Computer Project #1

Matlab Program

SDOF Equation of Motion

$$\ddot{x} + 2\zeta\omega\dot{x} + \omega^2 x = f_i + \frac{\Delta f_i}{\Delta t}(t - t_i)$$

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Dynamics of Structures

Introduction:

For the computer program number #1, I used the MATLAB program. I generated a step-by-step exact solution of the forced SDOF equation of motion

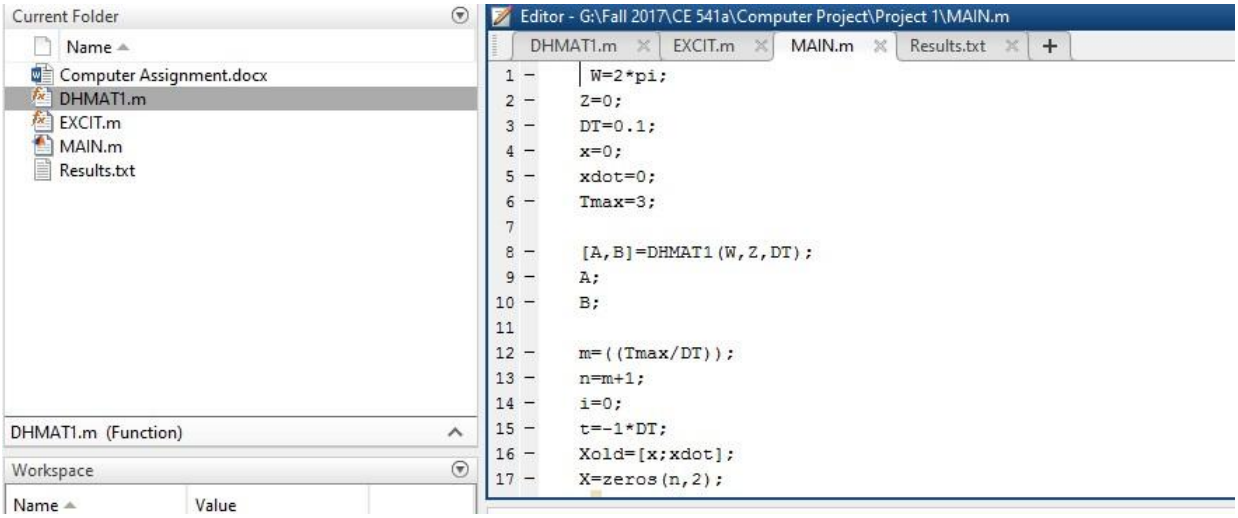
$$\ddot{x} + 2\zeta\omega\dot{x} + \omega^2 x = f_i + \frac{\Delta f_i}{\Delta t}(t - t_i)$$

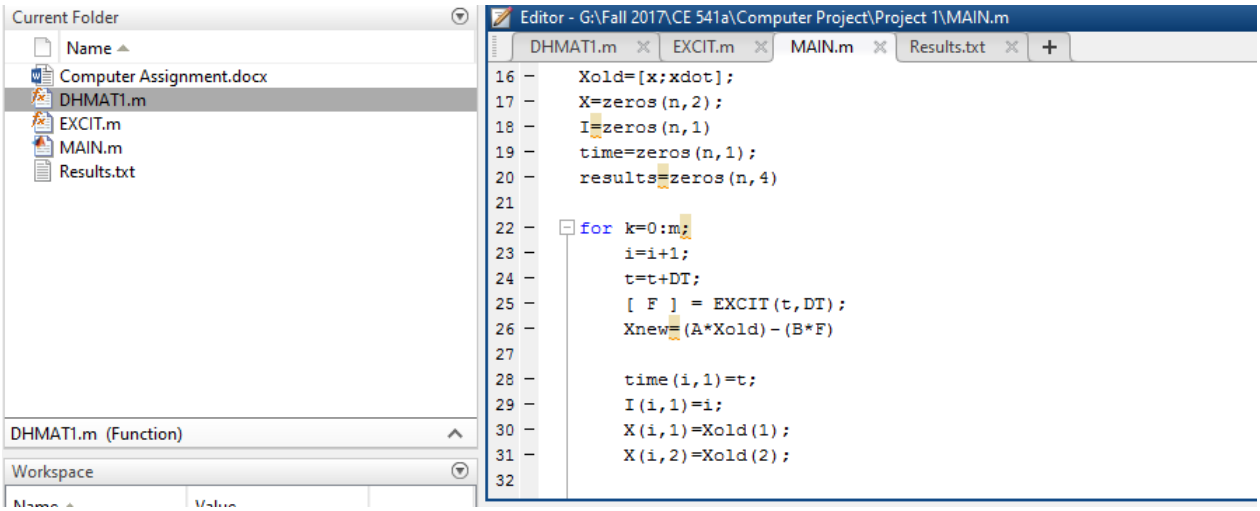
for any arbitrary excitation f(x).

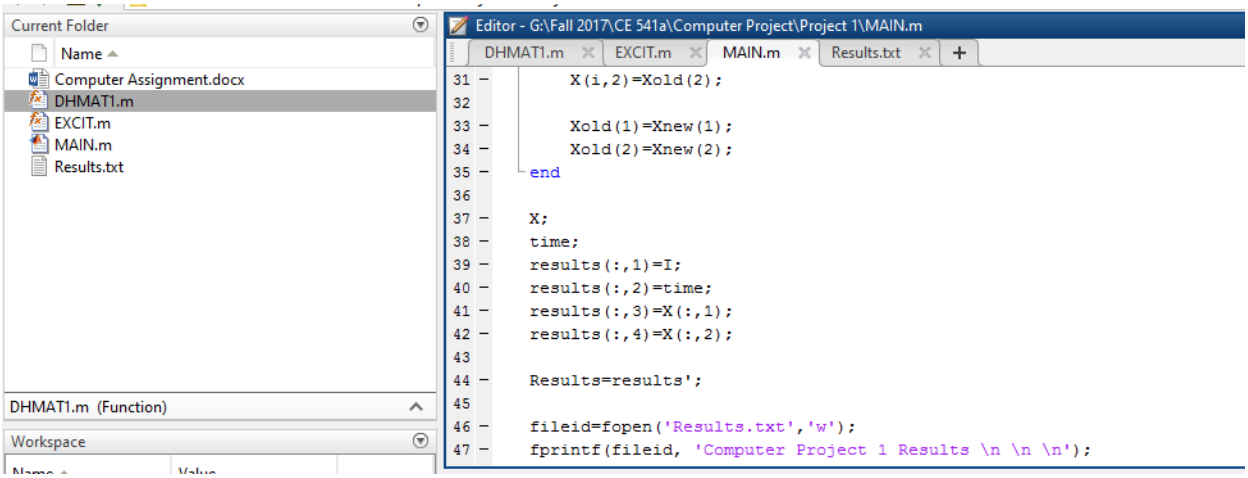
MATLAB:

When creating this program, created multiple files that work in accordance to one another to generate the output desired.

MAIN:







I then created the Duhamel Integral Matrix Function file. I labeled it DHMAT1. I input all the settings from the given report. This was a new function file which has the code

“

```
function [A,B] = DHMAT1( W,Z,DT )

Wd=W*sqrt(1-(Z^2));
a11=exp(-Z*W*DT)*((Z/sqrt(1-Z^2))*sin(Wd*DT)+cos(Wd*DT));
a22=exp(-Z*W*DT)*(cos(Wd*DT)-((Z/sqrt(1-Z^2))*sin(Wd*DT)));
a12=((exp(-Z*W*DT))/Wd)*sin(Wd*DT);
a21=(-W/sqrt(1-Z^2))*(exp(-Z*W*DT)*sin(Wd*DT));
b11=exp(-Z*W*DT)*(((((2*(Z^2)-
1)/((W^2)*DT))+(Z/W))*(sin(Wd*DT)/Wd))+(((2*Z/((W^3)*DT))+(1/W^2))*cos(Wd*DT)
))-((2*Z)/((W^3)*DT));
b12=-exp(-Z*W*DT)*(((((2*(Z^2)-
1)/((W^2)*DT)))*(sin(Wd*DT)/Wd))+(((2*Z/((W^3)*DT)))*cos(Wd*DT)))+((2*Z)/((W^
3)*DT))-(1/W^2);
```

```
b21=exp(-Z*W*DT)*((((2*(Z^2)-1)/((W^2)*DT))+(Z/W))*(cos(Wd*DT)-(Z/sqrt(1-
(Z^2)))*sin(Wd*DT))-
(((2*Z)/((W^3)*DT))+(1/W^2))*((Wd*sin(Wd*DT))+(Z*W*cos(Wd*DT))))+(1/((W^2)*DT
));
b22=-exp(-Z*W*DT)*((((2*(Z^2)-1)/((W^2)*DT)))*(cos(Wd*DT)-(Z/sqrt(1-
(Z^2)))*sin(Wd*DT))-(((2*Z)/((W^3)*DT)))*((Wd*sin(Wd*DT))+(Z*W*cos(Wd*DT))))-
(1/((W^2)*DT));
A=[a11 a12; a21 a22];
B=[b11 b12; b21 b22];

end   "
```

This function takes my given input (assigned in MAIN.m) and creates an output with the matrices A and B.

I then had to create a new function file which I called EXCIT, representing the exciting forces in this problem. The assignment required a unit step input where f(t) = 1 ; 0 ≤ t. So my code looks like this,

“

```
function [ F ] = EXCIT(t,DT)

F=zeros(2,1);
%fi is at time t
%fi1 is at t +dt
fi=1;
fi1=1;
F=[fi;fi1];

end   "
```

After creating these files, I created a MAIN file that runs all these files together. I labeled this file MAIN. This file takes the matrices created in DHMAT1, due to the original inputs from MAIN.m file and creates the equation to satisfy delta T in intervals all the way to Tmax. This code requires a loop; it also requires a way to stop, so when T ≥ Tmax the loop ends. Here is my code,

“

```
%Input
W=2*pi;
Z=0;
DT=0.1;
x=0;
xdot=0;
Tmax=3;


[A,B]=DHMAT1(W,Z,DT);
A;
B;

m=((Tmax/DT));
n=m+1;
```

```
i=0;
t=-1*DT;
Xold=[x;xdot];
X=zeros(n,2);
I=zeros(n,1)
time=zeros(n,1);
results=zeros(n,4)

for k=0:m;
    i=i+1;
    t=t+DT;
    [ F ] = EXCIT(t,DT);
    Xnew=(A*Xold)-(B*F)

    time(i,1)=t;
    I(i,1)=i;
    X(i,1)=Xold(1);
    X(i,2)=Xold(2);

    Xold(1)=Xnew(1);
    Xold(2)=Xnew(2);
end


X;
time;
results(:,1)=I;
results(:,2)=time;
results(:,3)=X(:,1);
results(:,4)=X(:,2);

Results=results';

fileid=fopen('Results.txt','w');
fprintf(fileid, 'Computer Project 1 Results \n \n \n');
fprintf(fileid, 'I= %f \n T= %f \n Xi= %f \n Xdoti= %f \n \n ',Results);
fclose(fileid); "
```

At the end of this file I created a new output file to open labeled Results.txt. This file arranges all the exact answers in I,T,Xi,Xdoti. This is what the output setting looks like,

```
Computer Project 1 Results

 I= 1.000000
 T= 0.000000
 Xi= 0.000000
 Xdoti= 0.000000

 I= 2.000000
 T= 0.100000
 Xi= 0.004838
 Xdoti= 0.093549

 I= 3.000000
 T= 0.200000
 Xi= 0.017503
 Xdoti= 0.151365

 I= 4.000000
 T= 0.300000
```

```
Xi= 0.033158
Xdoti= 0.151365

I= 5.000000
T= 0.400000
Xi= 0.045823
Xdoti= 0.093549

I= 6.000000
T= 0.500000
Xi= 0.050661
Xdoti= 0.000000

I= 7.000000
T= 0.600000
Xi= 0.045823
Xdoti= -0.093549

I= 8.000000
T= 0.700000
Xi= 0.033158
Xdoti= -0.151365

I= 9.000000
T= 0.800000
Xi= 0.017503
Xdoti= -0.151365

I= 10.000000
T= 0.900000
Xi= 0.004838
Xdoti= -0.093549

I= 11.000000
T= 1.000000
Xi= -0.000000
Xdoti= -0.000000

I= 12.000000
T= 1.100000
Xi= 0.004838
Xdoti= 0.093549

I= 13.000000
T= 1.200000
Xi= 0.017503
Xdoti= 0.151365

I= 14.000000
T= 1.300000
Xi= 0.033158
Xdoti= 0.151365

I= 15.000000
T= 1.400000
Xi= 0.045823
Xdoti= 0.093549

I= 16.000000
T= 1.500000
Xi= 0.050661
Xdoti= 0.000000

I= 17.000000
T= 1.600000
Xi= 0.045823
Xdoti= -0.093549

I= 18.000000
T= 1.700000
Xi= 0.033158
Xdoti= -0.151365

I= 19.000000
T= 1.800000
Xi= 0.017503
Xdoti= -0.151365

I= 20.000000
T= 1.900000
Xi= 0.004838
Xdoti= -0.093549

I= 21.000000
T= 2.000000
Xi= -0.000000
Xdoti= -0.000000

I= 22.000000
T= 2.100000
Xi= 0.004838
Xdoti= 0.093549
```

```
I= 23.000000
T= 2.200000
Xi= 0.017503
Xdoti= 0.151365

I= 24.000000
T= 2.300000
Xi= 0.033158
Xdoti= 0.151365

I= 25.000000
T= 2.400000
Xi= 0.045823
Xdoti= 0.093549

I= 26.000000
T= 2.500000
Xi= 0.050661
Xdoti= 0.000000

I= 27.000000
T= 2.600000
Xi= 0.045823
Xdoti= -0.093549

I= 28.000000
T= 2.700000
Xi= 0.033158
Xdoti= -0.151365

I= 29.000000
T= 2.800000
Xi= 0.017503
Xdoti= -0.151365

I= 30.000000
T= 2.900000
Xi= 0.004838
Xdoti= -0.093549

I= 31.000000
T= 3.000000
Xi= -0.000000
Xdoti= -0.000000
```