1(a) 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;

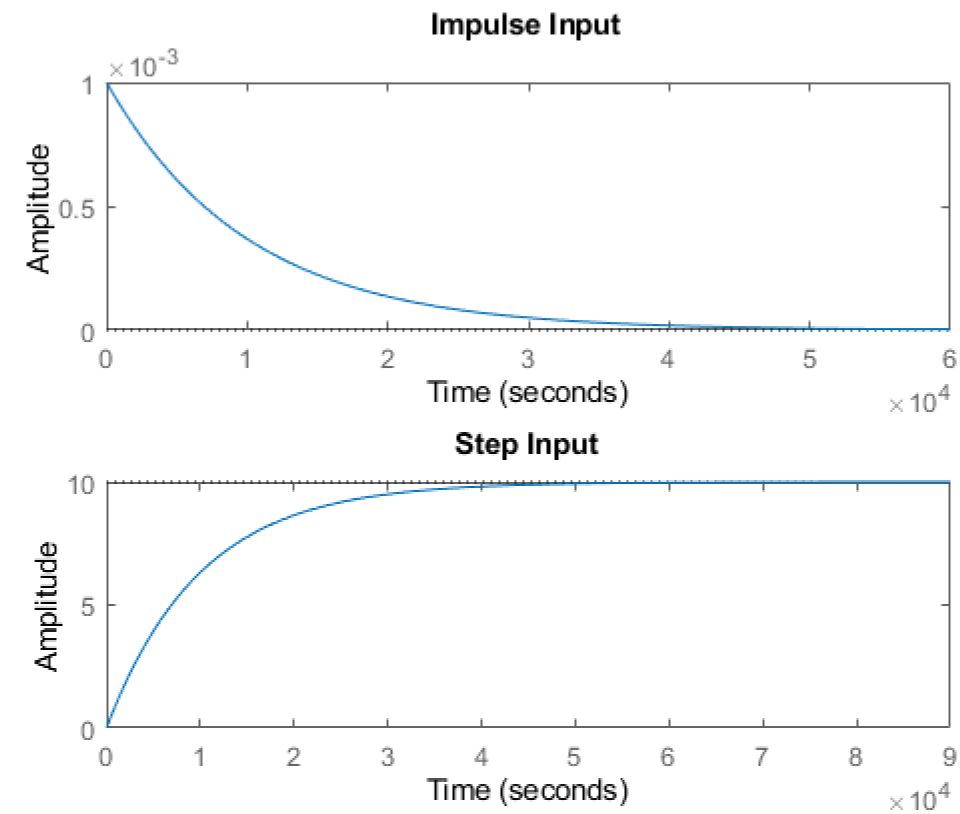
Code:

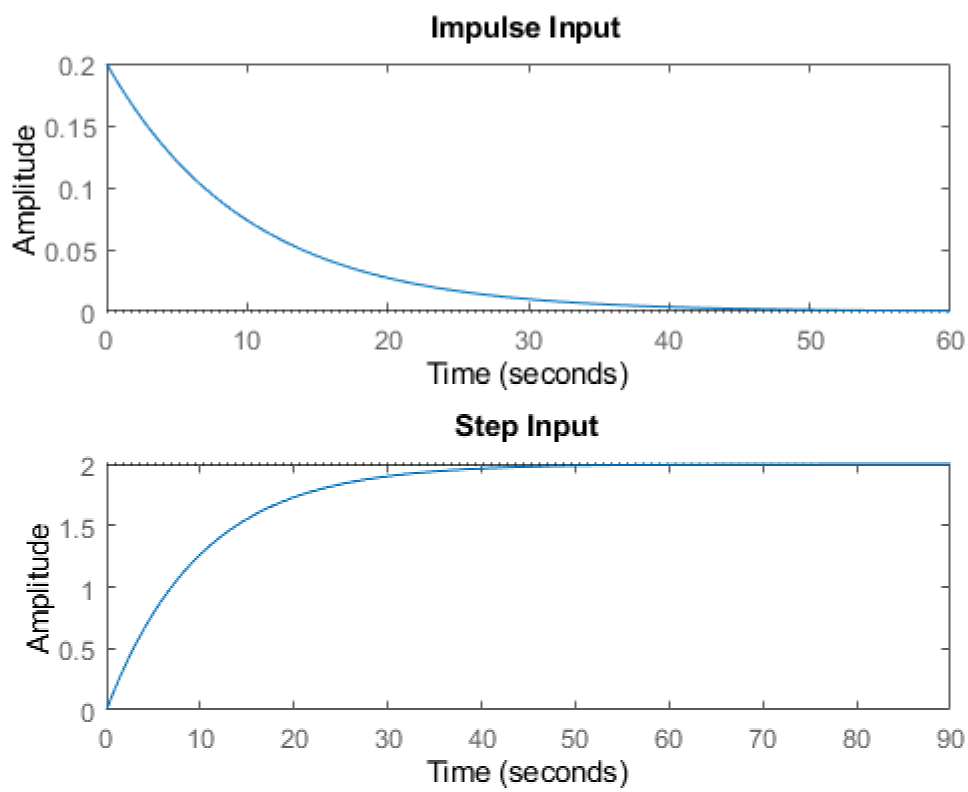
```
clc;
B1= ([0.1 0.5 1.7]);
M1=([1000 5 340]);
for i=1:3
    sys = tf([1/M1(i)],[1,B1(i)/M1(i)])
    figure(i);
    subplot(2,1,1);
    impulse(sys);
    title('Impulse Input');
    subplot(2,1,2);
    step(sys);
    title('Step Input');
    [z,p,k]= tf2zp([1/M1(i)],[1,B1(i)/M1(i)])
    figure(4);
    zplane(z,p);
    xlim([-4*1e5 2*1e5]);
    ylim([-4*1e5 2*1e5]);
    hold on;
    S = stepinfo(sys)
end
```

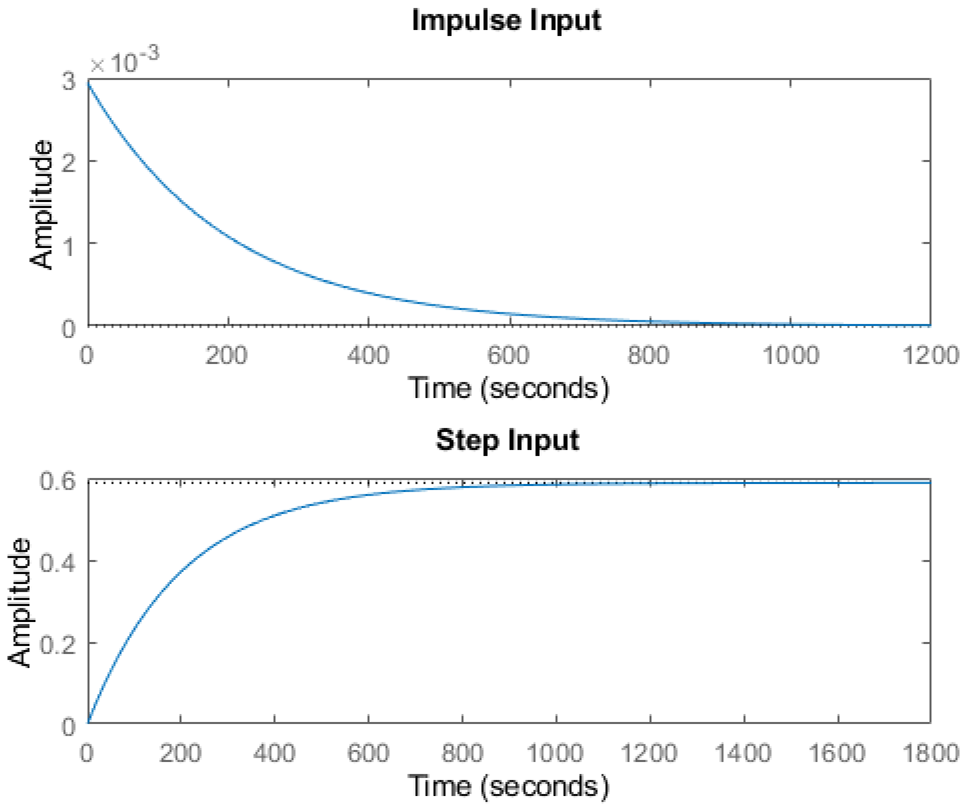
```
sys =

    0.001
  ----------
  s + 0.0001

Continuous-time transfer function.


z =
```

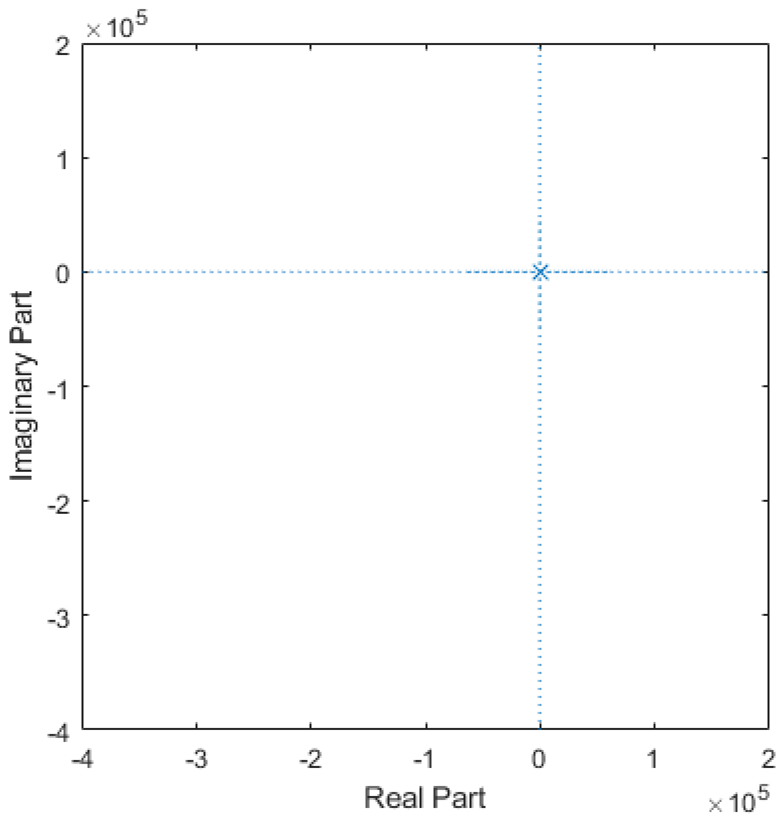
```
  0×1 empty double column vector


p =

  -1.0000e-04


k =

   1.0000e-03


S =

  struct with fields:

        RiseTime: 2.1970e+04
    SettlingTime: 3.9121e+04
     SettlingMin: 9.0450
     SettlingMax: 9.9997
       Overshoot: 0
      Undershoot: 0
            Peak: 9.9997
        PeakTime: 1.0546e+05


sys =

    0.2
  -------
  s + 0.1

Continuous-time transfer function.


z =

  0×1 empty double column vector


p =

   -0.1000


k =

    0.2000


S =

  struct with fields:
```

```
        RiseTime: 21.9701
    SettlingTime: 39.1207
     SettlingMin: 1.8090
     SettlingMax: 1.9999
       Overshoot: 0
      Undershoot: 0
            Peak: 1.9999
        PeakTime: 105.4584


sys =

  0.002941
  ---------
  s + 0.005

Continuous-time transfer function.


z =

  0×1 empty double column vector


p =

   -0.0050


k =

    0.0029


S =

  struct with fields:

        RiseTime: 439.4013
    SettlingTime: 782.4149
     SettlingMin: 0.5321
     SettlingMax: 0.5882
       Overshoot: 0
      Undershoot: 0
            Peak: 0.5882
        PeakTime: 2.1092e+03
```


Impulse Input
× 10^-3
1
0.5
0
Amplitude
0
1
2
3
4
5
6
Time (seconds)
× 10^4
Step Input
10
5
0
Amplitude
0
1
2
3
4
5
6
7
8
9
Time (seconds)
× 10^4


Impulse Input
0.2
0.15
0.1
0.05
0
Amplitude
0
10
20
30
40
50
60
Time (seconds)
Step Input
2
1.5
1
0.5
0
Amplitude
0
10
20
30
40
50
60
70
80
90
Time (seconds)


Impulse Input
×10^-3
Amplitude
3
2
1
0
0
200
400
600
800
1000
1200
Time (seconds)
Step Input
Amplitude
0.6
0.4
0.2
0
0
200
400
600
800
1000
1200
1400
1600
1800
Time (seconds)


×10^5
2
1
0
-1
-2
-3
-4
Imaginary Part
-4
-3
-2
-1
0
1
2
Real Part
×10^5

Math Analysis

Independent: Time(t) Dependent: Velocity(v) and Force(f) Constant: Mass(M) and Frictional Coefficient(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) s=0.001/(0.0001s+1)- a stable system as the poles are in the 2nd

```
%and 3rd quadrant.
% 2) There is no overshoot since it’s a first order system.
% 3) The rise time of 2nd system is least and hence it is the fastest
%system.
% 4) The settling time of 2nd system is least and hence making it more
%accurate than the rest of them.
% 5) The poles are moving farther away, the more the system becomes
 stable,
%as we can see in 2nd system.
```

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