Nathaniel Goldfarb

Table of Contents

HW2

```
clear all
close all
clc
```

Problem 1a

$m_1 = e^{0t}$

$m_2 = e^{-3t}$

Problem 1a

```
G = tf( [200], [1,3,0])
```

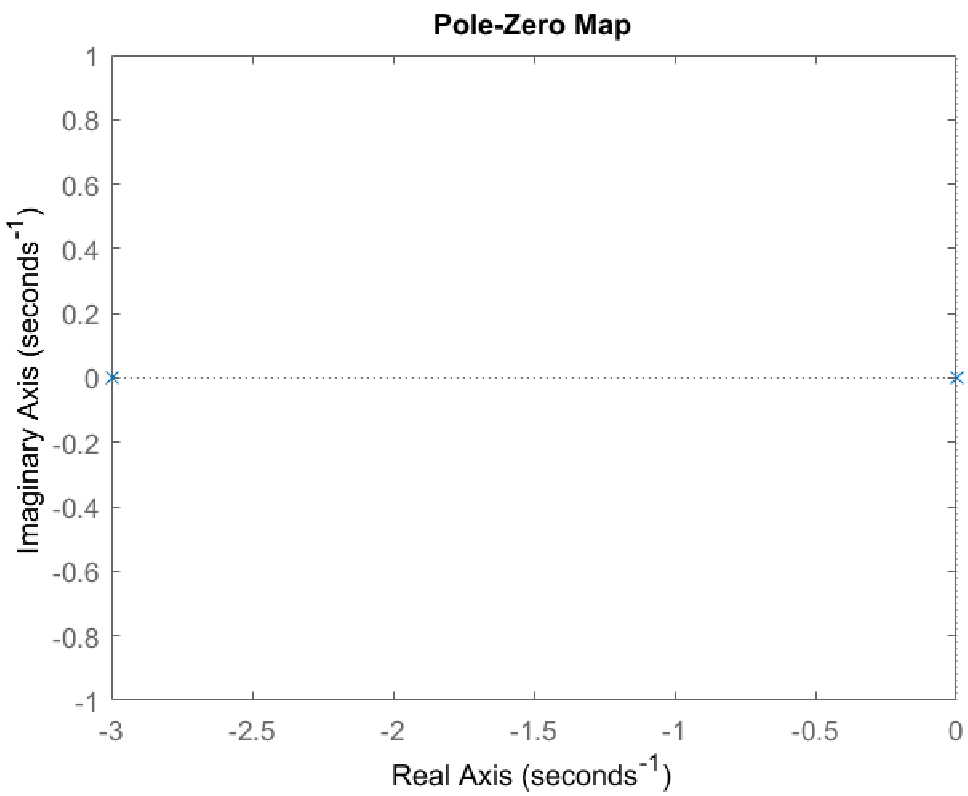
```
G =

     200
  ---------
  s^2 + 3 s

Continuous-time transfer function.
```

```
pole(G)
```

```
ans =

     0
    -3
```

Problem 1b

```
pzmap(G)
```



Since on poles is non-zero, and one is less then zero the system is said to maringal stable

Problem 1c1 and 1c2

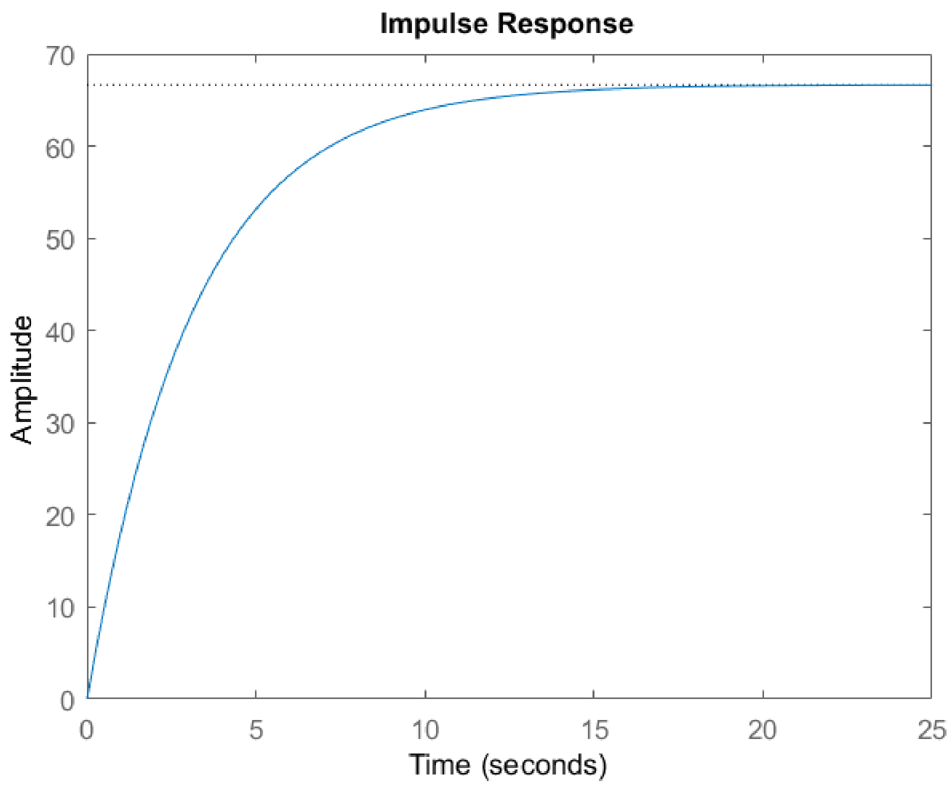
(x+4)^3 = x^3 + 12x^2 + 48x + 64

```
B = [ 64; 48; 12; 1]
A = [0 0 200 0;...
     3 0 0 200;...
     1 3 0 0;...
     0 1 0 0]
x = A\B

C = tf([ x(4) x(3)], [ x(2),x(3)])
```

```
B =

    64
    48
    12
     1


A =

     0     0   200     0
     3     0     0   200
     1     3     0     0
     0     1     0     0


x =

    9.0000
    1.0000
    0.3200
    0.1050


C =

  0.105 s + 0.32
  --------------
     s + 0.32

Continuous-time transfer function.
```

Problem 1c3

```
impulseplot(C*G)
```



Problem 2

Let, $\beta = (Js^2 + Bs)^{-1}$

Let, $\alpha = (K_p + K_i/s)$

Let, $\gamma = 1 + \alpha\beta + K_d\beta s$

$$\theta = \frac{\alpha\beta}{\gamma}\theta^d - \frac{\beta}{\gamma}D$$

Problem 3a

```
Kd = 20;
Kp = 30;
J = 2;
B = 1
omega = 1;
D = 1;
s = tf('s');
```

```
B =
```

```
      1
```

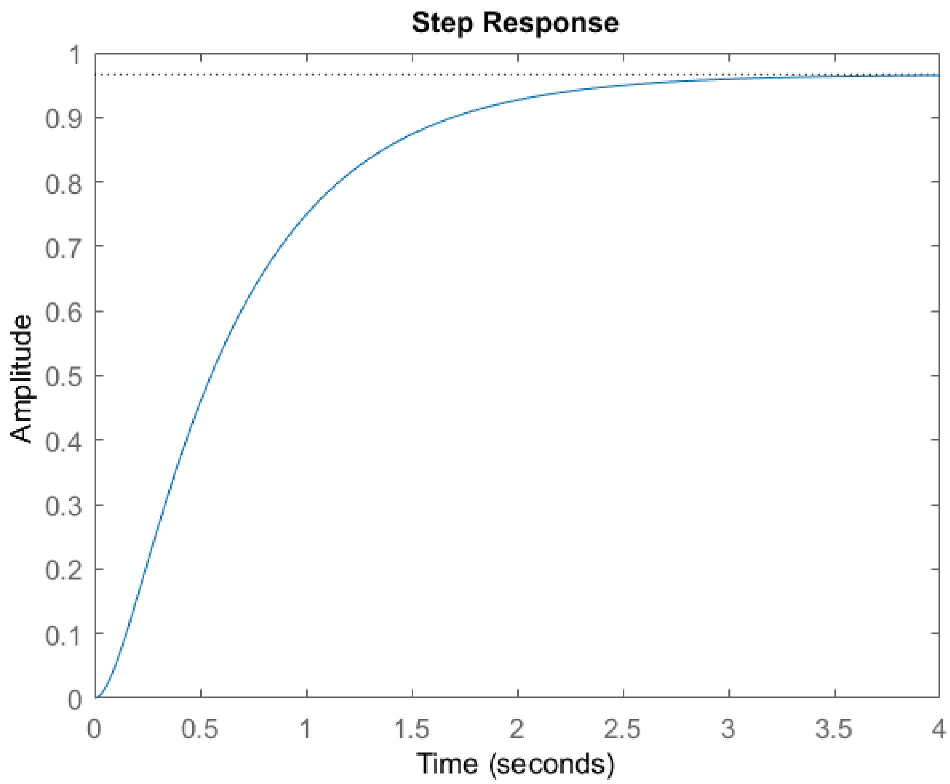
The model and controller are:

```
A  = 1/(J*s^2 + (B+Kd)*s + Kp);

H = A*((Kp*omega) - D)
```

```
H =

          29
  -----------------
  2 s^2 + 21 s + 30

Continuous-time transfer function.
```

The poles of the transfer function are:

```
figure(2)
step(H)
```



Based on the transfer fucntion The damping ratio and natural frequnecy is:

```
wn = sqrt(15)
```

```
zeta = (.5*21)/(2*wn)
a = 1;
b = 2*zeta*wn;
c = wn*wn;


wn =

    3.8730


zeta =

    1.3555


if b*b > 4*a*c
    disp('over Damped')
elseif b*b < 4*a*c
    disp('under damped')
else
    disp('critial damped')
end

over Damped
```

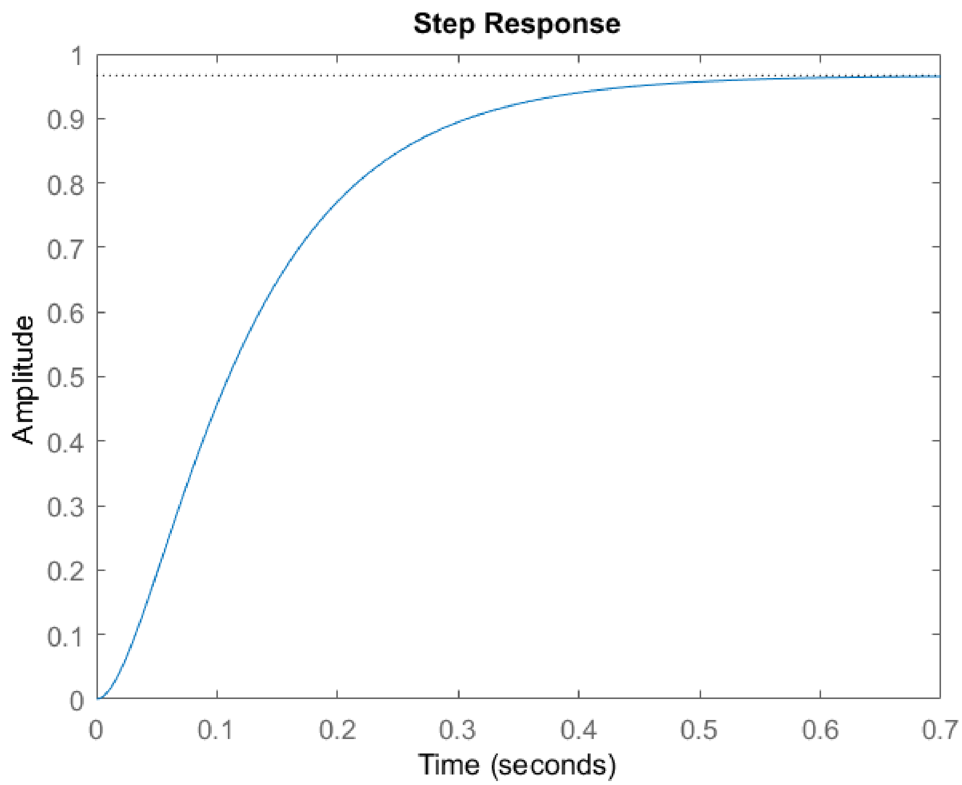
Problem 3b

The values for the PD control are

```
Kd_new = 79;
Kp_new = 600;
A  = 1/(J*s^2 + (B+Kd_new)*s + Kp_new);
H2 = A*((Kp*omega) - D)


H2 =

           29
  ------------------
  2 s^2 + 80 s + 600

Continuous-time transfer function.
```

Proble 3c

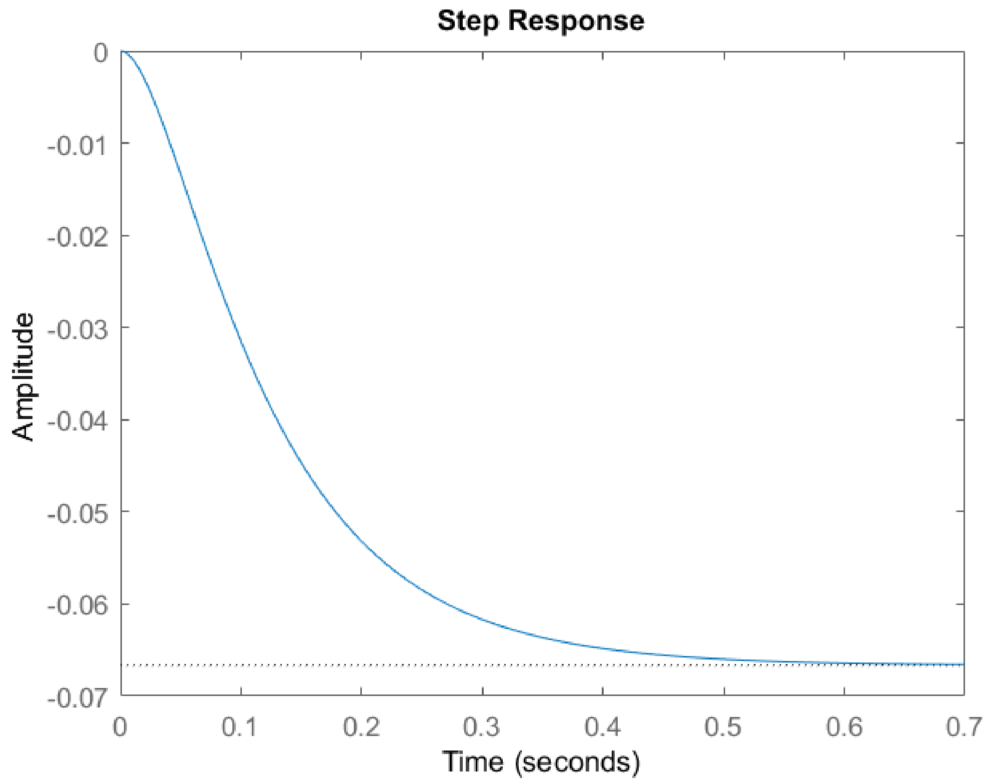
```
step(20*H2)
```



Problem 3d

$$\lim_{x \to \infty} s \frac{40}{s} \frac{-1}{2s^2 + 80s + 600} = -40/600$$

```
A  = 1/(J*s^2 + (B+Kd_new)*s + Kp_new);
D = 40;
omega = 0;
H3 = A*((Kp*omega) - D)
stepplot(H3)


H3 =

         -40
  ------------------
  2 s^2 + 80 s + 600

Continuous-time transfer function.
```



Problem 4a

using the RH the following bounaries are found

$1 + K_d > 0$

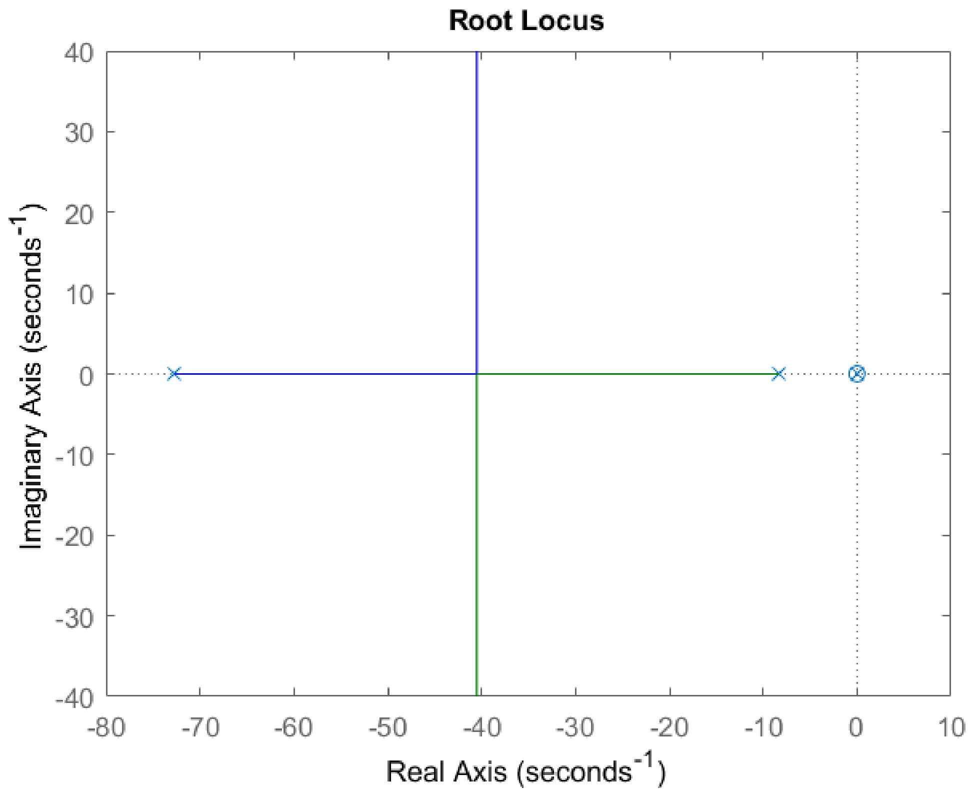
$K_p(1 + K_d) > 2K_I$

$K_I > 0$

Problem 4b

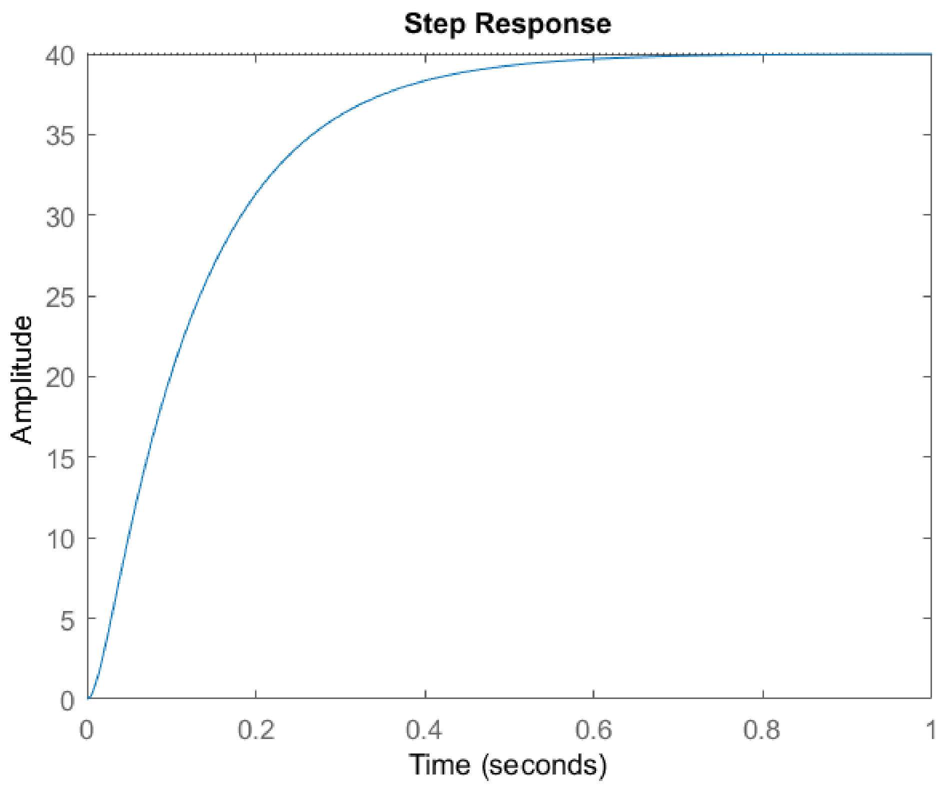
```
Ki_new = 1;
J = 1;
B = 2;
G = tf( [ Kp_new, Ki_new],[J, (B+Kd_new), Kp_new,Ki_new])
figure(3)
rlocus(G)


G =

         600 s + 1
  ------------------------
```

```
  s^3 + 81 s^2 + 600 s + 1

Continuous-time transfer function.
```



Problem 4c

```
figure(4)
step(40*G)
```



Problem 4d

```
Kp4 = 1;
Kd4 = 1;
```

Using the Routh Hurwitz criteria, the following value is set for Kd. These values are then pluged in to the closed loop transfer funciton. This reduces the system to a 2nd order with one zero pole

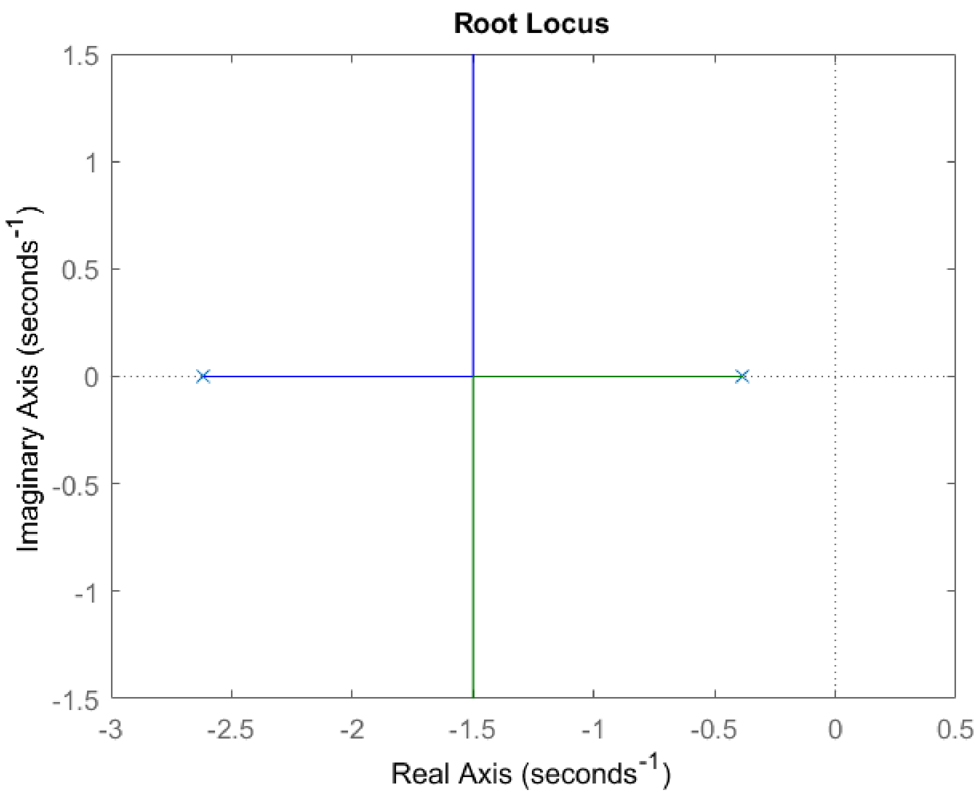
```
Ki4 = 0;

G = tf( [ Kp4, Ki4],[J, (B+Kd4), Kp4,Ki4])
```

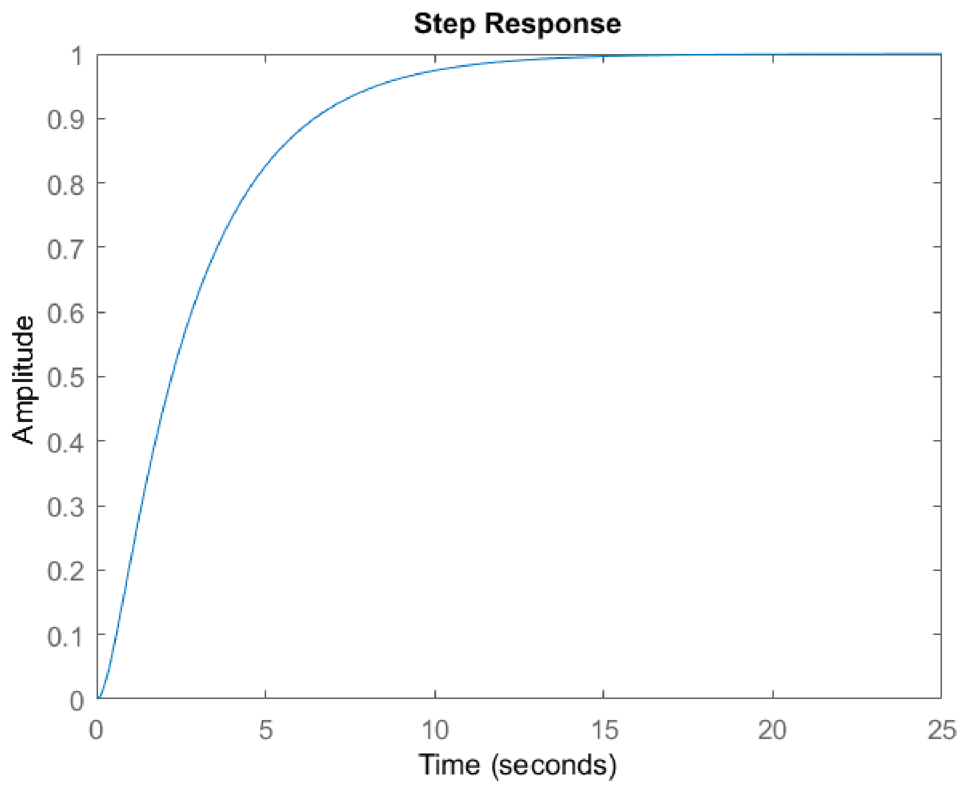
```
G =

        s
  ---------------
  s^3 + 3 s^2 + s

Continuous-time transfer function.
```

Ploting the root locus

```
figure(5)
rlocus(G)
```

```
figure(6)
step(G)
```





Published with MATLAB® R2016b