**% MODULE 4**

**% FOURIER SERIES CONTINUOUS**

To = pi; % Change according to given signal

wo=2\*pi/To;

h=0.001;

t=0:h:(To-h); % Choose whichever is feasible

%t= -pi:h:0-h;

%t= -To/2:h:(To/2)-h;

%x= exp(-t/2);

%x= exp(t/2);

%x= exp(-(t-0.5)/2);

%x= t.^2;

% x= exp(-t/10);

% y= -exp((-t1-pi)/10);

% z = x + y

% % plot(t-pi,x2 , t+pi , x1)

plot(t, x)

figure;

N=length(x);

%N1= length(y);

co=sum(x)/(N-1); % Average value / DC component : iska angle 0 degree hota hai.

% N-1 is used because there are N-1 spaces between N samples.

for n=1:10

aa(n)=2\*sum(x.\*cos(n\*wo\*t))/(N-1); % an : trigonometric

bb(n)= 2\*sum(x.\*sin(n\*wo\*t))/(N-1); %bn : trigonometric

C(n) = sqrt(aa(n).^2 + bb(n).^2) %C(n) : compact trigonometric

D(n)= sum(x.\*(exp(-j\*n\*wo\*t)))/(N-1); %D(n) : exponential

theta(n)= atan2(-bb(n),aa(n)); % angles for Cn and Dn

end

n=(1:10);

k=-n; % To plot graph in -ve x axis in abs(x)

phi= -angle(D); % To plot graph in +ve axis in angle(D)

% Plotting 1st graph of absolute values

subplot(2,1,1);

stem(n, abs(D))

hold on

stem(k, abs(D))

hold on

stem(0, co)

% Plotting 2nd graph of angles

subplot(2,1,2);

stem(n, angle(D))

hold on

stem(k,phi)

hold on

stem(0,0)

grid on

%To plot an or bn or cn

%Jo use krna hai kr lo aur gch rho

subplot(2,2,1); stem(n,aa(n),'k'); ylabel('a(n)'); xlabel('n');

subplot(2,2,2); stem(n,bb(n),'k'); ylabel('b(n)'); xlabel('n');

subplot(2,2,3); stem(n,C(n),'k'); ylabel('C(n)'); xlabel('n');

subplot(2,2,4); stem(n,theta(n),'k'); ylabel('theta(n)'); xlabel('n');

**% FOURIER SERIES DISCRETE**

**% Method 1:**

No = 5; % Periodicity

n= 0:No-1;

%xn =[ones(1,5) zeros(1,23) ones(1,4)];

%xn= 4\*cos(2.4\*pi\*n)+ 2\*sin(3.2\*pi\*n);

%xn= 2\*cos(3.2\*pi\*(n-3));

xn= exp(-n/2);

stem(n, xn)

figure

for r=0:No-1

xr(r+1) = sum(xn.\*exp(-1j\*r\*2\*(pi/No)\*n))/No;

end

r=n;

subplot(2,1,1);

stem(r,real(xr),'k');

ylabel('absXr');

xlabel('r');

xr=round(1000\*xr)/1000; %to avoid computational error

subplot(2,1,2);

stem(r,angle(xr),'k');

ylabel('angleXr');

xlabel('r');

**%Method 2:**

n = [0:1:4]; % Change accordingly

x = exp(-n/2); %Given function

four\_x = zeros(5); %Creating empty array

ti = 0;

for r = 0:1:4

ti = ti + 1;

four\_x(ti) = sum(x.\*exp(-1j\*2\*pi/5\*r\*n))/5;

end

%Plotting

subplot(2,2,1),stem(n,x);

subplot(2,2,2),stem(n,abs(four\_x));

subplot(2,2,3),stem(n,angle(four\_x));

**% Reconstruction of fourier series in discrete**

ti = 0

res = zeros(1,5); %res is the reconstructed signal

for n = 0:1:4

ti = ti +1;

temp = 0;

for r = 0:1:4

temp = temp + four\_x(r+1)\*exp(j\*2\*pi/5\*r\*n);

end

res(ti) = real(sum(temp));

end

subplot(2,2,4),stem(0:1:4,res);

**%FOURIER TRANSFORM CONTINUOUS**

%x= inline("t.\*((t>=0)&(t<1))","t");

%x= inline("1.\*((t>=-1)&(t<1))","t");

x = inline("(((3)^(0.5)).\*t).\*(t>=0 & t<0.5) + (-((3)^(0.5)).\*t + 3^(0.5)).\*(t>=0.5 & t<1)" , 't') %Unit triangle function

h=0.001;

t= -2:h:2-h;

plot(t, x(t))

title("Plot")

figure;

%fourier transform

t= -5:h:5;

FT= zeros(size(t));

temp=0;

for k= -5\*pi:h:5\*pi

temp=temp+1;

K= x(t).\*exp(-1j\*k\*t);

FT(temp)= sum(K)\*h;

end

w= -5\*pi:h:5\*pi;

plot(w, abs(FT))

title("Fourier Transform")

figure;

%signal reconstruction

temp1=0;

RS= zeros(size(t));

for tk= -5:h:5

temp1=temp1+1;

xx= (1/(2\*pi))\*FT.\*exp(1j\*w\*tk);

RS(temp1)= sum(xx)\*h;

end

plot(t, real(RS))

title("Re-constructed signal")

**%FOURIER TRANSFORM DISCRETE**

**% Credits : Rishab bhai**

x = inline("exp(-n/2).\*(n>=0 & n<4)" , 'n')

h=1;

t= -1:h:6-h; % Jo inline ki time range hai, usse thoda zyada rkh le

stem(t, x(t))

title("Plot")

figure;

%fourier transform

t= -1:h:6-h; % Same time range as defined above

FT= zeros(size(t));

temp=0;

for k= 0:.01:2\*pi %Fourier transform is periodic with To from 0 to 2pi.

temp=temp+1;

K= x(t).\*exp(-j\*k\*t);

FT(temp)= sum(K)\*h;

end

w= 0:.01:2\*pi; %Same as loop of k defined above

plot(w, abs(FT))

title("Fourier Transform")

figure;

%signal reconstruction

temp1=0;

RS= zeros(size(t));

w= 0:.01:2\*pi; % Again same

for tk= -5:h:5 % Range of reconstructed signal/ chahe initial range hi daal le, frk ni pdta

temp1=temp1+1;

xx= (1/(2\*pi))\*FT.\*exp(j\*w\*tk);

RS(temp1)= sum(xx)\*0.01;

end

stem([-5:5], real(RS)) % [-5:5] is time range array, jb tk ka loop chalta hai / main taan chaleya teri ore

title("Re-constructed signal")