2020

Programming Assignment

Deepak Choudhary

17CE31001

Fourier Analysis

Using Fourier analysis, plot steady state response of an un-damped SDF system subjected to a square wave excitation. Also, plot equivalent load from Fourier analysis for different value of number n.

Deepak Choudhary
17CE31001

Department of Civil
Engineering Indian
Institute of Technology
Kharagpur 721302

Code Part

(Done in Matlab R2017a. Code file is attached)

I have Used some assumption like

Mass	m=1kg
Time period of Load	T_0=1sec
Spring Constant	k=1000N/m

```
syms x n pi
sum=0;
% I have let Time Period T=1 and spring constant k=1000N/m and mass=1kg
 T=1;
 m=1;
 k=1000;
 w=sqrt(k/m);
 w0=2*pi/T;
 rn=n*w0/w


% Defining Square Wave Function
   y = piecewise(round(x)<=x,1,round(x)>x,-1);


% Calculating a0 an bn
    a0=(1/T)*(int(1,x,0,0.5)+int(-1,x,0.5,1));
    an=(2/T)*(int(cos(n*w0*x),x,0,0.5)+int(-cos(n*w0*x),x,0.5,1));
    bn=(2/T)*(int(sin(n*w0*x),x,0,0.5)+int(-sin(n*w0*x),x,0.5,1));

    an1=subs(an,n,1:7)
    bn1=subs(bn,n,1:7)



% Plotting Square wave function with Fourier Function
% this graph is basically F(t)/F0 to t/T0 graph

An1 = an*cos(n*w0*x);
Bn1 = bn*sin(n*w0*x);



figure(1)

    fplot(y,[0,1])
    title('Load and its Fourier Series')
    xlabel('T')
```

```
    ylabel('F(t)/F0')
    hold on
        fplot(fp(3,An1,Bn1,n,a0),[0,1])    % for n=3
        fplot(fp(5,An1,Bn1,n,a0),[0,1])    % for n=5
        fplot(fp(7,An1,Bn1,n,a0),[0,1])    % for n=7
    hold off

grid



% Plotting Steady State respose

An2 = (an*cos(n*w0*x))/(k*(1-rn^2));
Bn2 = (bn*sin(n*w0*x))/(k*(1-rn^2));

    an2=subs(An2,n,1:7)
    bn2=subs(Bn2,n,1:7)

figure(2)
   %fplot(y,[0,10])
    hold on
   title('Response of Undamped System')
    xlabel('T')
    ylabel('X(t)')
       % fplot(fp(3,An2,Bn2,n,a0),[0,1]) % for n=3
        fplot(fp(5,An2,Bn2,n,a0),[0,1]) % for n=5
        fplot(fp(7,An2,Bn2,n,a0),[0,1]) % for n=7
    hold off
grid




   % function to create sum for Fourier Function
    function p = fp(n1,an,bn,n,a0)

    An=subs(an,n,1:n1);
    Bn=subs(bn,n,1:n1);
    sum=a0;
    for i=1:n1
        sum=sum+An(i);
    end
    for i=1:n1
        sum=sum+Bn(i);
    end
    p = sum;

end
```

Output

a_n and b_n Calculated for Load

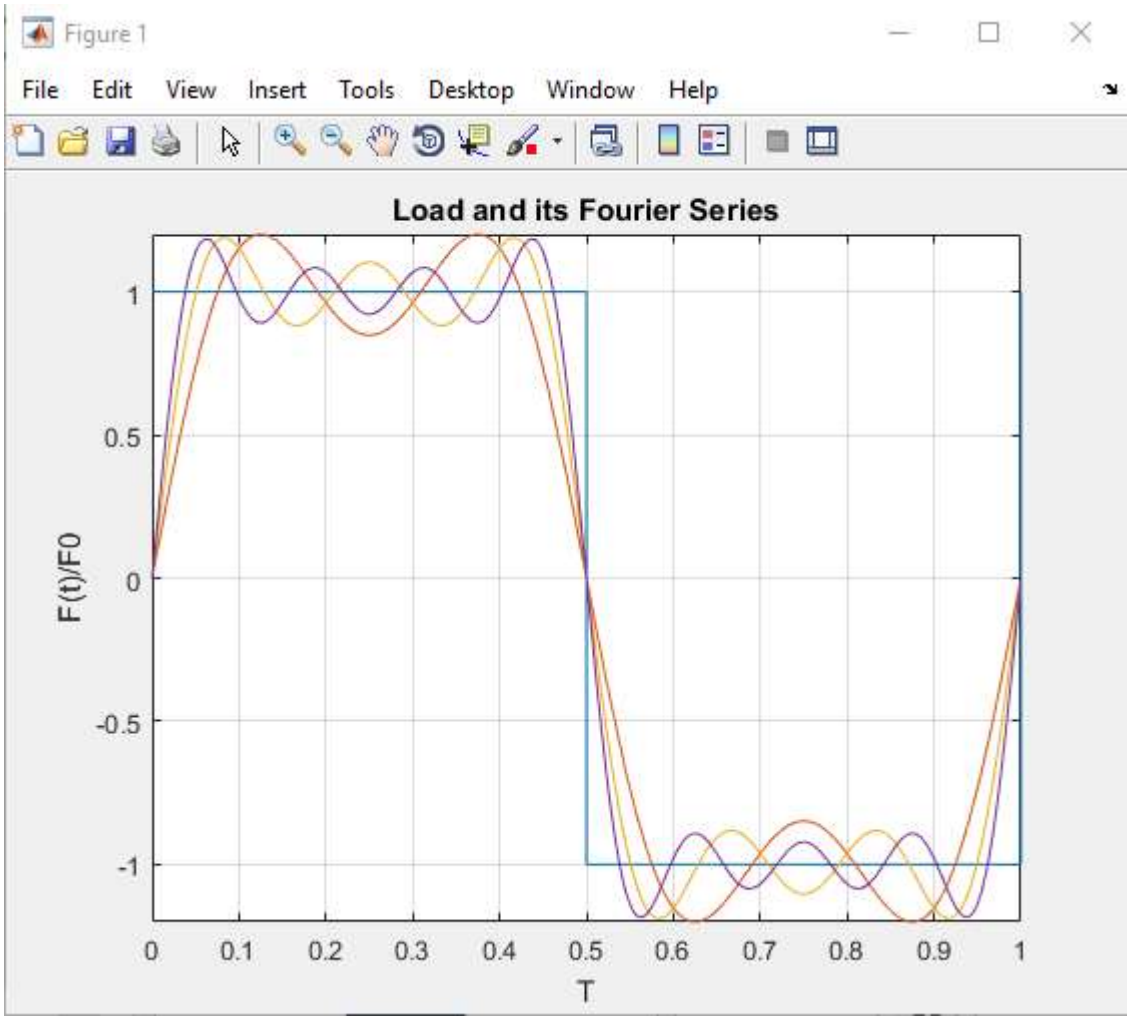
an1 =[0, 0, 0, 0, 0, 0, 0]

bn1 = [4/pi, 0, 4/(3*pi), 0, 4/(5*pi), 0, 4/(7*pi)]

Graphs 1

Load and Equivalent Fourier series and time for n=3,5,7

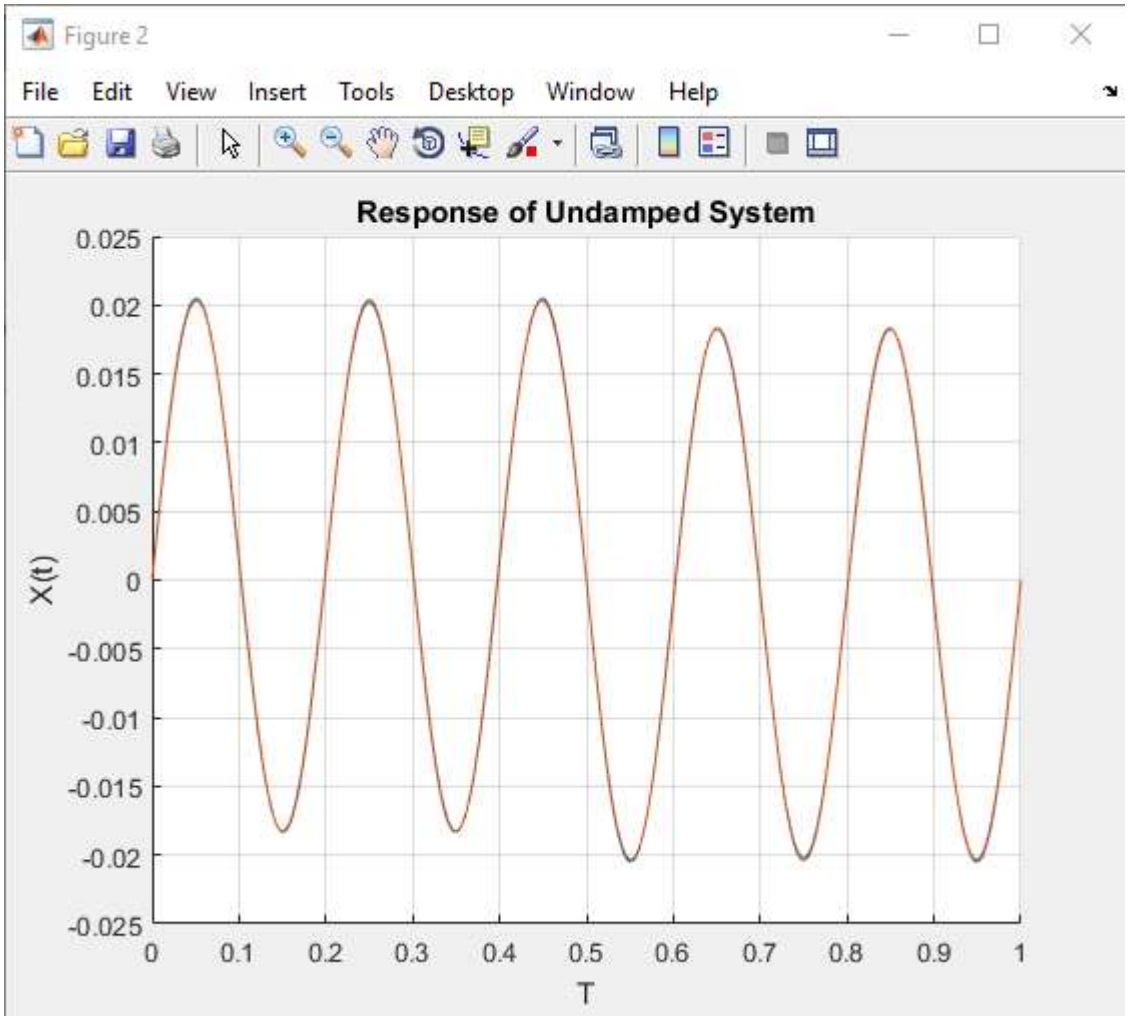
Time Period For Load is supposed to be 1



Graph 2

Steady State response for n=5,7

Between X(t) displacement and time t



Screenshot