Problem 2

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11 January 2022 09:59 AM

Earthqua...

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%Problem #2 Response Spectrum analysis for various cases of Damping
clc
fid = fopen('El Centro Ground Motion data.txt') ;  % open the text file
S = textscan(fid,'%s');    % text scan the data
fclose(fid) ;       % close the file
S = S{1} ;
a_g = cellfun(@(x)str2double(x), S);  % convert the cell array to double
% Remove NaN's which were strings earlier
a_g(isnan(a_g))=[];
col = 2;
count = 0;
temp_arr =[];
temp_row = [];
for i = 1:length(a_g)
    if count == col
        temp_arr = [temp_arr;
                    temp_row];
        count = 0;
        temp_row = [];
    end
    temp_row = [temp_row,a_g(i)];
    count = count +1;
end
temp_arr = [temp_arr;
            temp_row];
a_g = temp_arr(:,2:end);
a_g=a_g.*9.81;
clear temp_arr temp_row S;
% Creating Time axis
t=zeros(length(a_g),1);
for i=2:length(a_g)
    t(i)=t(i-1)+0.02;
end
del_t=t(2)-t(1);
%Producing ground velocity data
v_g=zeros(length(a_g),1);
for i=1:length(a_g)-1
    v_g(i+1)=v_g(i)+(del_t*(a_g(i+1)+a_g(i)))/2;
end
%Producing ground displacement data
u_g=zeros(length(a_g),1);
for i=1:length(a_g)-1
    u_g(i+1)=u_g(i)+del_t*v_g(i)+del_t*del_t*((a_g(i+1)/6)+(a_g(i)/3));
end
%Producing System response data
Tn=zeros(300,1); %vector storing the natural periods of the system
z=[0,0.02,0.05,0.1,0.2]; %vector storing the damping ratios
m=1; %mass of the system as unity
SD=zeros(300,length(z));
PSV=zeros(300,length(z));
PSA=zeros(300,length(z));
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for l=1:length(z)
    cnt=1;
    for j=0.01:0.01:3
        Tn(cnt)=j; %Natural Period of the system
        Z=z(l);
        Wn=(2*pi)/j; %Natural Frequency
        Wd=Wn*sqrt(1-Z^2); %Damped Natural Frequency
        %Defining Parameters required A,B,C,D & A1,B1,C1,D1
        A=exp(-Z*Wn*del_t)*((Z/sqrt(1-Z^2))*sin(Wd*del_t)+cos(Wd*del_t));
        B=exp(-Z*Wn*del_t)*(sin(Wd*del_t)/Wd);
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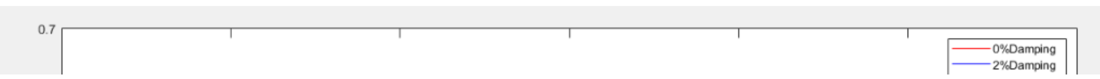
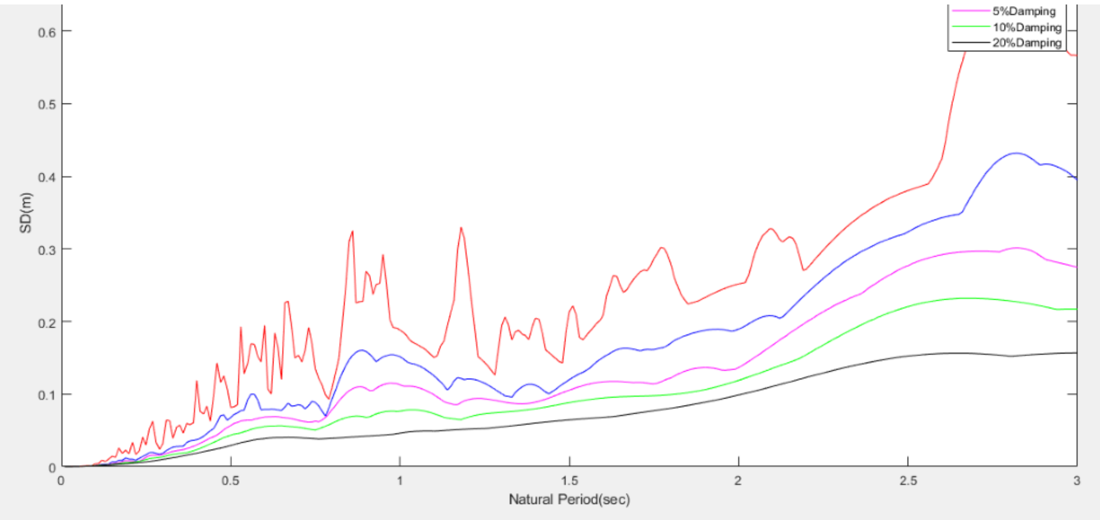
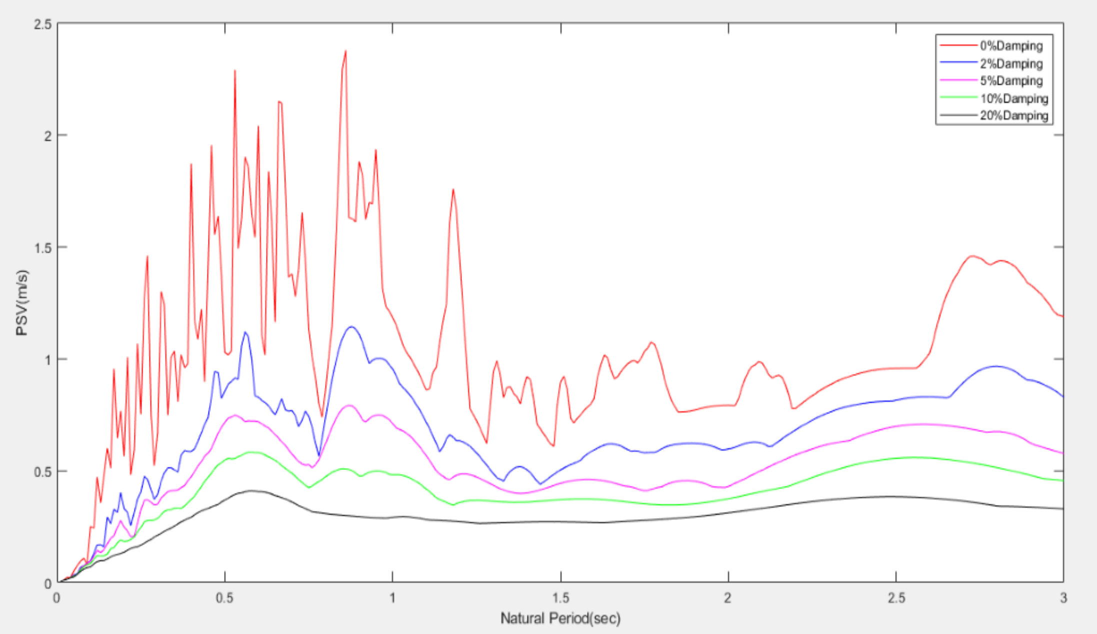
        C=(((2*Z)/(Wn*del_t))+exp(-Z*Wn*del_t)*(((1-2*Z^2)/(Wd*del_t)-(Z/sqrt(1-Z^2)))*sin(Wd*del_t)-(1+((2*Z)/(Wn*del_t)))*cos(Wd*del_t)))/Wn^2;
        D=(1-((2*Z)/(Wn*del_t))+exp(-Z*Wn*del_t)*(((2*Z^2-1)/(Wd*del_t))*sin(Wd*del_t)+((2*Z)/(Wn*del_t))*cos(Wd*del_t)))/Wn^2;
        A1=-exp(-Z*Wn*del_t)*((Wn/sqrt(1-Z^2))*sin(Wd*del_t));
        B1=exp(-Z*Wn*del_t)*(cos(Wd*del_t)-(Z/sqrt(1-Z^2))*sin(Wd*del_t));
        C1=((-1/del_t)+exp(-Z*Wn*del_t)*(((Wn/(sqrt(1-Z^2)))+(Z/(del_t*sqrt(1-Z^2))))*sin(Wd*del_t)+(cos(Wd*del_t)/del_t)))/Wn^2;
        D1=(1-exp(-Z*Wn*del_t)*((Z/sqrt(1-Z^2))*sin(Wd*del_t)+cos(Wd*del_t)))/(Wn^2*del_t);
        u=zeros(length(a_g),1); %Initialising displacement response vector of the SDOF system
        v=zeros(length(a_g),1); %Initialising velocity response vector of the SDOF system
        a=zeros(length(a_g),1); %Initialising Acceleration response vector for the SDOF system
        for i=1:length(a_g)-1
            u(i+1)=A*u(i)+B*v(i)-C*a_g(i)-D*a_g(i+1);
            v(i+1)=A1*u(i)+B1*v(i)-C1*a_g(i)-D1*a_g(i+1);
            a(i+1)=-a_g(i+1)-2*Z*Wn*v(i+1)-Wn^2*u(i+1);
        end
        SD(cnt,1)=max(abs(u)); %spectral displacement
        PSV(cnt,1)=max(abs(Wn*u)); %Pseudo Spectral Velocity
        PSA(cnt,1)=max(abs(Wn^2*u)); %Pseudo Spectral acceleration
        cnt=cnt+1;
    end
end
%plotting SD response Spectra
figure(1)
title('Spectral Displacement(SD) Response Spectra')
plot(Tn,SD(:,1),'red');
hold on
plot(Tn,SD(:,2),'blue');
hold on
plot(Tn,SD(:,3),'magenta');
hold on
plot(Tn,SD(:,4),'green');
hold on
plot(Tn,SD(:,5),'black');
hold on
xlabel('Natural Period(sec)');
ylabel('SD(m)');
```

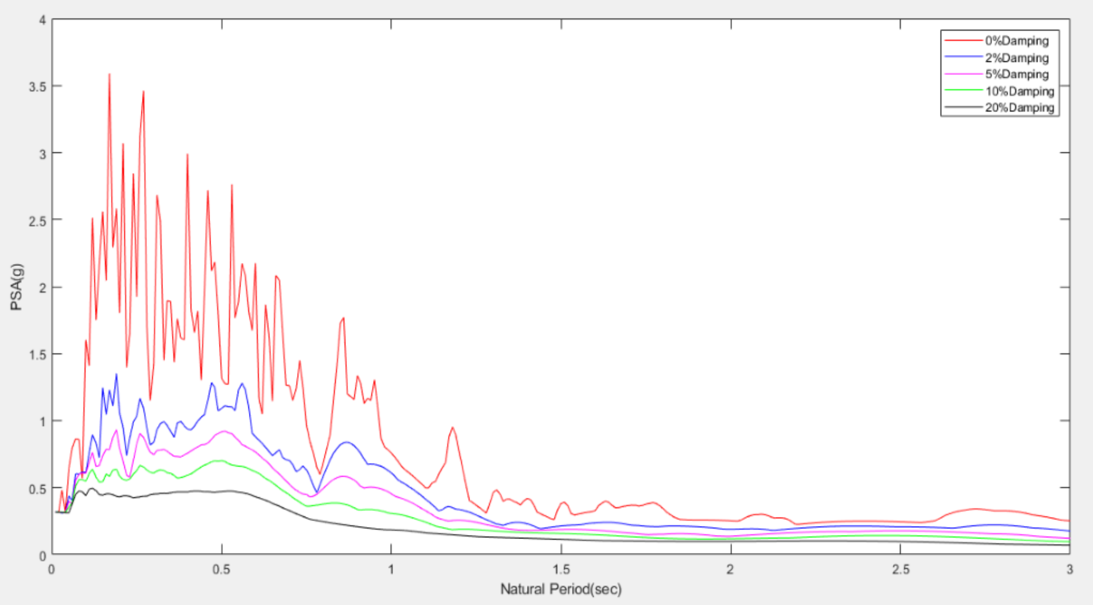


```
legend('0%Damping','2%Damping','5%Damping','10%Damping','20%Damping');
%Plotting PSV response spectra
figure(2)
title('Pseudo Spectral Velocity(PSV) Response Spectra')
plot(Tn,PSV(:,1),'red');
hold on
plot(Tn,PSV(:,2),'blue');
hold on
plot(Tn,PSV(:,3),'magenta');
hold on
plot(Tn,PSV(:,4),'green');
hold on
plot(Tn,PSV(:,5),'black');
hold on
xlabel('Natural Period(sec)');
ylabel('PSV(m/s)');
legend('0%Damping','2%Damping','5%Damping','10%Damping','20%Damping');
%Plotting PSA response spectra
figure(3)
title('Pseudo Spectral Acceleration(PSA) Response Spectra')
plot(Tn,PSA(:,1)./9.81,'red');
hold on
plot(Tn,PSA(:,2)./9.81,'blue');
hold on
plot(Tn,PSA(:,3)./9.81,'magenta');
hold on
plot(Tn,PSA(:,4)./9.81,'green');
hold on
plot(Tn,PSA(:,5)./9.81,'black');
hold on
xlabel('Natural Period(sec)');
ylabel('PSA(g)');
legend('0%Damping','2%Damping','5%Damping','10%Damping','20%Damping');
```




5%Damping
10%Damping
20%Damping
SD(m)
0 0.1 0.2 0.3 0.4 0.5 0.6
0 0.5 1 1.5 2 2.5 3
Natural Period(sec)


0%Damping
2%Damping
5%Damping
10%Damping
20%Damping
PSV(m/s)
0 0.5 1 1.5 2 2.5
0 0.5 1 1.5 2 2.5 3
Natural Period(sec)


0%Damping
2%Damping
5%Damping
10%Damping
20%Damping
PSA(g)
0 0.5 1 1.5 2 2.5 3 3.5 4
0 0.5 1 1.5 2 2.5 3
Natural Period(sec)