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Problem Set 5

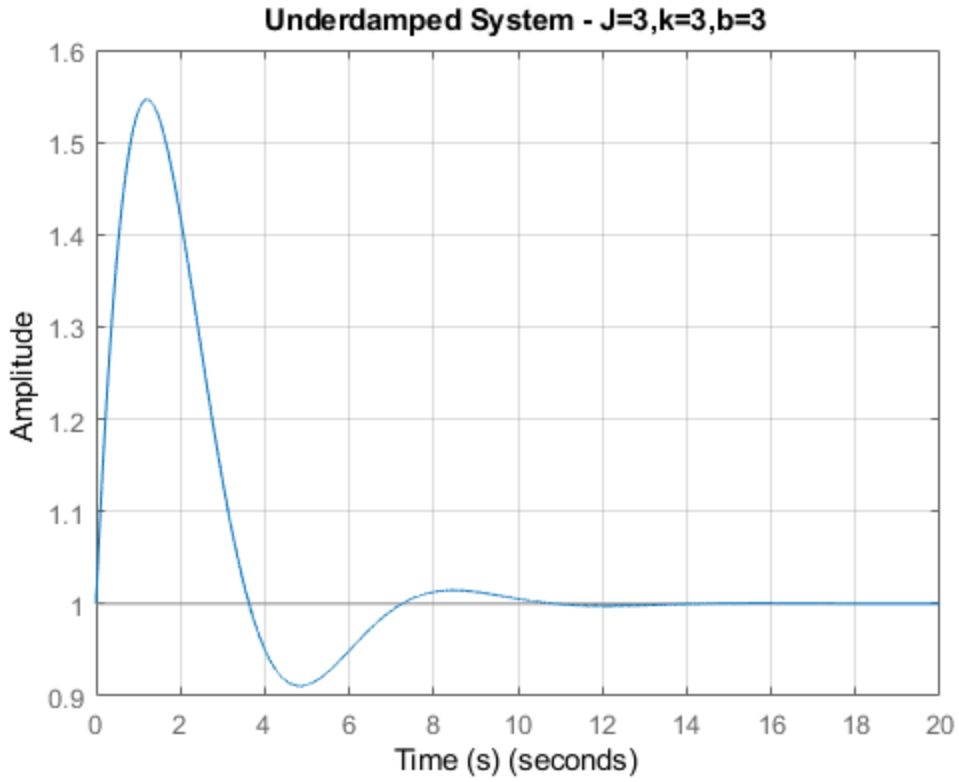
```
clear all
close all
```

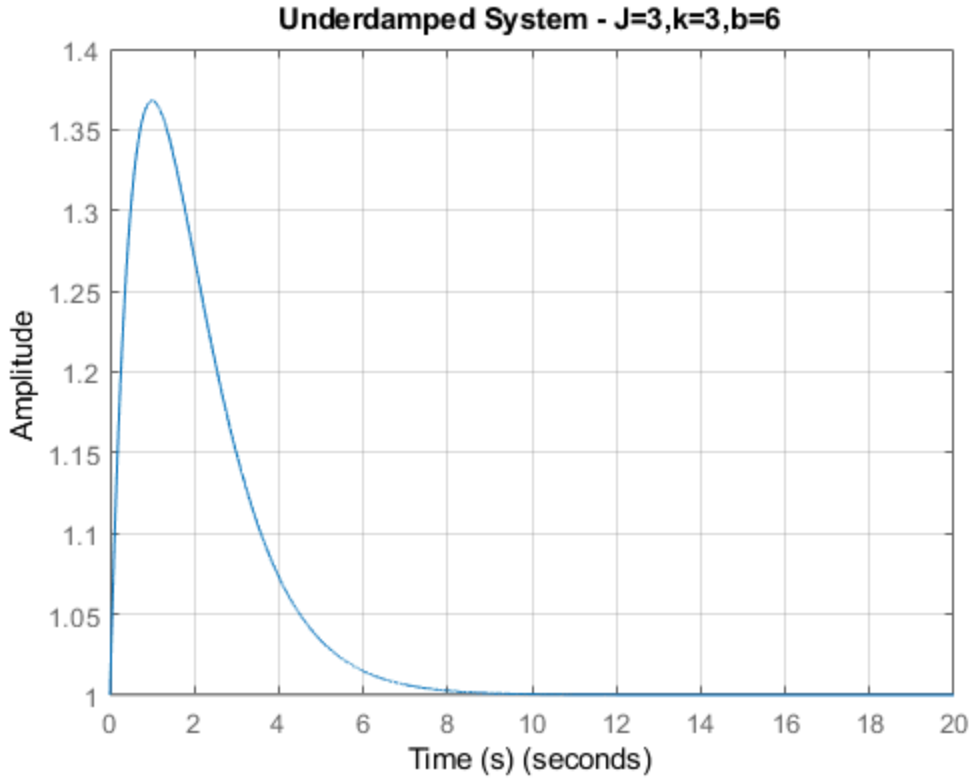
Problem 1 MATLAB

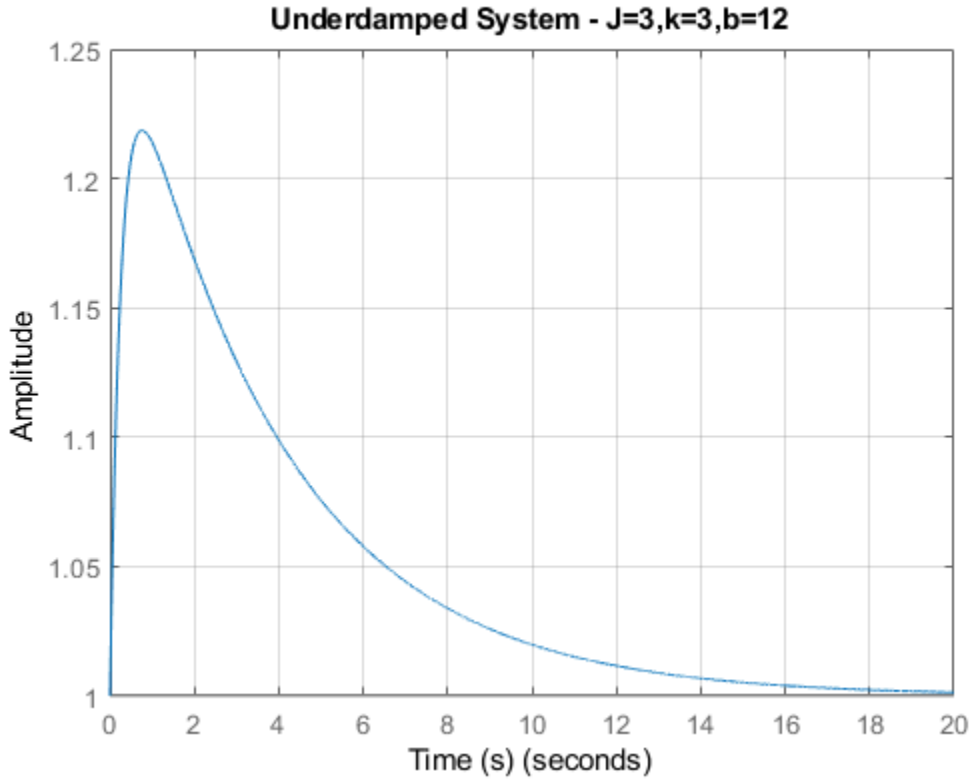
System Constants

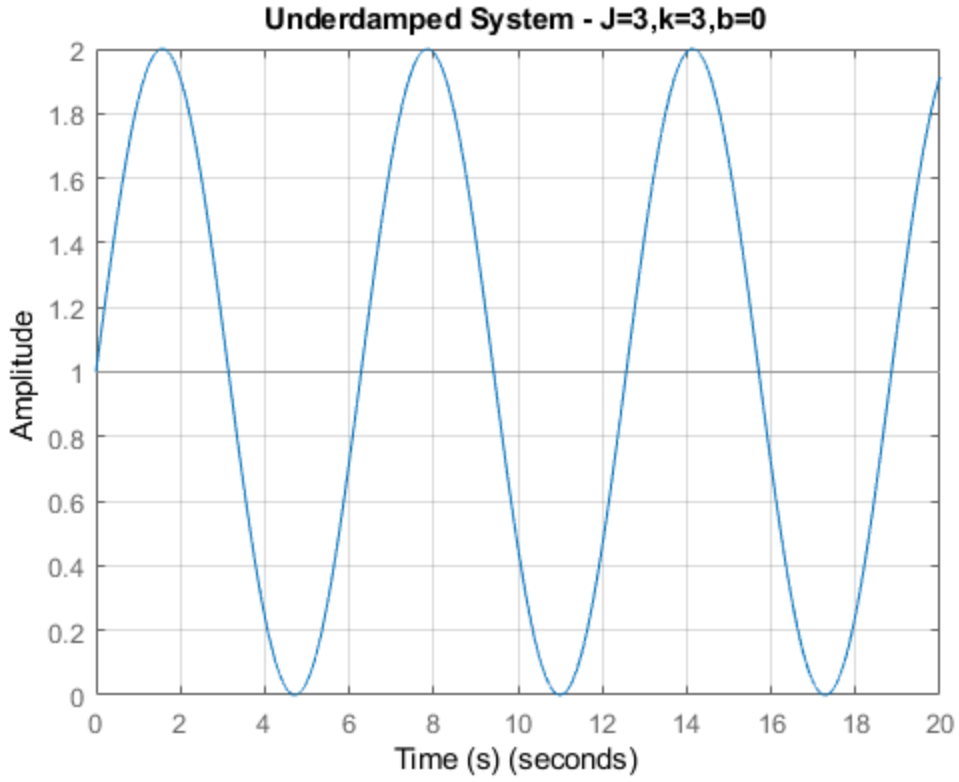
```
k = 3;
J = 3;
B = [3,6,12,0]; % Under, critically,over,undamped
K = 1;

% Calcs
Omega_n = sqrt(k/J);
Zeta = B./(2*sqrt(k*J));

Numer = K;
Denom = [1./Omega_n^2,2.*Zeta(1)/Omega_n,1;...
    1./Omega_n^2,2.*Zeta(2)/Omega_n,1;...
    1./Omega_n^2,2.*Zeta(3)/Omega_n,1;...
    1./Omega_n^2,2.*Zeta(4)/Omega_n,1];

TF1 = tf(Numer,Denom(1,:));
SS1 = ss(TF1);
TF2 = tf(Numer,Denom(2,:));
SS2 = ss(TF2);
TF3 = tf(Numer,Denom(3,:));
SS3 = ss(TF3);
TF4 = tf(Numer,Denom(4,:));
SS4 = ss(TF4);

% Vectors
t = 0:.001:20;
u = ones(1,length(t));


figure(1)
lsim(SS1,u,t,[1 1])
grid
title('Underdamped System - J=3,k=3,b=3')
ylabel('Amplitude')
```

```
xlabel('Time (s)')

figure(2)
lsim(SS2,u,t,[1 1])
grid
title('Underdamped System - J=3,k=3,b=6')
ylabel('Amplitude')
xlabel('Time (s)')

figure(3)
lsim(SS3,u,t,[1 1])
grid
title('Underdamped System - J=3,k=3,b=12')
ylabel('Amplitude')
xlabel('Time (s)')

figure(4)
lsim(SS4,u,t,[1 1])
grid
title('Underdamped System - J=3,k=3,b=0')
ylabel('Amplitude')
xlabel('Time (s)')
```




Underdamped System - J=3,k=3,b=6
Amplitude
Time (s) (seconds)
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0
2
4
6
8
10
12
14
16
18
20

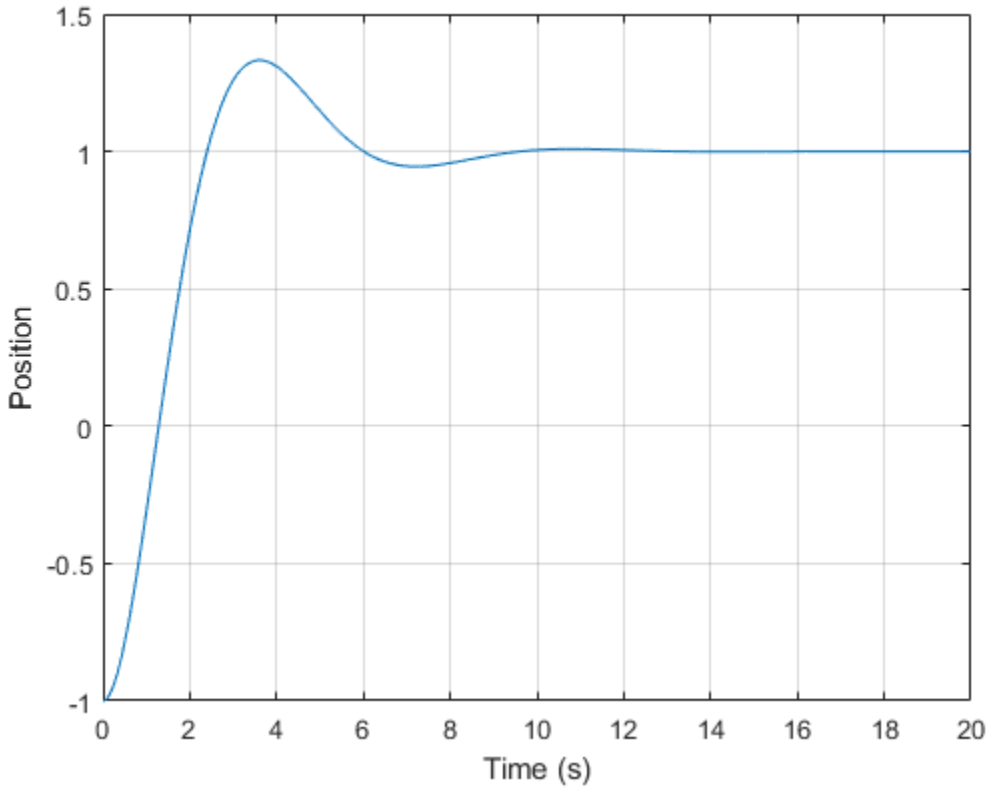

Underdamped System - J=3,k=3,b=12
Amplitude
Time (s) (seconds)
1.25
1.2
1.15
1.1
1.05
1
0
2
4
6
8
10
12
14
16
18
20



Problem 3

```
clear all

% Constants
J = 3;
K = 3;
B = 3;

% Time stuff
t_i = 0;
t_f = 20;
dt = 0.01;
step = t_f/dt;


% State space vars
A = [0,1;-K/J,-B/J];
B = [0;K/J];
C = [1,0;0,1];
D = [0;0];
x_0 = [-1;0];
u = 1;
x_dot = A*x_0 + B*u;
```

```
for t = 1:step
    x_0 = x_dot*dt + x_0;
    x_dot = A*x_0 + B*u;
    y(t) = x_0(1);
end

time = linspace(0,step*dt,step);

figure(5)
plot(time,y)
grid on
xlabel('Time (s)')
ylabel('Position')
```



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