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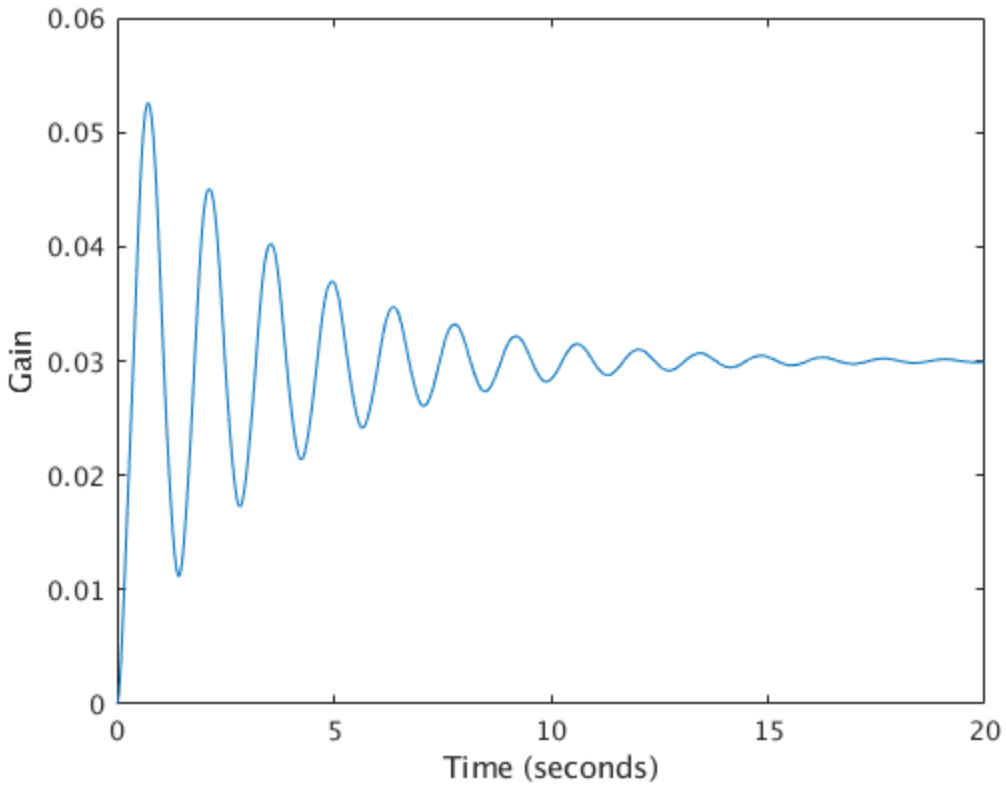
Control Systems HW6 Problem 1

```
K1 = 100;   M1 = 1;   B1 = 2;

A1 =   [0,  0,  0,  1,  0,  0;...
        0,  0,  0,  0,  1,  0;...
        0,  0,  0,  0,  0,  1;...
        -2*K1/M1,   K1/M1,  0,  -2*B1/M1,   0,  B1/M1;...
        K1/M1,  -2*K1/M1,   K1/M1,  0,  0,  0;...
        0,  K1/M1,  -K1/M1, B1/M1, 0,  -B1/M1;];
B1 =   [0;  0;  0;  0;  0;  1/M1];
C1 =   [0,  0,  1,  0,  0,  0];
D1 =   [0];

G1 = ss(A1,B1,C1,D1);
tf(G1)
zpk(G1)

t1 = 0:0.01:20;
y1 = step(G1,t1);
plot(t1, y1);
xlabel('Time (seconds)');
ylabel('Gain');
```

```
ans =

             s^4 + 4 s^3 + 400 s^2 + 800 s + 30000
  ---------------------------------------------------------
  s^6 + 6 s^5 + 504 s^4 + 2000 s^3 + 60800 s^2 + 6e04 s + 1e06

Continuous-time transfer function.


ans =

             (s^2 + 2.042s + 102.1) (s^2 + 1.958s + 293.9)
  -------------------------------------------------------------------
  (s^2 + 0.5498s + 19.86) (s^2 + 4.714s + 157) (s^2 + 0.7358s + 320.7)

Continuous-time zero/pole/gain model.
```



Control Systems HW6 Problem 2

```
K2 = 100;   M2 = 1;   B2 = 2;

A2 =   [0,  0,  0,  0,  1,  0,  0,  0;  ...
        0,  0,  0,  0,  0,  1,  0,  0;  ...
        0,  0,  0,  0,  0,  0,  1,  0;  ...
        0,  0,  0,  0,  0,  0,  0,  1;  ...
        -2*K2/M2,   K2/M2,  0,  0,  -2*B2/M2, B2/M2,    0,  0;  ...
        K2/M2,  -2*K2/M2,   K2/M2,  0,  B2/M2, -2*B2/M2,    B2/M2,  0;
  ...
        0,  K2/M2,  -2*K2/M2,   K2/M2,  0,  B2/M2,  -2*B2/M2,   B2/M2;
  ...
        0,  0,  K2/M2,  -K2/M2, 0,  0,  -B2/M2, B2/M2]
B2 =   [0;  0;  0;  0;  0;  0;  0;  1/M2];
C2 =   [0, 0, 0, 1, 0, 0, 0, 0];
D2 =   [0];
G2 = ss(A2,B2,C2,D2);
tf(G2)
zpk(G2)

t2 = 0:0.01:100;
y2 = step(G2,t2);
figure;
plot(t2, abs(y2));
```

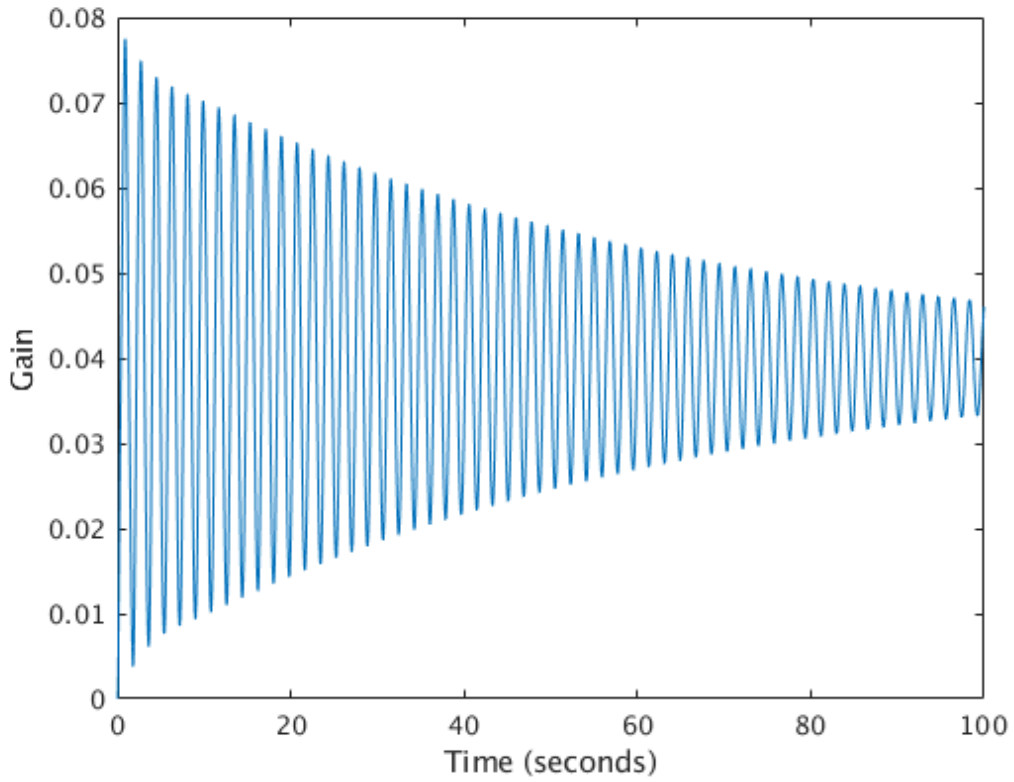
```
xlabel('Time (seconds)');
ylabel('Gain');
```

```
A2 =

     0     0     0     0     1     0     0     0
     0     0     0     0     0     1     0     0
     0     0     0     0     0     0     1     0
     0     0     0     0     0     0     0     1
  -200   100     0     0    -4     2     0     0
   100  -200   100     0     2    -4     2     0
     0   100  -200   100     0     2    -4     2
     0     0   100  -100     0     0    -2     2
```

```
ans =

     s^6 + 12 s^5 + 640 s^4 + 4032 s^3 + 1.048e05 s^2 + 2.4e05 s +
 4e06

 ---------------------------------------------------------------------------

  s^8 + 10 s^7 + 720 s^6 + 3984 s^5 + 1.524e05 s^4 + 3.584e05 s^3

                                                    + 1e07 s^2 + 4e06 s +
 1e08

Continuous-time transfer function.
```

```
ans =

       (s^2 + 1.172s + 58.58) (s^2 + 4s + 200) (s^2 + 6.828s + 341.4)

 ---------------------------------------------------------------------------

  (s^2 + 0.03365s + 12.12) (s^2 + 0.641s + 101.8) (s^2 + 2.915s +
 232.2)
```

```
                                                    (s^2 + 6.41s +
 348.8)

Continuous-time zero/pole/gain model.
```



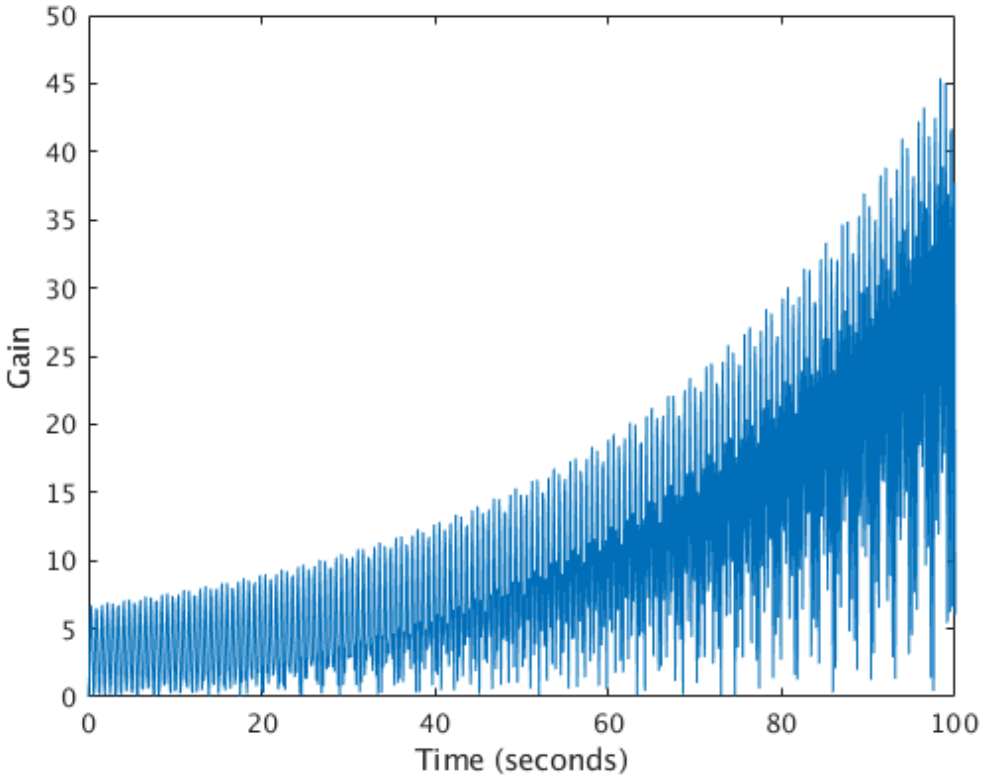
Control Systems HW6 Problem 3

```
K3 = 5; J3 = 2;

A3 =   [0,  0,  0,  1,  0,  0;  ...
        0,  0,  0,  0,  1,  0;  ...
        0,  0,  0,  0,  0,  1;  ...
       -5^4*K3/(J3*5^4),   5^4*K3/(J3*5^4),    0,  0,  0,  0;  ...
        (5^4*K3) /(J3*5^2),  -(K3*5^4 + 5^2*K3)/(J3*5^2),    K3*5^2/
(J3*5^2),    0,  0,  0;  ...
        0,  5^2*K3/(J3),    -(5^2*K3 + K3)/(J3),    0,  0,  0];
B3 =   [0;  0;  0;  1/(5^4*J3);  0;  0];
C3 =   [0, 0, 1, 0, 0, 0];
D3 =   [0];
G3 = ss(A3,B3,C3,D3);
tf(G3)
zpk(G3)
```

```
ans =

                                    3.125

 ------------------------------------------------------------------------

  s^6 + 5.128e-17 s^5 + 132.5 s^4 + 9.55e-15 s^3 + 4238 s^2 +
 3.659e-13 s

                                                                        +
 15.62


Continuous-time transfer function.


ans =

                      3.125
  ---------------------------------------------
  (s^2 + 0.003688) (s^2 + 53.93) (s^2 + 78.57)

Continuous-time zero/pole/gain model.
```

Control Systems HW6 Problem 4

```
G4 = tf([132666],[1 393.646 79.8463 39401.9])

t4 = 0:0.1:100;
y4 = step(G4,t4);
figure;
plot(t4, abs(y4));
xlabel('Time (seconds)');
ylabel('Gain');


G4 =

                132666
  ----------------------------------
  s^3 + 393.6 s^2 + 79.85 s + 3.94e04

Continuous-time transfer function.
```



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