Contents


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% MAE 231 - HW6.1
% 02/25/15

clear all
close all
clc
```

Problem 1:

In order to understand the effect of damping in design, develop some sense of how the response changes with the damping ratio by plotting the response of a single-degree-of-freedom system for a fixed amplitude, frequency, and phase, as ζ changes through a set of values between -1 and 1. Choose a set of 11 values in that range, and plot the response of a system with general solution: $x(t) = e^{-7\zeta t} sin(7t\sqrt{1-\zeta^2})$ for each value of zeta. This can be done on the same figure, as long as the distinctive behavior of each response is distinguishable. If not, use a few figures.

Find: Find 11 responses for $-1 \leq \zeta \leq 1$

Calculations

```
x = @(time, zeta) exp(-7 .* zeta .* time) .* sin(7 .* time...
                  .* sqrt(1 - zeta .^ 2));

time      = linspace(0, 5, 100);
zeta      = linspace(-1, 1, 11);
indexZeta = find(zeta > 0);
strZeta   = {'\zeta = 0.2', '\zeta = 0.4', '\zeta = 0.6', '\zeta = 0.8',...
             '\zeta = 1'};

for n = [1 : length(zeta)]

    if zeta(n) <= 0
        figure(n)
        hold on
        title(strcat('Response of $$ x(t) = e^{-7\zeta t} sin(7t\sqrt{1 - \zeta^2}), \ \zeta = $$',
...
                        num2str(zeta(n))), 'Interpreter', 'latex')

    else
        figure(100)
        hold on
        title('Response of $$ x(t) = e^{-7\zeta t} sin(7t\sqrt{1 - \zeta^2}), \ \zeta > 0 $$',...
              'Interpreter', 'latex')

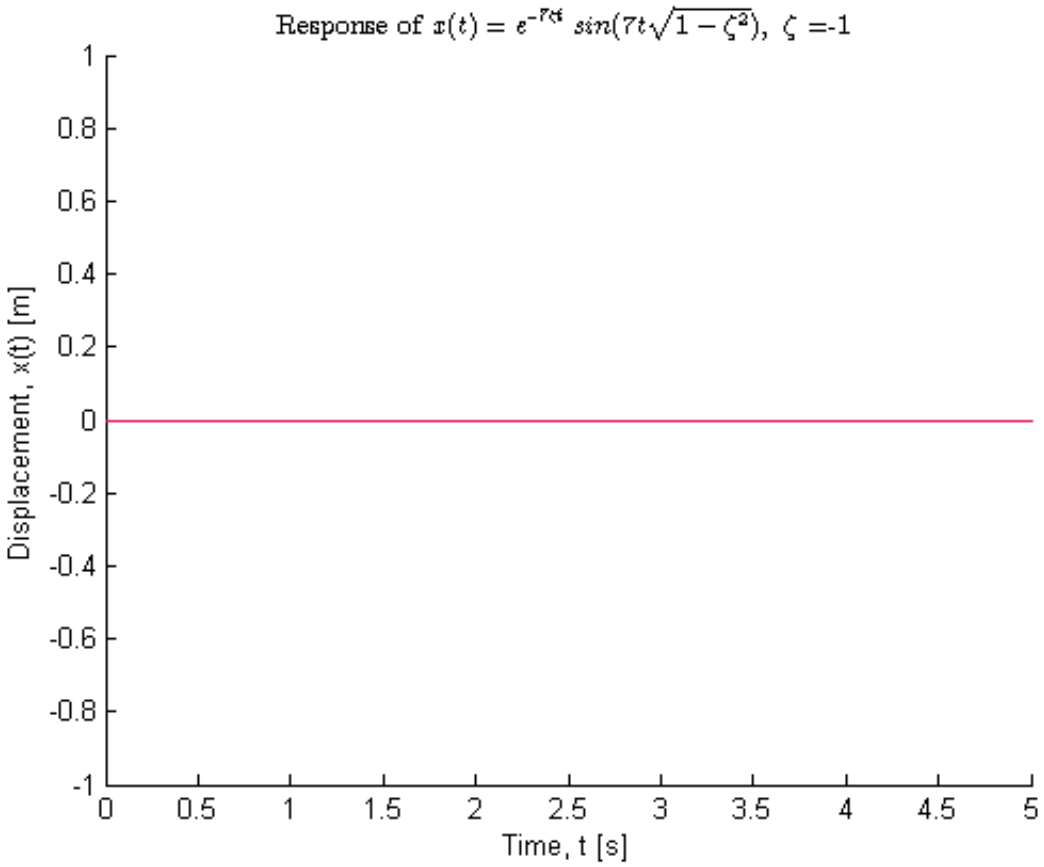
    end

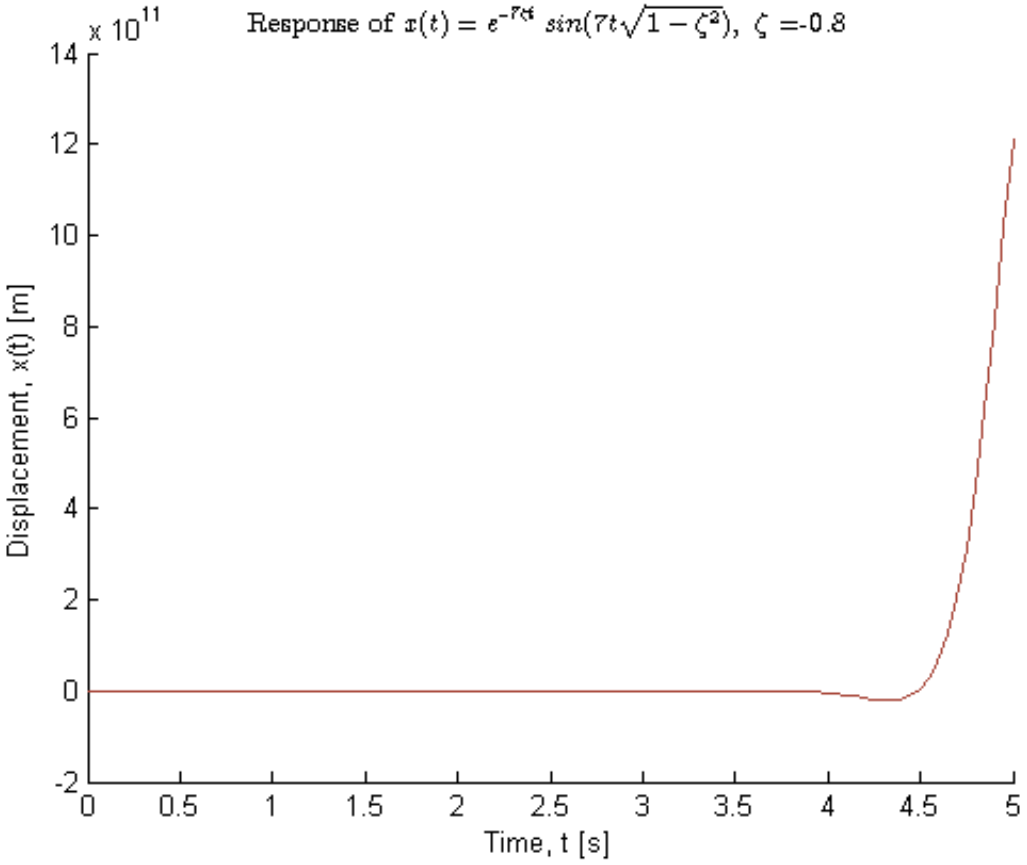
    plot(time, x(time, zeta(n)), 'color', rand(1, 3))
```

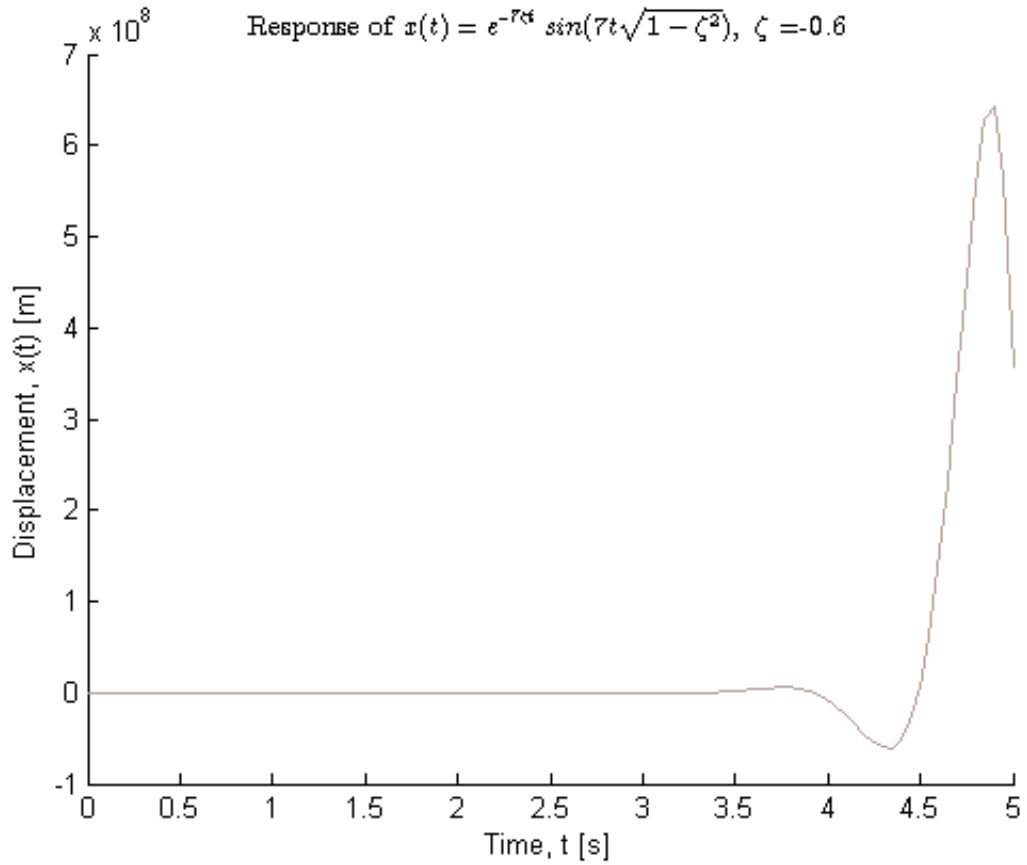
```
    xlabel('Time, t [s]')
    ylabel('Displacement, x(t) [m]')

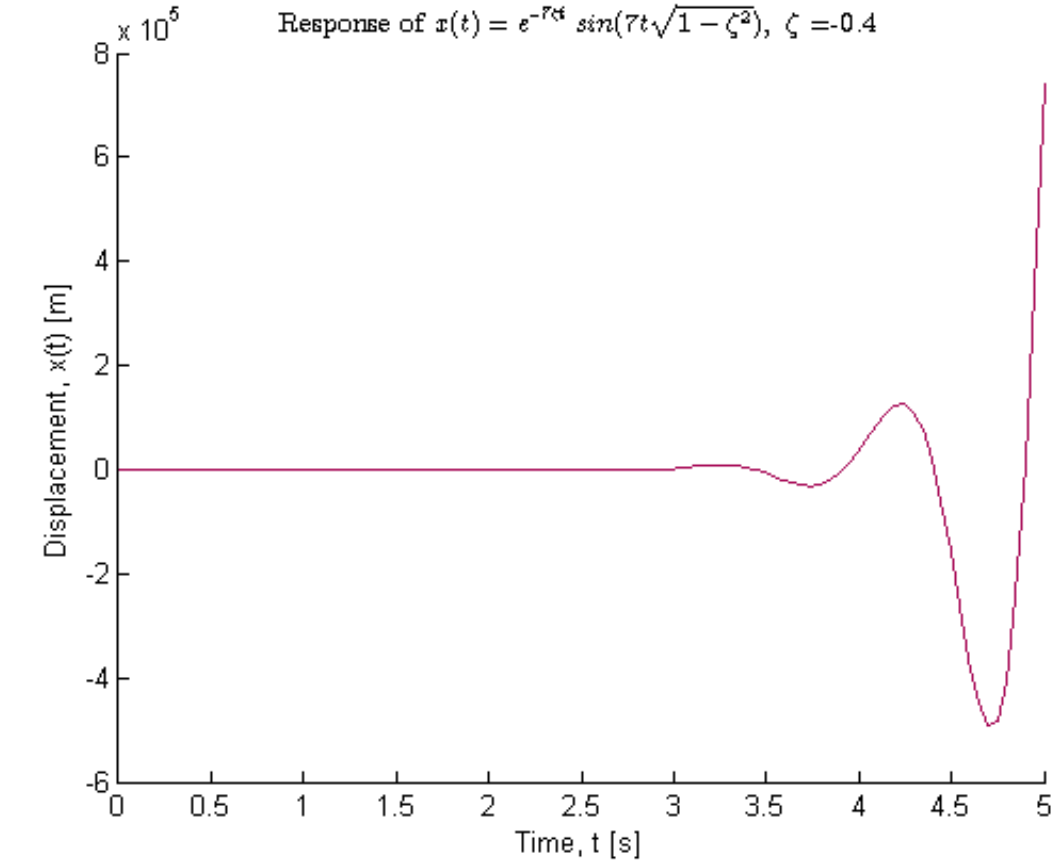
end

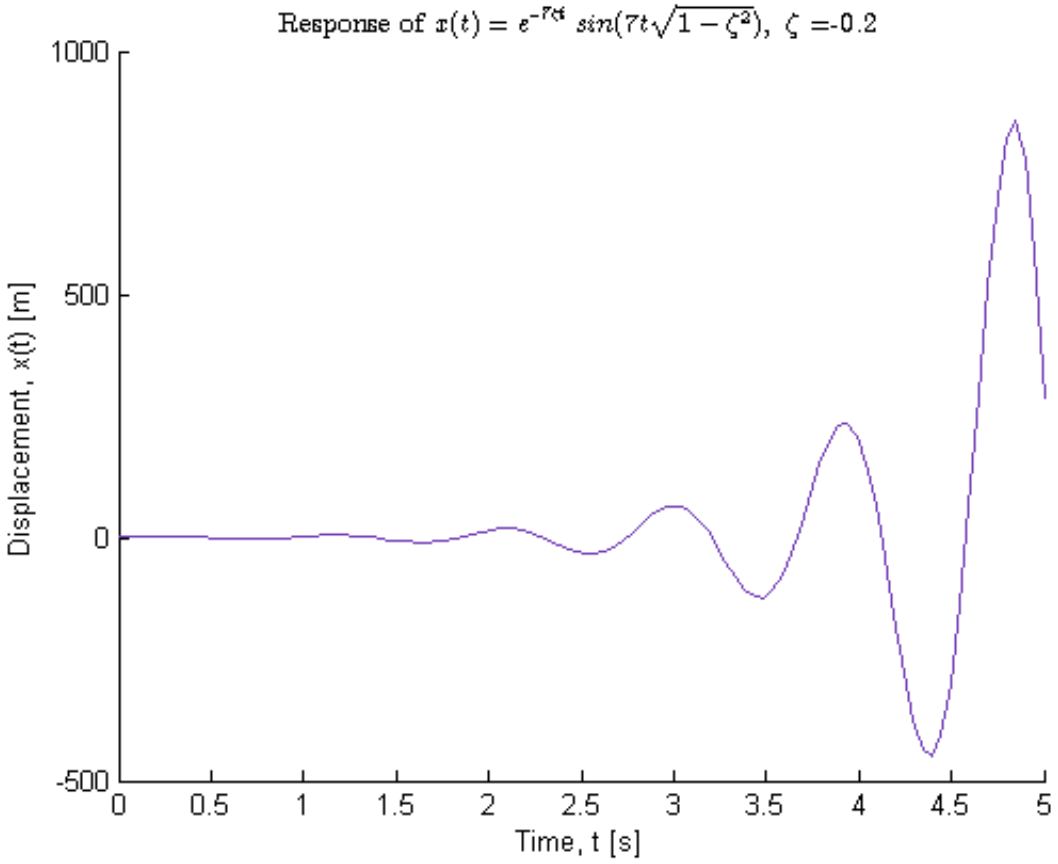
figure(100)
legend(strZeta)
```

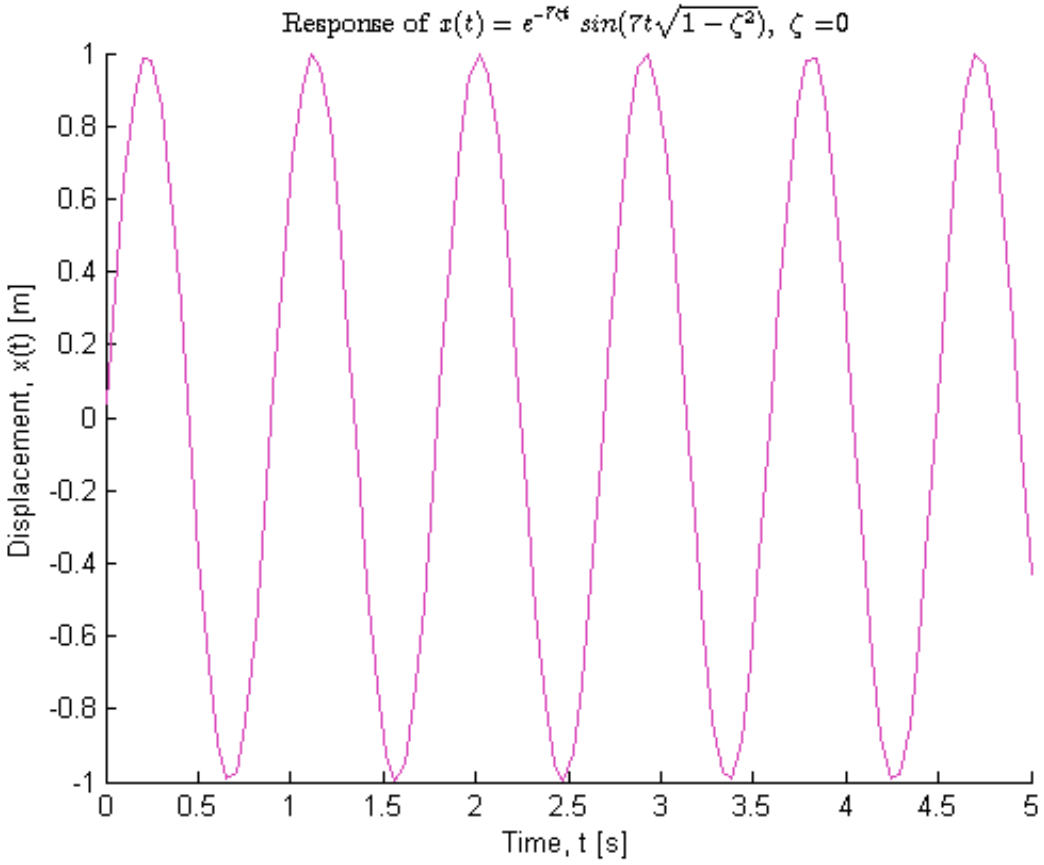


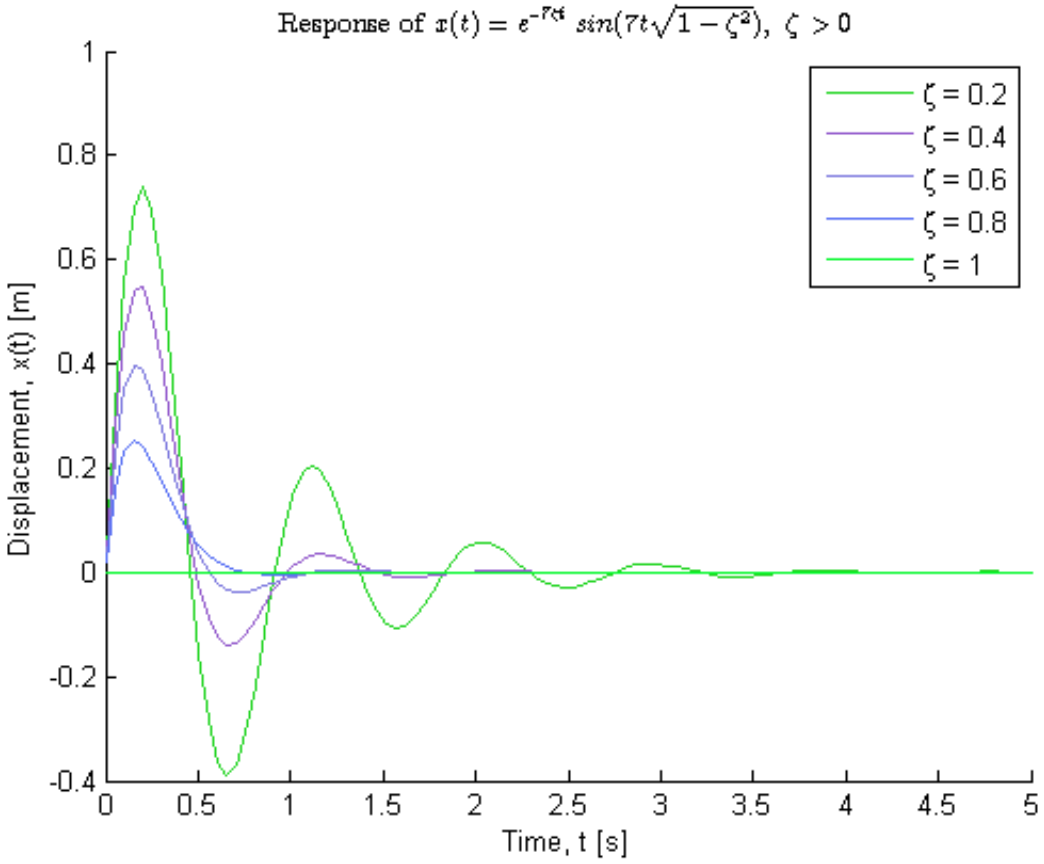

x 10^11
Response of $x(t) = e^{-7\zeta t}\ sin(7t\sqrt{1-\zeta^2})$, ζ =-0.8
Displacement, x(t) [m]
Time, t [s]
14
12
10
8
6
4
2
0
-2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


x 10^8
Response of $x(t) = e^{-7\zeta t}\ sin(7t\sqrt{1-\zeta^2})$, ζ =-0.6
Displacement, x(t) [m]
Time, t [s]
7
6
5
4
3
2
1
0
-1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


Response of $x(t) = e^{-7\zeta t}\ sin(7t\sqrt{1-\zeta^2})$, ζ =-0.4
x 10^5
8
6
4
2
0
-2
-4
-6
Displacement, x(t) [m]
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time, t [s]


Response of $x(t) = e^{-7\zeta t}\ sin(7t\sqrt{1-\zeta^2})$, ζ =-0.2
1000
500
0
-500
Displacement, x(t) [m]
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time, t [s]


Response of $x(t) = e^{-\zeta\omega t}\ sin(\omega t\sqrt{1-\zeta^2}),\ \zeta = 0$
Displacement, x(t) [m]
Time, t [s]
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5


Response of $x(t) = e^{-\zeta\omega t}\ sin(\omega t\sqrt{1-\zeta^2}),\ \zeta > 0$
ζ = 0.2
ζ = 0.4
ζ = 0.6
ζ = 0.8
ζ = 1
Displacement, x(t) [m]
Time, t [s]
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

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