Indian Institute of Information Technology, Allahabad
Department of Electronics and Communication Engineering

Course Name: Control System Lab

EXPERIMENT NO: 7

STUDY THE EFFECT OF P, PD, PI, PID controller.

Objective: Unity feedback systems with forward path transfer function $G = \frac{1}{s^2 + 10s + 20}$

study the effect of adding:

I. Proportional (P) controller
II. Proportional- Derivative (PD) Controller
III. Proportional – Integral (PI) Controller
IV. Proportional – Integral – Derivative (PID) Controller

Materials Required: MATLAB Software.

MATLAB Code :

```
clc;
clear all;
close all;
n1=[1];
d1=[1 10 20];
g=tf(n1,d1);% forward path transfer function
t= feedback(g,1) % close loop transfer function
step(t)
stepinfo(t)
hold on
%% addition of proportional controller
kp=300; % proportional controller gain
g1=kp*g %forward path gain with controller
t1=feedback(g1,1) % close loop transfer function with proportional
controller
step(t1,'g')
stepinfo(t1)
hold on
%% addition of proportional -derivative controller gcpd= (kd*s+kp)
kp=300; % proportional controller gain
kd=10; % derivative controller gain
nc=[kd kp];
dc=1;
gcpd=tf(nc,dc) % transfer function of PD controller
g2=gcpd*g ;% system forward path gain with  PDcontroller
t2=feedback(g2,1)% close loop transfer function with PD controller
step(t2,'r')
stepinfo(t2)
hold on

%% addition of proportional -Integral controller gcpi= (kp+ki/s)
kp=300; % proportional controller gain
ki=70; % derivative controller gain
nc1=[kp ki];
dc1=[1 0];
gcpi=tf(nc1,dc1) % transfer function of PI controller
```

```
g3=gcpi*g ;% system forward path gain with  PI controller
t3=feedback(g3,1)% close loop transfer function with PI controller
step(t3,'y')
stepinfo(t3)
hold on
%% addition of proportional- Integral- Derivative controller
gcpid=(kp+ki/s+kd)
kp=300; % proportional controller gain
ki=70; % Integral controller gain
kd=10; % derivative controller gain
nc2=[kd kp ki];
dc2=[1 0];
gcpid=tf(nc2,dc2) % transfer function of PID controller
g4=gcpid*g ;% system forward path gain with  PID controller
t4=feedback(g4,1)% close loop transfer function with PID controller
step(t4,'m')
stepinfo(t4)
%%
grid on
legend('without controller','with P controller','with PD controller','with PI controller','with PID controller' )
title('step respnse of closed loop system')
```

Result:

System close loop transfer function

```
t =

         1
  ---------------

  s^2 + 10 s + 21
```

I. **Close loop transfer function with P controller**

```
t1 =

        300
  ----------------
  s^2 + 10 s + 320
```

II. **Close loop transfer function with P D controller**

```
gcpd =

  10 s + 300



t2 =

     10 s + 300
  ----------------
  s^2 + 20 s + 320
```

III. Close loop transfer function with P I controller

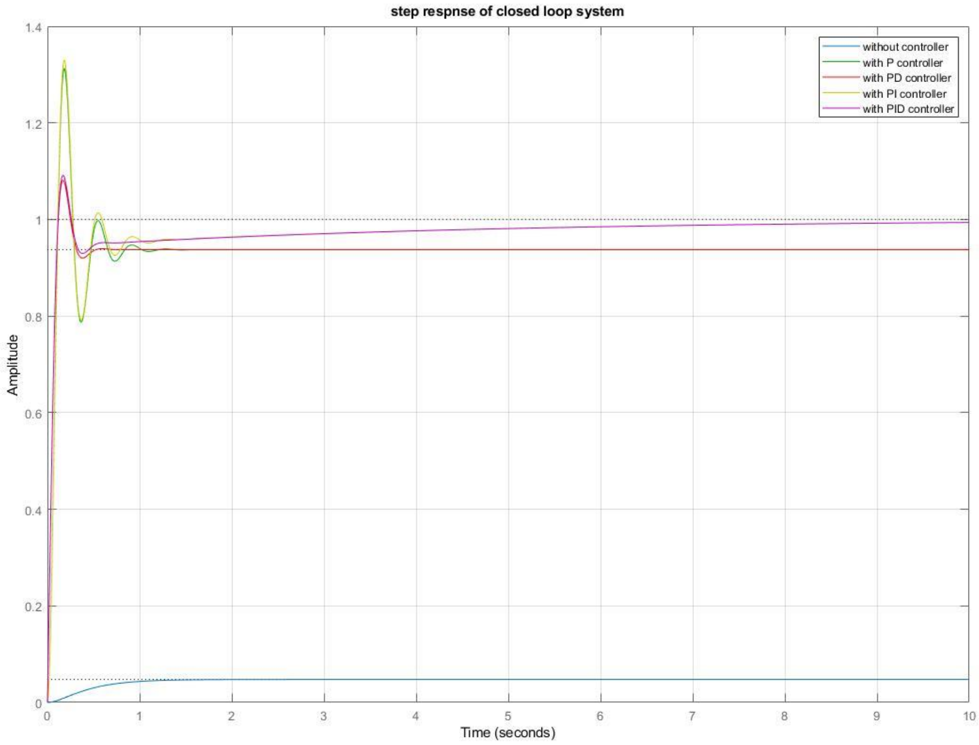
```
gcpi =

  300 s + 70
  ----------
      s



t3 =

         300 s + 70
  -------------------------
  s^3 + 10 s^2 + 320 s + 70
```

IV. Close loop transfer function with P I D controller

```
gcpid =

  10 s^2 + 300 s + 70
  -------------------
           s



t4 =

     10 s^2 + 300 s + 70
  -------------------------
  s^3 + 20 s^2 + 320 s + 70
```

Observation Table:

Controller	Rise time	Peak time	Settling time	Overshoot (%)
System	0.8330	3.5394	1.4902	0
System with P	0.0727	0.1842	0.7724	40.0588
System with PD	0.0777	0.1704	0.2897	15.3418
System with PI	0.0764	0.1789	4.7172	32.9606
System with PID	0.0855	0.1676	4.7446	9.1209


step respnse of closed loop system
without controller
with P controller
with PD controller
with PI controller
with PID controller
Amplitude
Time (seconds)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9
10