EXP 1b

Q1. Find Pole, Zero and Gain of the transfer function G(s) = $\frac{s^2+3s+2}{(s+4)(s^2+4s+7)}$ and plot pole zero diagram.

```
clc;
close all;
clear all;
num = [1 3 2]
d1 = [1 4]
d2 = [1 4 7]
den = conv(d1,d2)
g = tf(num, den)
[z p k] = tf2zp (num, den)
pzmap(g)
```

Q2. Find Pole, Zero and Gain of the transfer function G(s) = $\frac{s^2+9}{s^2(s-3)(s+4)(s^2+4s+13)}$ and plot pole zero diagram.

```
clc;
close all;
clear all;
num = [1 0 9]
d1 = [1]
d2 = [1 -3]
d3 = [1 4]
d4 = [1 4 13]
den1 = conv(d1,d2)
den2 = conv(den1,d3)
den3 = conv(den2,d4)
g = tf(num, den3)
[z p k] = tf2zp (num, den3)
pzmap(g)
```

Q3. Find Pole, Zero and Gain of the transfer function G(s) = $\frac{2s^2+18s+36}{s(s-2)(s+4)(s^2+2s+1)}$ and plot pole zero diagram.

```
clc;
close all;
clear all;
```

```
num = [2 18 36]
d1 = [1 0]
d2 = [1 -2]
d3 = [1 4]
d4 = [1 2 1]
den1 = conv(d1,d2)
den2 = conv(den1,d3)
den3 = conv(den2,d4)
g = tf(num, den3)
[z p k] = tf2zp (num, den3)
pzmap(g)
```

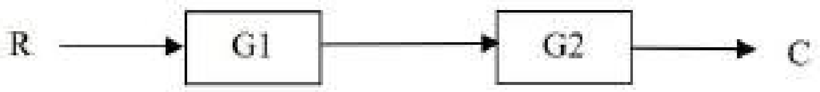
Q4. Write Matlab code to obtain transfer function of a system from its pole ,zero, gain values. Assume pole locations are -3, 2, zero at -1 and gain is 7 (hint: [num, den] = zp2tf(z, p, k))

```
clc;
close all;
clear all;
p = [-3, 2];
z = [-1];
k = 7;
[num,den] = zp2tf(z,p,k)
g = tf(num,den)
pzmap(g)
```

EXP 2

Q1. Determine the Transfer function of the following block diagram.

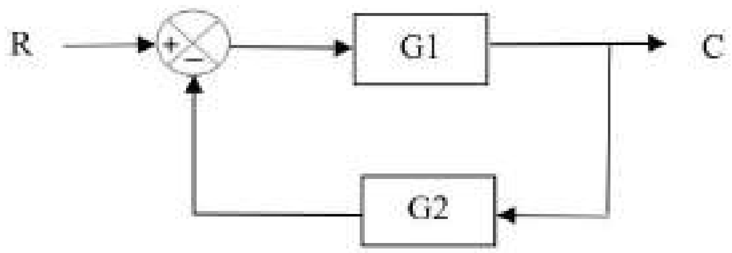
$G1 = \frac{1}{s+2}$, $G2 = \frac{1}{s+3}$




```
clc;
clear all;
close all;
G1 = tf([1],[1 2])
G2 = tf([1],[1 3])
m = series(G1,G2)
```

Q2. Determine the Transfer function of the following block diagram.

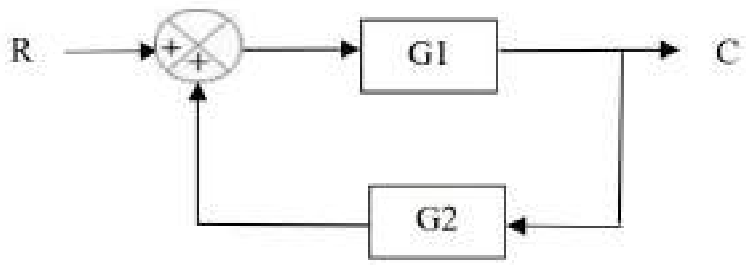
$$G1 = \frac{1}{s+2}\ , \quad G2 = \frac{1}{s+3}$$




```
clc;
clear all;
close all;
G1 = tf([1],[1 2])
G2 = tf([1],[1 3])
m = feedback(G1,G2,-1)
```

Q3. Determine the Transfer function of the following block diagram.

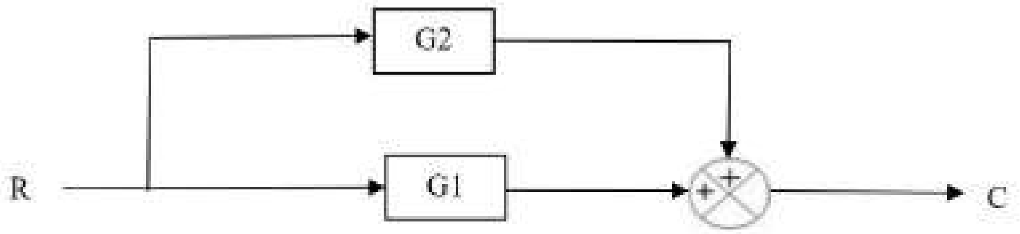
$$G1 = \frac{1}{s+2}\ , \quad G2 = \frac{1}{s+3}$$




```
clc;
clear all;
close all;
G1 = tf([1],[1 2])
G2 = tf([1],[1 3])
m = feedback(G1,G2,1)
```

Q4. Determine the Transfer function of the following block diagram.

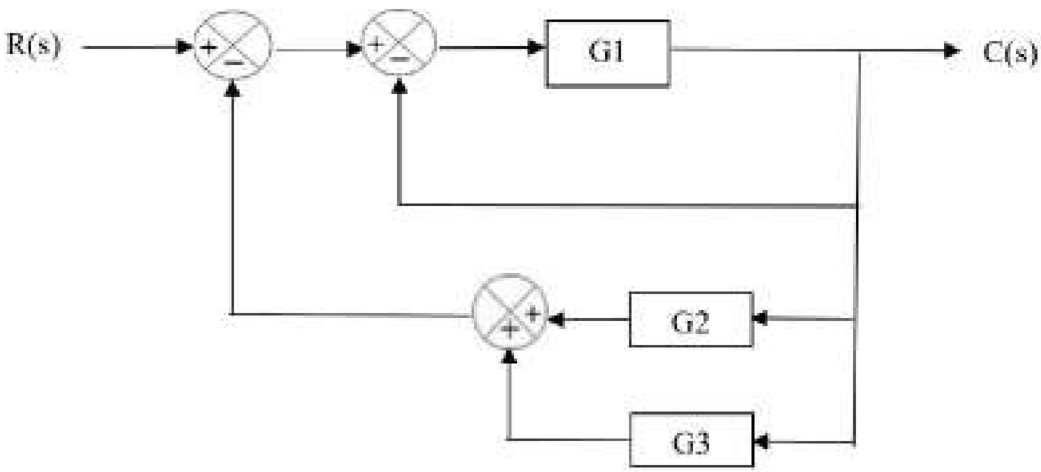
$$G1 = \frac{1}{s+2}\ , \qquad G2 = \frac{1}{s+3}$$




```
clc;
clear all;
close all;
G1 = tf([1],[1 2])
G2 = tf([1],[1 3])
m = parallel(G1,G2)
```

Q5. Determine the Transfer function of the following block diagram.

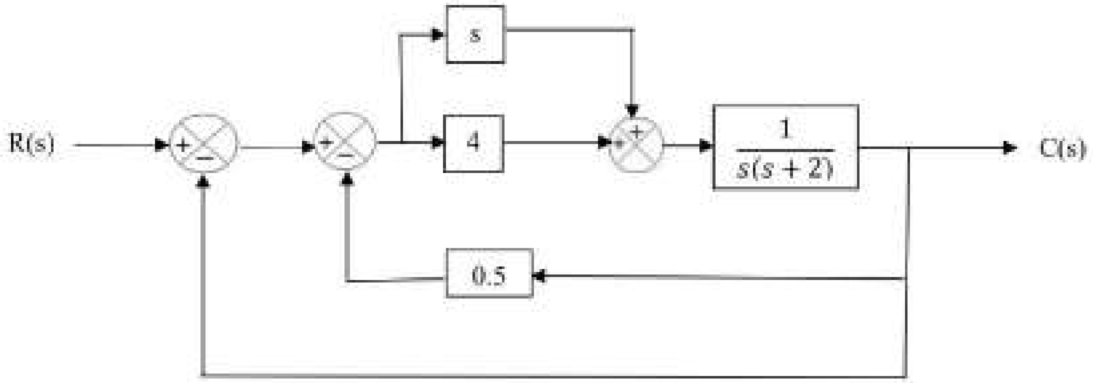
$$G1 = \frac{4}{s(s+4)}\ , \qquad G2 = s + 1.2\ ,\ G3 = s + 0.8$$




```
clc;
clear all;
close all;
G1 = tf([4],[1 4 0])
G2 = tf([1 1.2],[1])
G3 = tf([1 0.8],[1])
```

```
m = parallel(G2,G3)
n = feedback(G1,1,-1)
g = feedback(n,m,-1)
```

Q6. Determine the Transfer function of the following block diagram.




```
clc;
clear all;
close all;
G1 = tf([1 0], [1])
G2 = tf([4], [1])
G3 = tf([0.5], [1])
G4 = tf([1], [1 2 0])
m1 = parallel(G1,G2)
m2 = series(m1,G4)
m3 = feedback(m2,G3,-1)
g = feedback(m3,1,-1)
```

EXP 3

Q1. Obtain step response of a unity feedback system having forward path transfer function of $G(s) = \frac{1}{s+5}$

```
clc;
clear all;
close all;
n=[1]
d=[1 5]
g=tf(n,d)
```

```
f=feedback(g,1,-1)
step(f)
```

Q2. Obtain impulse response of a unity feedback system having forward path transfer function of $G(s) = \frac{1}{s+5}$

```
clc;
clear all;
close all;
n=[1]
d=[1 5]
g=tf(n,d)
f=feedback(g,1,-1)
impulse(f,'g')
```

Q3. Obtain step and impulse response of a unity feedback system having forward path transfer function of $G(s) = \frac{2}{s+7}$

```
clc;
clear all;
close all;
n=[2]
d=[1 7]
g=tf(n,d)
f=feedback(g,1,-1)
subplot(1,2,1)
step(f)
subplot(1,2,2)
impulse(f,'g')
```

Q4. Obtain Step response of a unity feedback system having forward path transfer function of $(s) = \frac{1}{s^2+2s+5}$. Show Rise time, peak overshoot, settling time, final value .

(Hint: right click on plot and check all properties of characteristics.)

```
clc;
clear all;
close all;
```

```
n=[1]
d=[1 2 5]
g=tf(n,d)
f=feedback(g,1,-1)
step(f)
```

Q5. Obtain impulse response of a unity feedback system having forward path transfer function of $G(s) = \frac{1}{s^2+2s+5}$

```
clc;
clear all;
close all;
n=[1]
d=[1 2 5]
g=tf(n,d)
f=feedback(g,1,-1)
impulse(f,'g')
```

Q6. Obtain step and impulse response of a unity feedback system having forward path transfer function of $(s) = \frac{1}{s^2+3s+4}$.

```
clc;
clear all;
close all;
n=[1]
d=[1 3 4]
g=tf(n,d)
f=feedback(g,1,-1)
subplot(1,2,1)
step(f)
subplot(1,2,2)
impulse(f,'g')
```

Q7. Obtain step and impulse response of a unity feedback system having forward path transfer function of $(s) = \frac{17}{(s+4)(s+8)}$.

```
clc;
clear all;
close all;
n=[17]
d1=[1 4]
d2=[1 8]
d = conv(d1, d2)
g=tf(n,d)
f=feedback(g,1,-1)
subplot(1,2,1)
step(f)
subplot(1,2,2)
impulse(f,'g')
```

Q8. A unity feedback system has open loop transfer function $G(s) = \frac{\omega_n^2}{s^2+2\xi\omega_n s}$, where ξ = damping ratio and $\omega_n = natural\ frequency$. Determine the impulse response for $\xi = 0.1$ to 2 . From the plot comment what is the effect of damping ratio on peak amplitude, settling time .

```
clc;
clear all;
close all;
w = 5;
e1 = 0.1;
e2 = 0.4;
e3 = 0.7;
e4 = 1.0;
e5 = 1.3;
e6 = 1.6;
e7 = 1.9;

n = [w*w]
d1 = [1 2*e1*w 0]
g1 = tf(n,d1)
f1 = feedback(g1, 1, -1)
subplot(3,3,1)
impulse(f1,'b')

d2 = [1 2*e2*w 0]
g2 = tf(n,d2)
f2 = feedback(g2, 1, -1)
```

```
subplot(3,3,2)
impulse(f2,'g')

d3 = [1 2*e3*w 0]
g3 = tf(n,d3)
f3 = feedback(g3, 1, -1)
subplot(3,3,3)
impulse(f3,'r')

d4 = [1 2*e4*w 0]
g4 = tf(n,d4)
f4 = feedback(g4, 1, -1)
subplot(3,3,4)
impulse(f4,'c')

d5 = [1 2*e5*w 0]
g5 = tf(n,d5)
f5 = feedback(g5, 1, -1)
subplot(3,3,5)
impulse(f5,'m')

d6 = [1 2*e6*w 0]
g6 = tf(n,d6)
f6 = feedback(g6, 1, -1)
subplot(3,3,6)
impulse(f6,'y')

d7 = [1 2*e7*w 0]
g7 = tf(n,d7)
f7 = feedback(g7, 1, -1)
subplot(3,3,7)
impulse(f7,'k')
```

Q9. A unity feedback system has open loop transfer function $G(s) = \frac{\omega_n^2}{s^2+2\xi\omega_n s}$, where ξ = damping ratio and $\omega_n = natural\ frequency$. Determine the step response for $\xi = 0.1$ to 2. From the plot comment what is the effect of damping ratio on rise time, peak amplitude, settling time.

```
clc;
clear all;
close all;
```

```
w = 5;
e1 = 0.1;
e2 = 0.4;
e3 = 0.7;
e4 = 1.0;
e5 = 1.3;
e6 = 1.6;
e7 = 1.9;

n = [w*w]
d1 = [1 2*e1*w 0]
g1 = tf(n,d1)
f1 = feedback(g1, 1, -1)
subplot(3,3,1)
step(f1,'b')

d2 = [1 2*e2*w 0]
g2 = tf(n,d2)
f2 = feedback(g2, 1, -1)
subplot(3,3,2)
step(f2,'g')

d3 = [1 2*e3*w 0]
g3 = tf(n,d3)
f3 = feedback(g3, 1, -1)
subplot(3,3,3)
step(f3,'r')

d4 = [1 2*e4*w 0]
g4 = tf(n,d4)
f4 = feedback(g4, 1, -1)
subplot(3,3,4)
step(f4,'c')

d5 = [1 2*e5*w 0]
g5 = tf(n,d5)
f5 = feedback(g5, 1, -1)
subplot(3,3,5)
step(f5,'m')

d6 = [1 2*e6*w 0]
g6 = tf(n,d6)
f6 = feedback(g6, 1, -1)
```

```
subplot(3,3,6)
step(f6,'y')

d7 = [1 2*e7*w 0]
g7 = tf(n,d7)
f7 = feedback(g7, 1, -1)
subplot(3,3,7)
step(f7,'k')
```

EXP 4

Q1.Obtain Root Locus Plot of a system having forward path transfer function of $G(s) = \frac{(1+s)}{s(1+0.7s)}$

```
clc;
clear all;
close all;
n = [1 1]
d1 = [1 0]
d2 = [0.7 1]
d = conv(d1, d2)
g = tf(n,d)
rlocus(g)
```

Q2. Obtain Root Locus Plot of a system having forward path transfer function of $G(s) = \frac{1}{s(s+1)(s+4)}$

```
clc;
clear all;
close all;
n = [1]
d1 = [1 0]
d2 = [1 1]
d3 = [1 4]
d4 = conv(d1,d2)
d = conv(d3,d4)
g = tf(n,d)
rlocus(g)
```

Q3. Sketch the root locus plot for the open loop transfer function , $G(s)H(s) = \frac{K(s^2+4)}{s(s+2)}$

Calculate the value of K at (a) breakaway point (b) s= − 0.69 + j0.88

(Hint : click on break away point , click on the point s= − 0.69 + j0.88)

```
clc;
clear all;
close all;
num=[1 0 4]
den=[1 2 0]
g=tf(num,den)
rlocus(num,den)
rlocfind(num,den)
```

Q4. Sketch the root locus plot for the open loop transfer function , $G(s)H(s) = \frac{K(s+2)}{s^2+2s+2}$

```
clc;
clear all;
close all;
n = [1 2]
d = [1 2 2]
g = tf(n,d)
rlocus(g)
rlocfind(n,d)
```

Q5. Sketch the root locus plot for the open loop transfer function,$G(s)H(s) = \frac{K}{s(s^2+2s+2)}$

```
clc;
clear all;
close all;
n = [1]
d1 = [1 0]
d2= [1 2 2]
d= conv(d1,d2)
g = tf(n,d)
rlocus(g)
rlocfind(n,d)
```

Q6. Sketch the root locus plot for the open loop transfer function,

$$G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$$

```
clc;
clear all;
close all;
n = [1]
d1 = [1 0]
d2= [1 6]
d3=[1 4 13]
d4= conv(d1,d2)
d = conv(d3,d4)
g = tf(n,d)
rlocus(g)
rlocfind(n,d)
```

EXP 5

Q1.Obtain Nyquist Plot of a system having forward path transfer function of $(s) = \frac{(3+s)}{(s+2)(s-2)}$. Is the system is stable?

```
clc;
clear all;
close all;
n = [1 3]
d1 = [1 2]
d2 = [1 -2]
d = conv(d1, d2)
g = tf(n,d)
nyquist(g)
```

Q2. Obtain Nyquist Plot of a system having forward path transfer function of $(s) = \frac{1}{s(s+1)(s+4)}$. Is the system is stable?

```
clc;
clear all;
close all;
n = [1]
d1 = [1 0]
d2 = [1 1]
d3 = [1 4]
d4 = conv(d1, d2)
d = conv(d3,d4)
g = tf(n,d)
nyquist(g)
```

Q3. The open loop transfer function of a unity feedback control system is given below:

$G(s) = \frac{(s+0.25)}{s^2(s+0.5)(s+1)}$ **. Obtain Nyquist Plot. Is the closed loop system stable?**

```
clc;
clear all;
close all;
n = [1 0.25]
d1 = [1 0 0]
d2 = [1 0.5]
d3 = [1 1]
d4 = conv(d1, d2)
d = conv(d3,d4)
g = tf(n,d)
nyquist(g)
```

Q4. The open loop transfer function of a unity feedback control system is given below:

$G(s) = \frac{2.2}{s(s+1)(s^2+2s+2)}$ **. Obtain Nyquist Plot. Is the closed loop system stable?**

```
clc;
clear all;
close all;
n = [2.2]
d1 = [1 0]
d2 = [1 1]
d3 = [1 2 2]
```

```
d4 = conv(d1, d2)
d = conv(d3,d4)
g = tf(n,d)
nyquist(g)
```

Q5.Obtain bode Plot of a system having forward path transfer function of $G(s) = \frac{(1+s)}{s(1+0.5s)}$ and comment on the stability .

```
clc;
clear all;
close all;
n = [1 1]
%d1 = [0.5 1]
%d2 = [1 0]
%d = conv(d1,d2)
d = [0.5 1 0]
g = tf(n,d)
bode(g)
margin(g)
```

Q6. Obtain bode Plot of a system having forward path transfer function of $G(s) = \frac{4(1+s)}{s(s+7)(s+10)}$ and comment on stability.

```
clc;
clear all;
close all;
n = [4 4]
d1 = [1 0]
d2 = [1 7]
d3 = [1 10]
d4 = conv(d1,d2)
d = conv(d3, d4)
g = tf(n,d)
bode(g)
```

Q7. Obtain bode Plot of a system having forward path transfer function of $G(s) = \frac{50}{(s+1)(s+2)}$ and comment on the stability.

```
clc;
clear all;
close all;
n = [50]
d1 = [1 1]
d2 = [1 2]
d = conv(d1, d2)
g = tf(n,d)
bode(g)
```

Q8. Obtain bode Plot of a system having forward path transfer function of $G(s) = \frac{48(s+10)}{s(s+20)(s^2+2.4s+16)}$ and comment on the stability.

```
clc;
clear all;
close all;
n = [48 480]
d1 = [1 0]
d2 = [1 20]
d3 = [1 2.4 16]
d4 = conv(d1,d2)
d = conv(d3, d4)
g = tf(n,d)
bode(g)
```

EXP 6

Q1.Consider a unity feedback system with forward path transfer function of $G(s) = \frac{1}{s^2+10s+20}$. Show the effect of addition of a PD controller on the system performance for different K_D values. (Take $K_P = 500$ and $K_D = 10, 5, 0.02$)

```
clc;
clear all;
close all;
num = [1]
den = [1 10 20]
g = tf(num,den)
```

```
t_f = feedback(g,1,-1)
step(t_f,'y')
hold on

kp1 = 10
num1 = [kp1]
den1 = [1 10 20]
g1 = tf(num1,den1)
tf1 = feedback(g1,1,-1)
step(tf1,'m')
hold on

kp = 500
kd1 = 10
num2 = [kd1 kp]
den2 = [1 10 20]
g2 = tf(num2,den2)
tf2 = feedback(g2,1,-1)
step(tf2,'b')
hold on

kd2 = 5
num3 = [kd2 kp]
den3 = [1 10 20]
g3 = tf(num3, den3)
tf3 = feedback(g3,1,-1)
step(tf3,'r')
hold on

kd3 = 0.02
num4 = [kd3 kp]
den4 = [1 10 20]
g4 = tf(num4, den4)
tf4 = feedback(g4,1,-1)
step(tf4,'g')
```

Q2.Consider a unity feedback system with forward path transfer function of $G(s) = \frac{1}{s^2+10s+20}$. Show the effect of addition of a PI controller on the system performance for different K_D values. (Take $K_P = 500$ and $K_I = 1, 100, 500$)

```
clc;
clear all;
close all;
num = [1]
den = [1 10 20]
g = tf(num,den)
t_f = feedback(g,1,-1)
step(t_f,'y')
hold on

kp1 = 10
num1 = [kp1]
den1 = [1 10 20]
g1 = tf(num1,den1)
tf1 = feedback(g1,1,-1)
step(tf1,'m')
hold on

kp = 500
ki1 = 1
num2 = [kp ki1]
d = [1 0] %due to integrator, order and type increased
den2 = conv(d,den)
g2 = tf(num2,den2)
tf2 = feedback(g2,1,-1)
step(tf2,'b')
hold on

ki2 = 100
num3 = [kp ki2]
den3 = conv(d,den)
g3 = tf(num3, den3)
tf3 = feedback(g3,1,-1)
step(tf3,'r')
hold on

ki3 = 500
num4 = [kp ki3]
den4 = conv(d,den)
g4 = tf(num4, den4)
tf4 = feedback(g4,1,-1)
step(tf4,'g')
hold on
```

Q3.Consider a unity feedback system with forward path transfer function of $G(s) = \frac{1}{s^2+10s+20}$. Show the effect of addition of a PD controller on the system performance. (Take $K_D = 10$ and $K_p = 300$)

```
clc;
clear all;
close all;
num = [1]
den = [1 10 20]
g = tf(num,den)
t_f = feedback(g,1,-1)
step(t_f,'y')
hold on

kp1 = 10
num1 = [kp1]
den1 = [1 10 20]
g1 = tf(num1,den1)
tf1 = feedback(g1,1,-1)
step(tf1,'m')
hold on

kp = 300
kd1 = 10
num2 = [kd1 kp]
den2 = [1 10 20]
g2 = tf(num2,den2)
tf2 = feedback(g2,1,-1)
step(tf2,'b')
hold on
```

Q4.Consider a unity feedback system with forward path transfer function of $G(s) = \frac{1}{s^2+10s+20}$. Show the effect of addition of a PI controller on the system performance. (Take $K_I = 70$ and $K_p = 30$)

```
clc;
clear all;
close all;
```

```
num = [1]
den = [1 10 20]
g = tf(num,den)
t_f = feedback(g,1,-1)
step(t_f,'y')
hold on

kp1 = 10
num1 = [kp1]
den1 = [1 10 20]
g1 = tf(num1,den1)
tf1 = feedback(g1,1,-1)
step(tf1,'m')
hold on

kp = 30
ki = 70
num2 = [kp ki]
d = [1 0] %due to integrator, order and type increased
den2 = conv(d,den)
g2 = tf(num2,den2)
tf2 = feedback(g2,1,-1)
step(tf2,'b')
hold on
```

Q5.Consider a unity feedback system with forward path transfer function of $G(s) = \frac{1}{s^2+10s+20}$. Show the effect of addition of a PID controller on the system performance. (Take $K_D = 50$ and $K_p = 350$, $K_I = 300$)

```
clc;
clear all;
close all;
num = [1]
den = [1 10 20]
g = tf(num,den)
t_f = feedback(g,1,-1)
step(t_f,'y')
hold on

kp1 = 10
```

```
num1 = [kp1]
den1 = [1 10 20]
g1 = tf(num1,den1)
tf1 = feedback(g1,1,-1)
step(tf1,'m')
hold on

kd = 50
kp = 350
ki = 300
num2 = [kd kp ki]
d = [1 0]
den2 = conv(d,den)
g2 = tf(num2,den2)
tf2 = feedback(g2,1,-1)
step(tf2,'b')
hold on
```