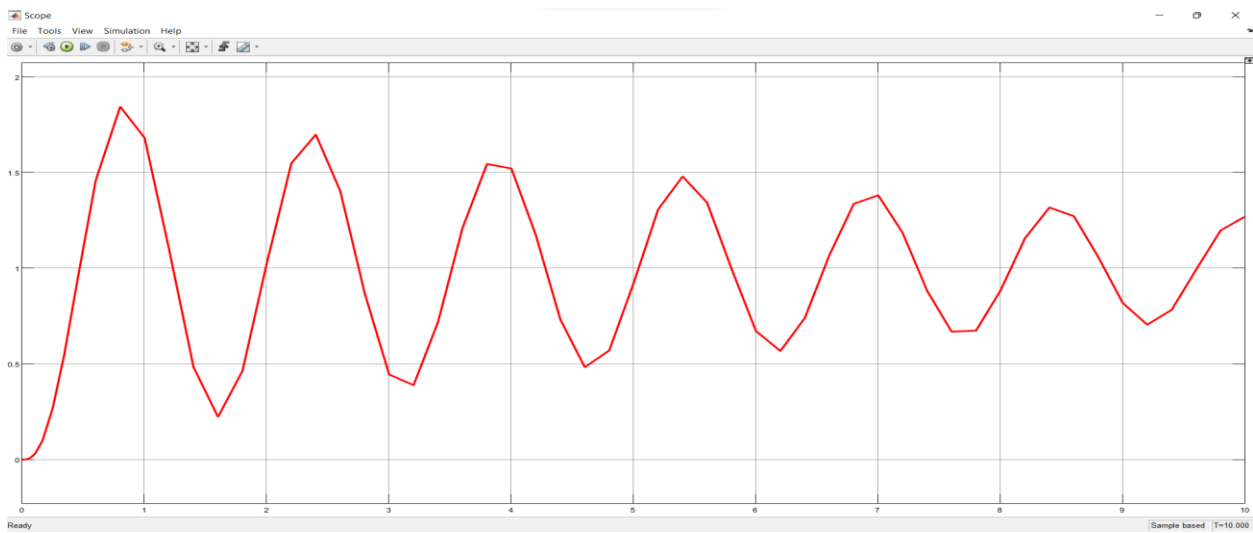
- a) Rise time = 0.276 s
- b) Peak amplitude= 1.86
- c) Overshoot = 85.6
- d) Settling time = 29.9 s
- e) Final value = 1

PID controller

- a) Rise time = 3.75
- b) Peak amplitude = 1.75
- c) Overshoot = 75.3
- d) Settling time= 145
- e) Final value= 1

In Simulink Modeling :

P controller



PID Controller

