***SS LAB***

***EXPERIMENT # 04 (CTFS)***

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***OBJECTIVE::*** To study and analyze the continuous time Fourier series (CTFS) .

***MATLAB CODE::***

clc; clear all; close all;

t = linspace(-10,10,10000);

x =@(t)rec(t,0.5);

T = 5 ; j =1;

w1 = (2\*pi)./T;

ci = @(t,n)x(t).\*exp(-1i\*w1\*n.\*t)./T;

sum0 = 0 ; sum1 = 0 ; sum2 =0 ; sum3=0; sum4 = 0 ;sum5 =0 ;

sum6 =0 ;sum7 =0;sum81 =0;sum82 = 0;sum9 =0;

for i=-100:1:100-1

% Normal input function

c0(1,j) = integral(@(t)ci(t,i),0,T);

sum0 = sum0 + c0(1,j).\*exp(1i\*w1\*i.\*t);

% a) x(t - 8)

sum1 = sum1 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i\*8);

% b) 3x(t + 9) - 5x(t)

sum2 = sum2 + 3\*c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(1i\*w1\*i.\*9) - 5\*c0(1,j).\*exp(1i\*w1\*i.\*t);

% c) x(-t)

sum3 = sum3 + c0(1,j).\*exp(-1i\*w1\*i.\*t);

% d) x(-t/9)

sum4 = sum4 + c0(1,j).\*exp(-1i\*w1\*i.\*t\*(1/9));

% d) x\*(t)

sum5 = sum5 + conj(c0(1,j)).\*exp(-1i\*w1\*i.\*t);

% e) d(x(t))/dt

sum6 = sum6 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*(1i\*w1\*i);

% f) integral(x(t))

if(i~=0)

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t))./((1i\*w1\*i));

else

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t)).\*(t);

end

% g) x(7\*t/12)\*x(t -8/3)

sum81 = sum81 + c0(1,j).\*exp(1i\*(7/12)\*w1\*i.\*t);

sum82 = sum82 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i.\*(8/3));

% h) exp(j\*(6\*pi/T)\*t)\*x(t)

sum9 = sum9 + c0(1,j).\*exp(1i\*w1\*(i-3).\*t);

j = j + 1;

end

subplot(5,2,1); plot(t,sum0); subplot(5,2,2); plot(t,sum1);

subplot(5,2,3); plot(t,sum2); subplot(5,2,4); plot(t,sum3);

subplot(5,2,5); plot(t,sum4); subplot(5,2,6); plot(t,sum5);

subplot(5,2,7); plot(t,sum6); subplot(5,2,8); plot(t,sum7);

subplot(5,2,9); plot(t,sum81.\*sum82); subplot(5,2,10); plot(t,sum9);

%WHEN T = 10ms

T = 10 ; j =1;

w1 = (2\*pi)./T;

ci = @(t,n)x(t).\*exp(-1i\*w1\*n.\*t)./T;

sum0 = 0 ; sum1 = 0 ; sum2 =0 ; sum3=0; sum4 = 0 ;sum5 =0 ;

sum6 =0 ;sum7 =0;sum81 =0;sum82 = 0;sum9 =0;

for i=-100:1:100-1

% Normal input function

c0(1,j) = integral(@(t)ci(t,i),0,T);

sum0 = sum0 + c0(1,j).\*exp(1i\*w1\*i.\*t);

% a) x(t - 8)

sum1 = sum1 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i\*8);

% b) 3x(t + 9) - 5x(t)

sum2 = sum2 + 3\*c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(1i\*w1\*i.\*9) - 5\*c0(1,j).\*exp(1i\*w1\*i.\*t);

% c) x(-t)

sum3 = sum3 + c0(1,j).\*exp(-1i\*w1\*i.\*t);

% d) x(-t/9)

sum4 = sum4 + c0(1,j).\*exp(-1i\*w1\*i.\*t\*(1/9));

% d) x\*(t)

sum5 = sum5 + conj(c0(1,j)).\*exp(-1i\*w1\*i.\*t);

% e) d(x(t))/dt

sum6 = sum6 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*(1i\*w1\*i);

% f) integral(x(t))

if(i~=0)

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t))./((1i\*w1\*i));

else

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t)).\*(t);

end

% g) x(7\*t/12)\*x(t -8/3)

sum81 = sum81 + c0(1,j).\*exp(1i\*(7/12)\*w1\*i.\*t);

sum82 = sum82 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i.\*(8/3));

% h) exp(j\*(6\*pi/T)\*t)\*x(t)

sum9 = sum9 + c0(1,j).\*exp(1i\*w1\*(i-3).\*t);

j = j + 1;

end

subplot(5,2,1); plot(t,sum0); subplot(5,2,2); plot(t,sum1);

subplot(5,2,3); plot(t,sum2); subplot(5,2,4); plot(t,sum3);

subplot(5,2,5); plot(t,sum4); subplot(5,2,6); plot(t,sum5);

subplot(5,2,7); plot(t,sum6); subplot(5,2,8); plot(t,sum7);

subplot(5,2,9); plot(t,sum81.\*sum82); subplot(5,2,10); plot(t,sum9);

%WHEN T = 10ms

T = 20 ; j =1;

w1 = (2\*pi)./T;

ci = @(t,n)x(t).\*exp(-1i\*w1\*n.\*t)./T;

sum0 = 0 ; sum1 = 0 ; sum2 =0 ; sum3=0; sum4 = 0 ;sum5 =0 ;

sum6 =0 ;sum7 =0;sum81 =0;sum82 = 0;sum9 =0;

for i=-100:1:100-1

% Normal input function

c0(1,j) = integral(@(t)ci(t,i),0,T);

sum0 = sum0 + c0(1,j).\*exp(1i\*w1\*i.\*t);

% a) x(t - 8)

sum1 = sum1 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i\*8);

% b) 3x(t + 9) - 5x(t)

sum2 = sum2 + 3\*c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(1i\*w1\*i.\*9) - 5\*c0(1,j).\*exp(1i\*w1\*i.\*t);

% c) x(-t)

sum3 = sum3 + c0(1,j).\*exp(-1i\*w1\*i.\*t);

% d) x(-t/9)

sum4 = sum4 + c0(1,j).\*exp(-1i\*w1\*i.\*t\*(1/9));

% d) x\*(t)

sum5 = sum5 + conj(c0(1,j)).\*exp(-1i\*w1\*i.\*t);

% e) d(x(t))/dt

sum6 = sum6 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*(1i\*w1\*i);

% f) integral(x(t))

if(i~=0)

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t))./((1i\*w1\*i));

else

sum7 = sum7 + c0(1,j).\*exp((1i\*w1\*i.\*t)).\*(t);

end

% g) x(7\*t/12)\*x(t -8/3)

sum81 = sum81 + c0(1,j).\*exp(1i\*(7/12)\*w1\*i.\*t);

sum82 = sum82 + c0(1,j).\*exp(1i\*w1\*i.\*t).\*exp(-1i\*w1\*i.\*(8/3));

% h) exp(j\*(6\*pi/T)\*t)\*x(t)

sum9 = sum9 + c0(1,j).\*exp(1i\*w1\*(i-3).\*t);

j = j + 1;

end

subplot(5,2,1); plot(t,sum0); subplot(5,2,2); plot(t,sum1);

subplot(5,2,3); plot(t,sum2); subplot(5,2,4); plot(t,sum3);

subplot(5,2,5); plot(t,sum4); subplot(5,2,6); plot(t,sum5);

subplot(5,2,7); plot(t,sum6); subplot(5,2,8); plot(t,sum7);

subplot(5,2,9); plot(t,sum81.\*sum82); subplot(5,2,10); plot(t,sum9);

***Function::***

function [out] = rec(t,k)

out =0;

for i=-10:0.02:10

if(mod(i,5)==0)

uni1 = t>=i-k;

uni2 = t>=i+k;

out = out + uni1 - uni2;

end

end

***OBSERVATIONS::***

After doing this experiment we learnt fourier series and its properties. It was really fun when we switch to frequency domain and get result easily by using properties.

***FIGURES::***

***WHEN T = 5 ms***

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***WHEN T = 10 ms***

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