1(c) First Order Equation

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Plant Description

The Mass-damper first order system is taken as Plant. Equation: f= Bv + M v' f = force; B= coefficient of friction; M = mass ; v= velocity. Values: B1= 0.4, M1=1000; B2= 0.5, M2= 500; B3= 1.7, M3= 340;

Code:

```
%Negative Feedback using gain input
clc;
B1= 0.5;
M1= 5;
P = 2;
sys = tf([P],[M1,B1+1])
figure(1);
subplot(2,2,1);
impulse(sys);
title('Impulse Input for k');
subplot(2,2,2);
step(sys);
title('Step Input for k');
subplot(2,2,3);
[z,p,k]= tf2zp([P],[M1,B1+1])
pzmap(sys)
subplot(2,2,4)
bode(sys)
margin(sys)
[Gm,Pm,Wcg,Wcp] = margin(sys)
hold on;
S = stepinfo(sys)

B2= 0.5;
M2= 5;
P2 = 2;
sys = tf([P2],[M2,B2+1,0])
figure(2)
subplot(2,2,1);
impulse(sys);
title('Impulse Input for Integrator controller');
```

```
subplot(2,2,2);
step(sys);
title('Step Input for Integrator controller ');
subplot(2,2,3);
[z,p,k]= tf2zp([P2],[M2,B2+1,0])
pzmap(sys)
subplot(2,2,4)
bode(sys)
margin(sys)
[Gm,Pm,Wcg,Wcp] = margin(sys)
hold on;
S = stepinfo(sys)

%Positive Feedback using integral input
B3= 0.8;
M3= 5;
sys = tf([1],[M3,B3-1,0])
figure(3);
subplot(2,2,1);
impulse(sys);
title('Step Input for Positive feedback');
subplot(2,2,2);
step(sys);
title('Step Input for Positive feedback');
subplot(2,2,3);
[z,p,k]= tf2zp([1],[M3,B3-1,0])
pzmap(sys)
subplot(2,2,4)
bode(sys)
margin(sys)
[Gm,Pm,Wcg,Wcp] = margin(sys)
hold on;
S = stepinfo(sys)

%Positive Feedback using differentiator input
B4= 0.8;
M4= 5;
sys = tf([1,0],[M4,B4-1])
figure(4)
subplot(2,2,1);
impulse(sys);
title('Step Input for Positive feedback');
subplot(2,2,2);
step(sys);
title('Step Input for Positive feedback');
subplot(2,2,3);
[z,p,k]= tf2zp([1,0],[M4,B4-1])
pzmap(sys)
subplot(2,2,4)
bode(sys)
margin(sys)
[Gm,Pm,Wcg,Wcp] = margin(sys)
hold on;
S = stepinfo(sys)
```

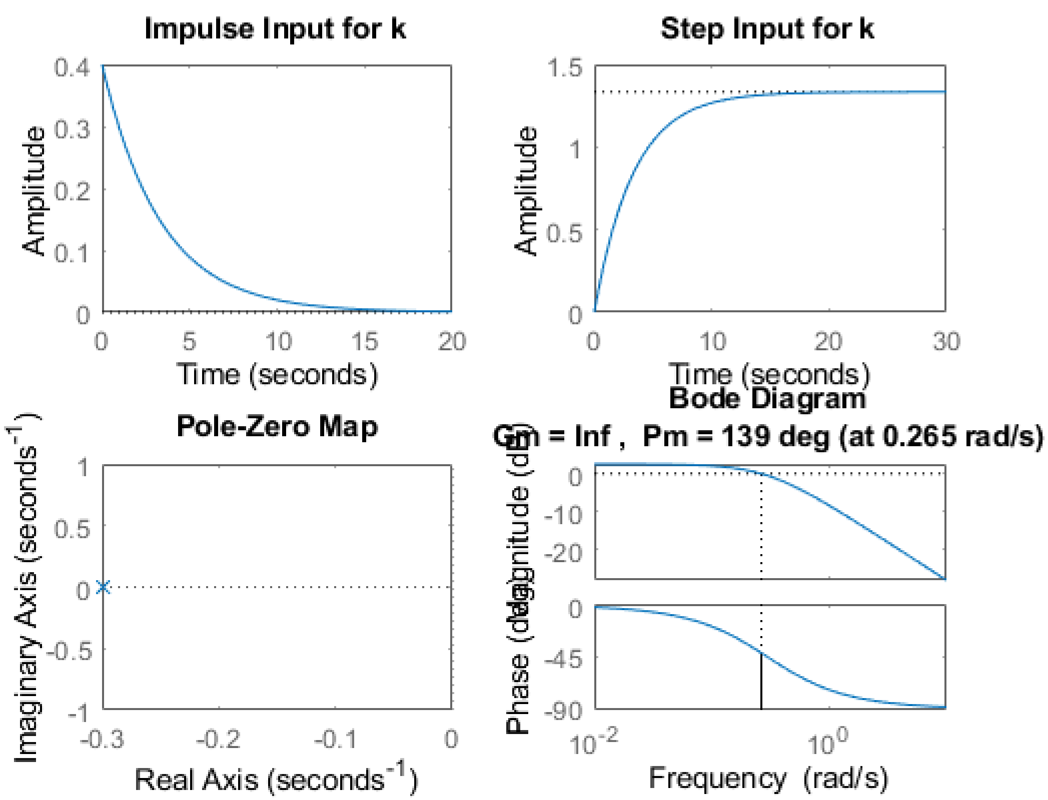
```
sys =

      2
  ---------
  5 s + 1.5

Continuous-time transfer function.


z =

  0×1 empty double column vector


p =

   -0.3000


k =

    0.4000


Gm =

   Inf


Pm =

  138.5925


Wcg =

   NaN


Wcp =

    0.2646


S =

  struct with fields:

        RiseTime: 7.3234
    SettlingTime: 13.0402
     SettlingMin: 1.2060
     SettlingMax: 1.3333
       Overshoot: 0
```

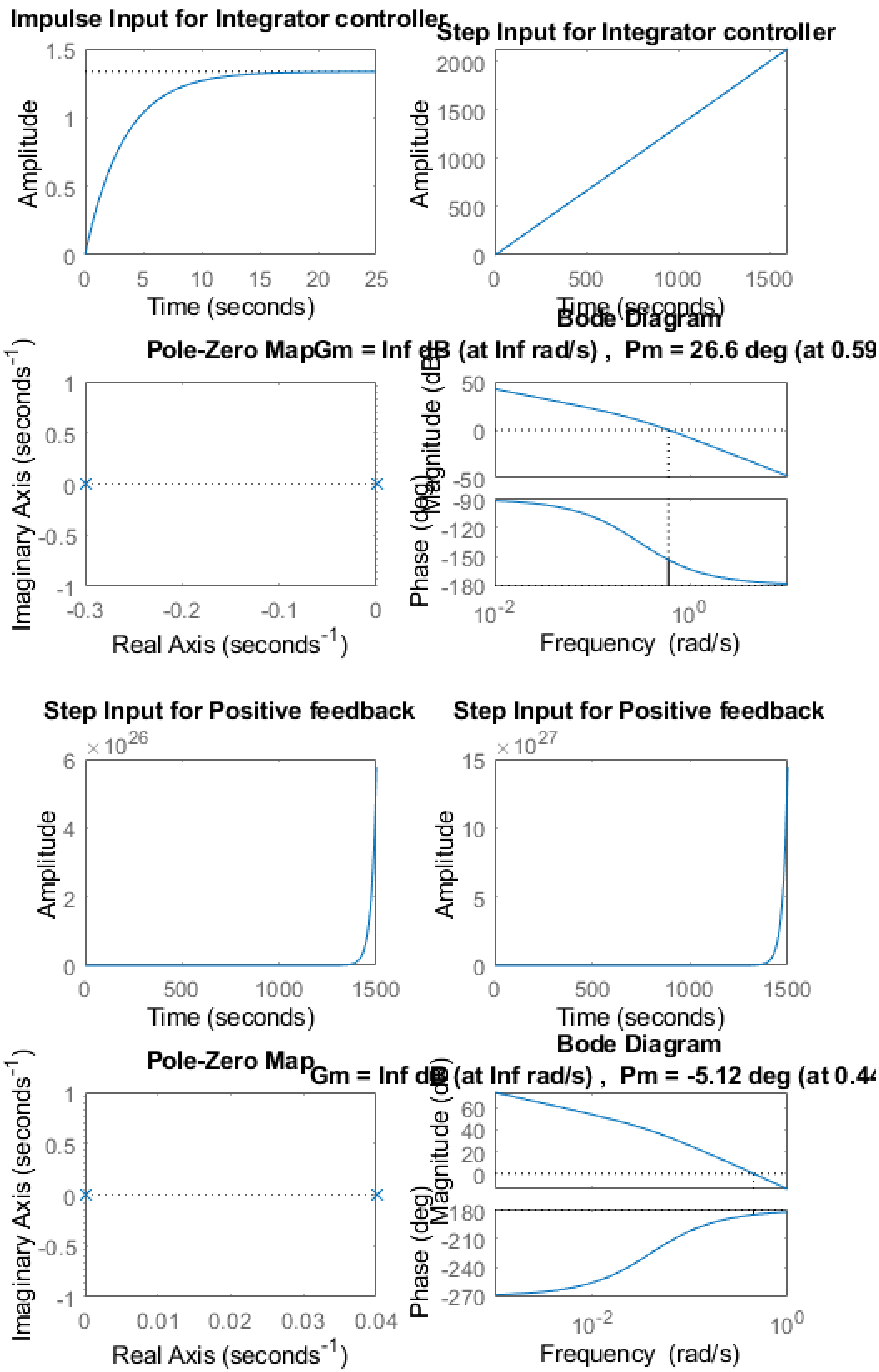
```
      Undershoot: 0
            Peak: 1.3333
        PeakTime: 35.1528


sys =

        2
  -------------
  5 s^2 + 1.5 s

Continuous-time transfer function.


z =

  0×1 empty double column vector


p =

         0
   -0.3000


k =

    0.4000


Gm =

   Inf


Pm =

   26.6470


Wcg =

   Inf


Wcp =

    0.5979


S =

  struct with fields:
```

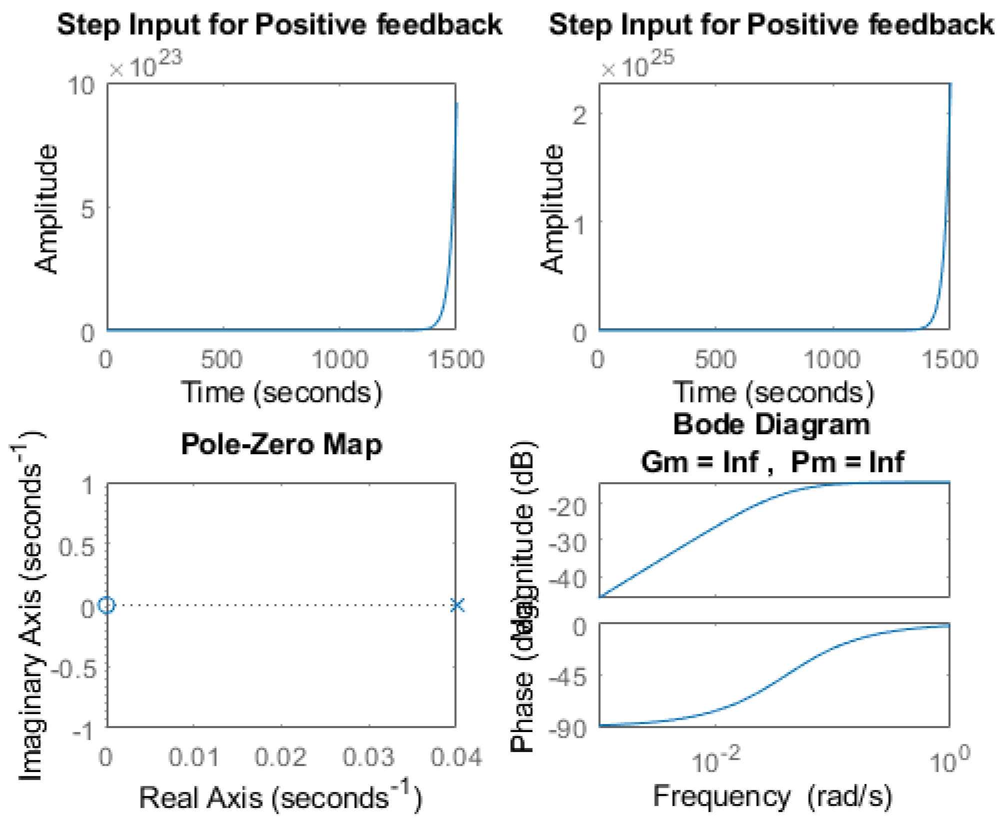
```
        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


sys =

        1
  -------------
  5 s^2 - 0.2 s

Continuous-time transfer function.


z =

  0×1 empty double column vector


p =

         0
    0.0400


k =

    0.2000

Warning: The closed-loop system is unstable.

Gm =

   Inf


Pm =

   -5.1214


Wcg =

   Inf


Wcp =

    0.4463
```

```
S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


sys =

      s
  ---------
  5 s - 0.2

Continuous-time transfer function.


z =

     0


p =

    0.0400


k =

    0.2000

Warning: The closed-loop system is unstable.

Gm =

   Inf


Pm =

   Inf


Wcg =

   NaN
```

```
Wcp =

   NaN


S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf
```




Impulse Input for Integrator controller
Amplitude
Time (seconds)
Step Input for Integrator controller
Amplitude
Time (seconds)
Pole-Zero Map
Imaginary Axis (seconds^-1)
Real Axis (seconds^-1)
Bode Diagram
Gm = Inf dB (at Inf rad/s) , Pm = 26.6 deg (at 0.59
Magnitude (dB)
Phase (deg)
Frequency (rad/s)
Step Input for Positive feedback
× 10^26
Amplitude
Time (seconds)
Step Input for Positive feedback
× 10^27
Amplitude
Time (seconds)
Pole-Zero Map
Imaginary Axis (seconds^-1)
Real Axis (seconds^-1)
Bode Diagram
Gm = Inf dB (at Inf rad/s) , Pm = -5.12 deg (at 0.44
Magnitude (dB)
Phase (deg)
Frequency (rad/s)



Math Analysis

Independent: Time(t) Dependent: Velocity(v) and Force(f) Constant: Mass(M) and Frictional Coefficien-t(B)

```
% Roots:(-B)/M

% IVT:
% 1. For step input: 0
% 2. For impulse input: 1/M

% FVT:
% 1. For step input: 1/B
% 2. For impulse input: 0

% Time Response Results:
% Rise Time :4tau = (4M)/B; where tau = M/B
```

Comparison Analysis:(Speed, Accuracy and stability):

1) When a P controller is introduced in a negative feedback system, the

```
%rise time and settling time decrease making the system more stable
 and
```

```
%more faster.
% 2) The P controller increases the amplitude of the entire system as
 well.
% 3) The gain margin is infinity and phase margin is 139 deg
 indicating
%that the loop never goes below 180 degree. The loop gain tf is a
 stable
%low pass of first order.
% 4) For positive feedback with controllers, the system becomes
 unstable.
```

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