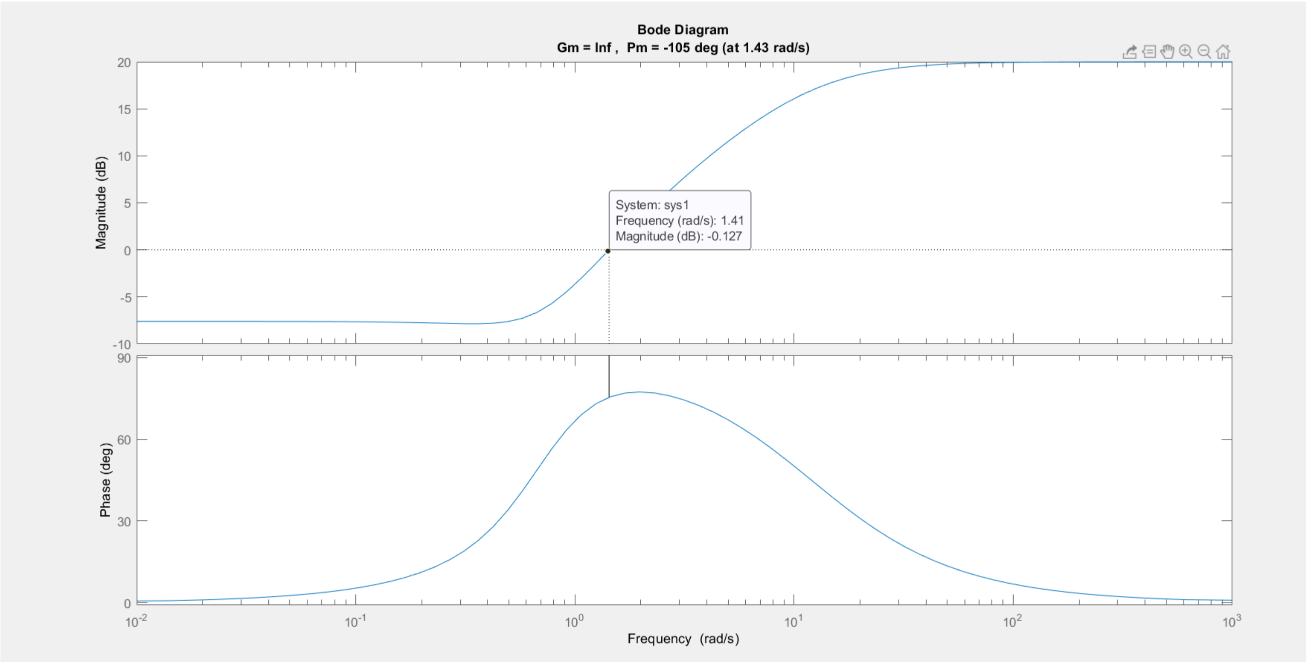
Analysis of Bode plot of given system:

G(s)H(s) = $\frac{10(s2+s+0.5)}{s(s+1)(s+12)}$

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.

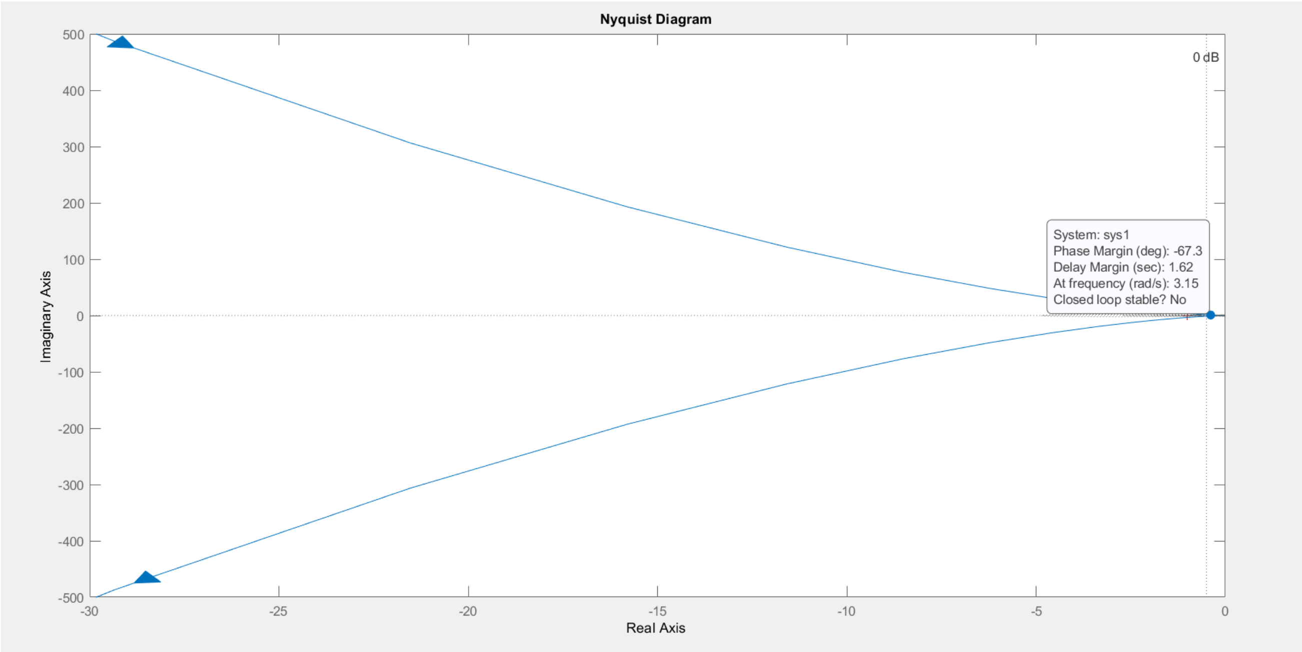
$$G(s)=\frac{100(s+4)(s+32)}{s^3(s+50)(s+10)}$$

MATLAB Code for the system is:

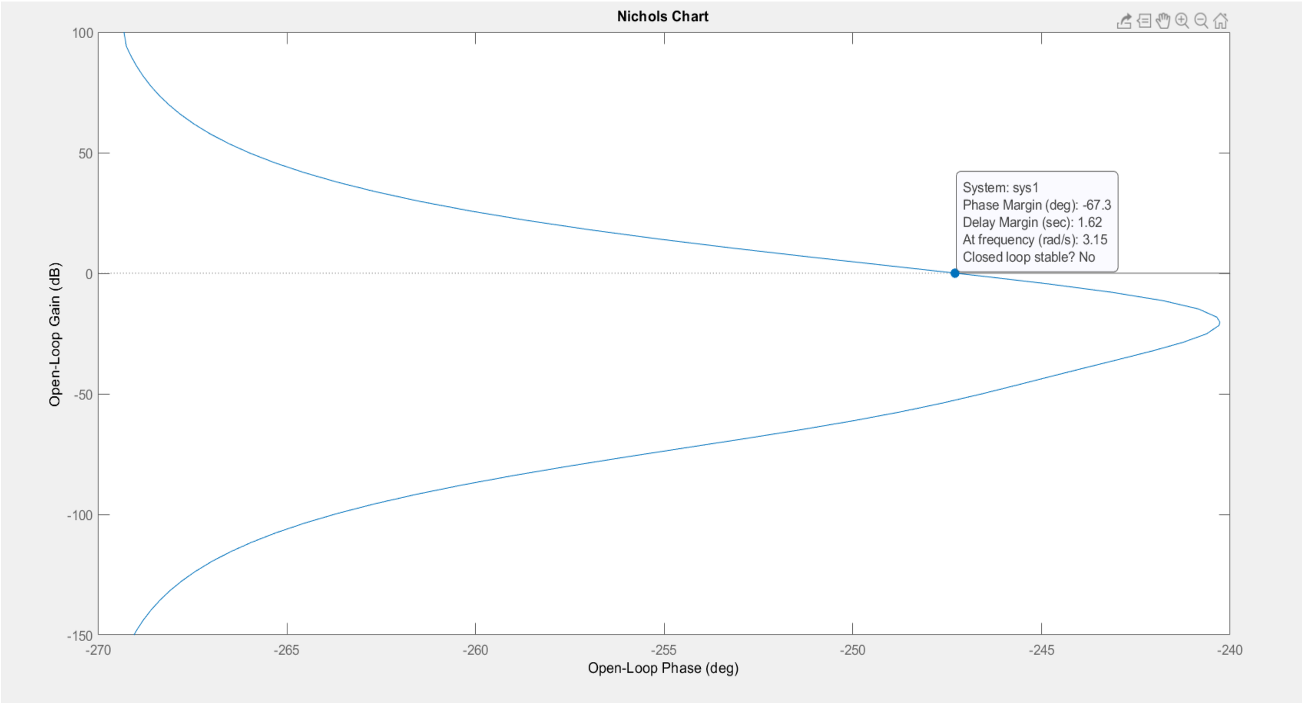
```
clc
clear all
num=conv([100 400],[1 32])
den=conv([1 50 0 0 0], [0 0 0 1 10])
sys1=tf(num,den)
figure
nyquist(sys1);
grid
figure
nichols(sys1);
```

Nyquist Chart

The system is found to be unstable.

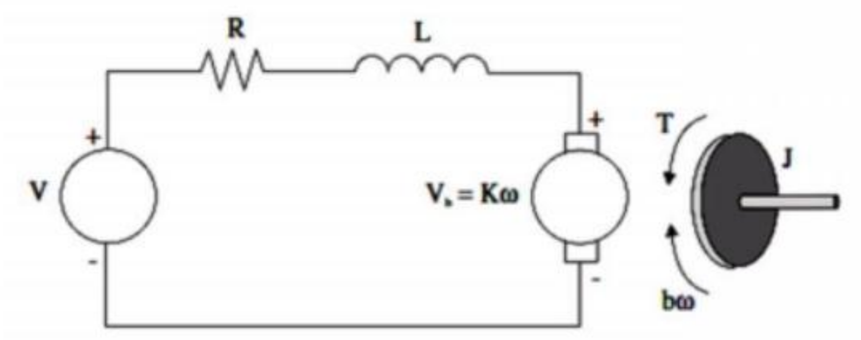


Nichols Chart



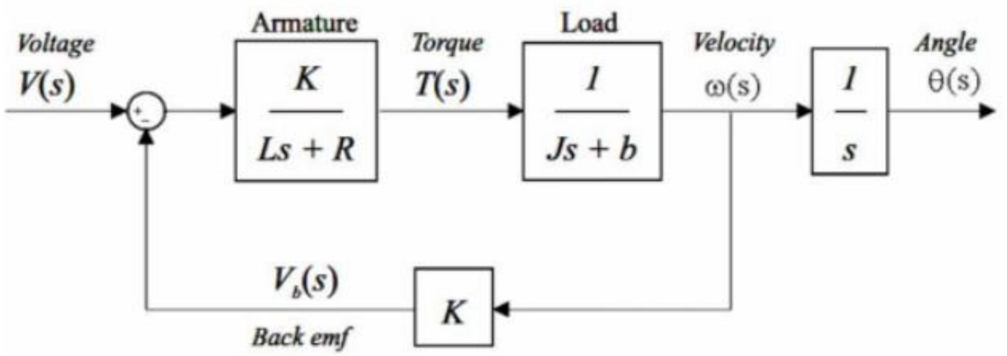
Interesting problem :

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 kg. m2, damping friction of the mechanical system b =0.1 Nms, back electro motive force constant K =0.01 Nm/A, electric resistance R = 1 Ω ,electric inductance L = 0.5 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 Kp = 100, then use PID controller with Kp = 1, Ki = 0.8, and Kd = 0.3. Comment on the changes in the output response with the P or PID controller.

Code for the system is

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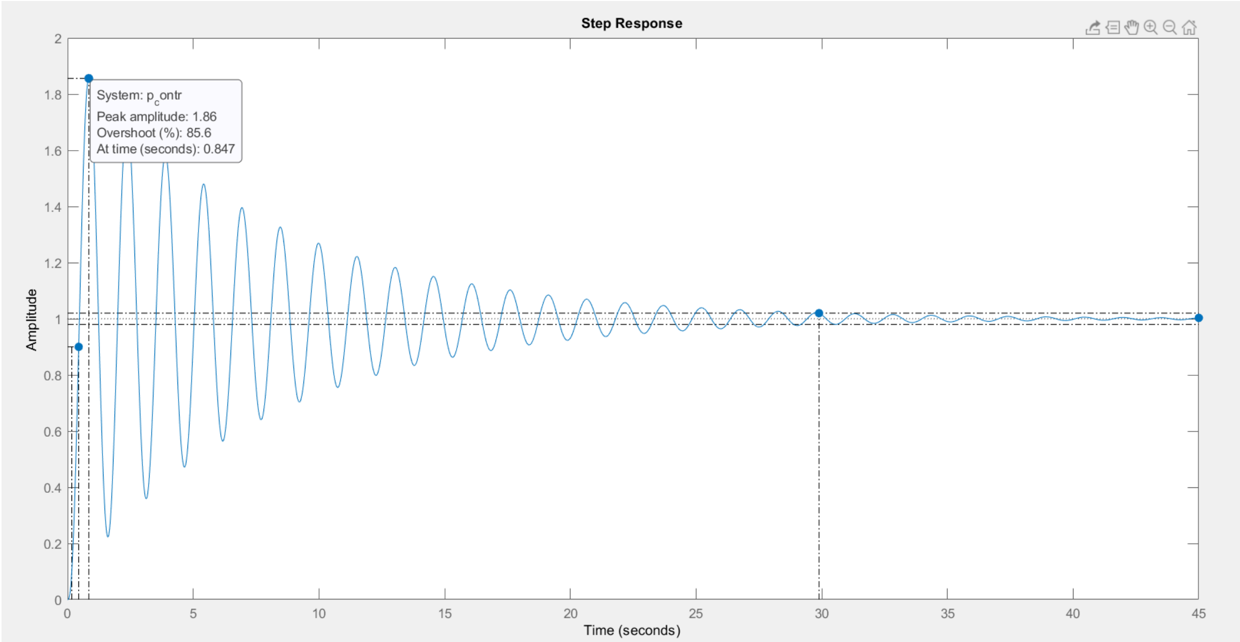
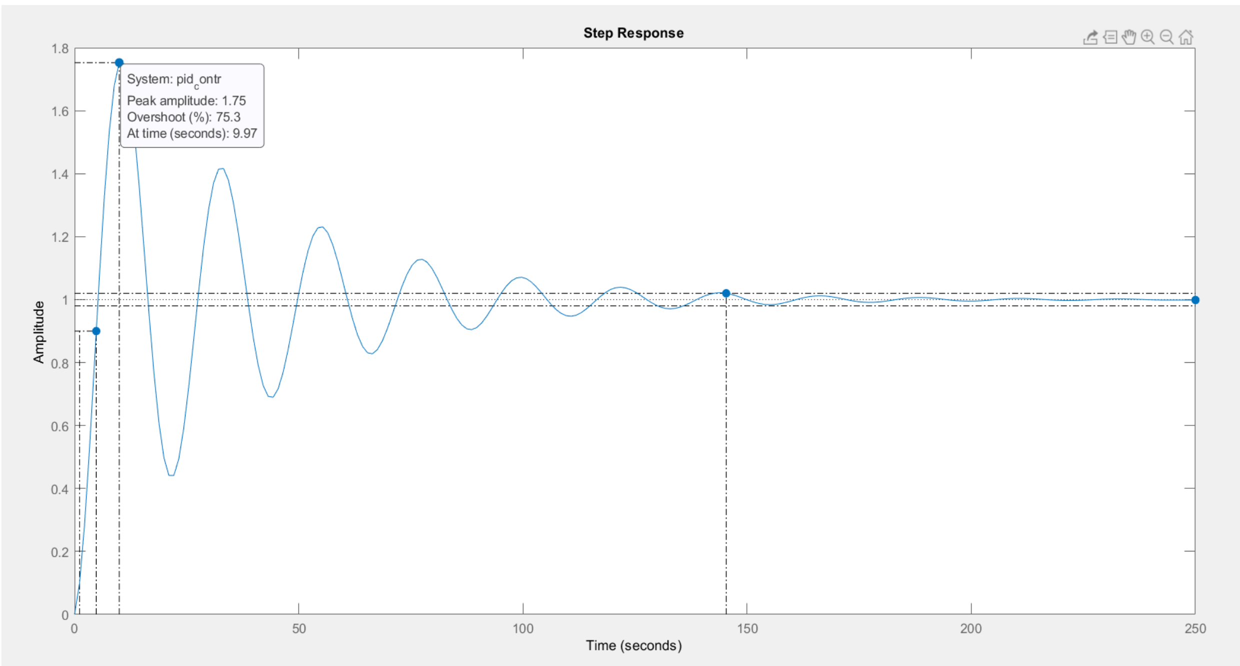
lab3.m

```
clc
clear all
num=0.01;
den=conv([1 0],conv([0.5 1],[0.01 0.1]));
Gs=tf(num,den)
Hs=0.01;
sys1=feedback(Gs,Hs)

kp=100;
p_contr=feedback(kp*sys1,1)
figure
step(p_contr)

kp=1
ki=0.8
kd=0.3
contr=tf([kd kp ki],[1 0]);
pid_contr=feedback(contr*sys1,1)
figure
step(pid_contr)
```

a) P controller



b) PID controller



Observing the graph :

P controller

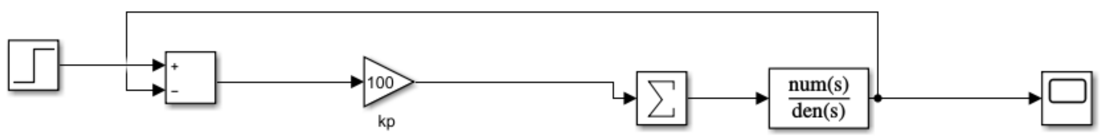
a) Rise time = 0.276 s
b) Peak amplitude= 1.86
c) Overshoot = 85.6
d) Settling time = 29.9 s
e) Final value = 1

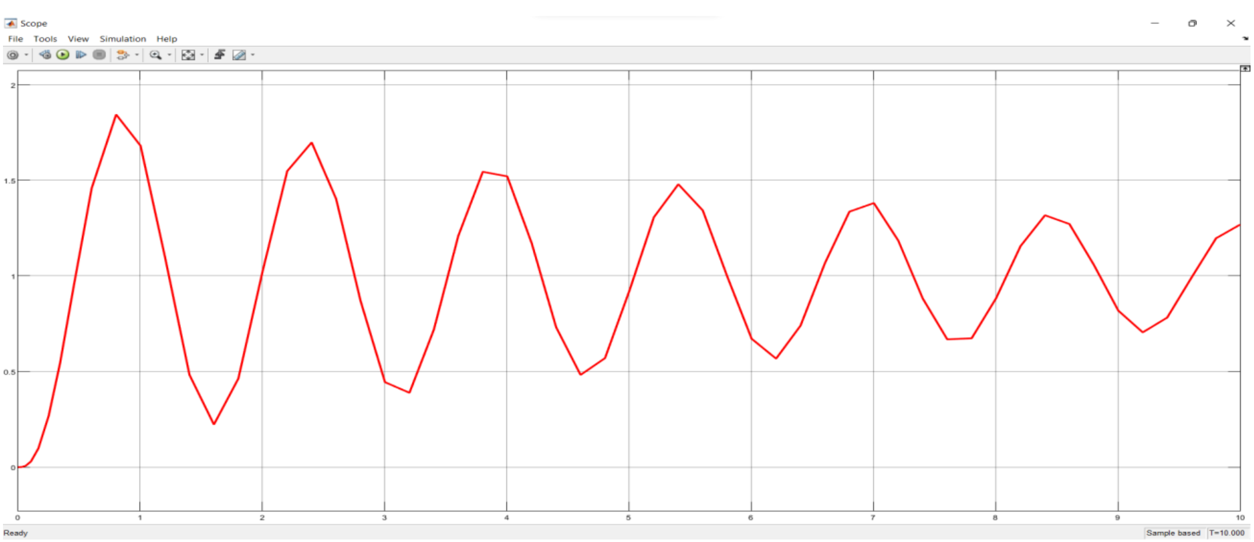
PID controller

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