DSAA HOMEWORK 1

NAME :- ANIRUDH KANNAN V P

ROLL NO: - 201601004

PROBLEM 1:-

1) *x(t) = e ^ -|t| where t belongs to real nos*

SECTION 1:-

(i) $x(t) = e^{-|t|} \quad t \in R$

$$E = \int_{-\infty}^{\infty} |x(t)^2| \, dt = \int_{-\infty}^{\infty} \left(e^{-|t|}\right)^2 dt$$

$$= \int_{-\infty}^{0} e^{2t} \, dt + \int_{0}^{\infty} e^{-2t} \, dt$$

$$= \left[\frac{e^{2t}}{2}\right]_{-\infty}^{0} + \left[-\frac{e^{-2t}}{2}\right]_{0}^{\infty}$$

$$= \frac{e^{0}}{2} - \frac{e^{-\infty}}{2} + -\frac{e^{-\infty}}{2} - \left(-\frac{e^{0}}{2}\right)$$

$$\frac{1}{2} - 0 - 0 + \frac{1}{2}$$

$$\Rightarrow \boxed{E = 1J}$$

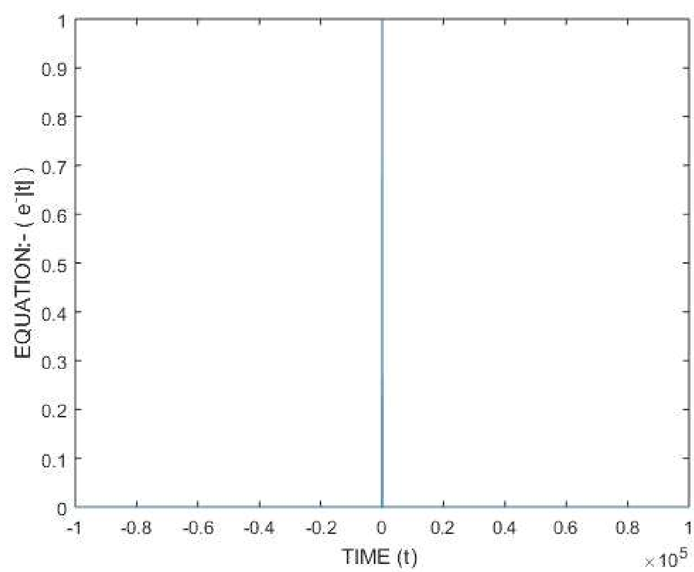
$$P = \lim_{T \to \infty} \frac{E}{2T} = \frac{1}{\infty} = 0 \Rightarrow \boxed{P = 0} \text{ watts}$$

Since $E = 1J$ which is non-zero and Power $= 0$ watts, it is an energy signal.

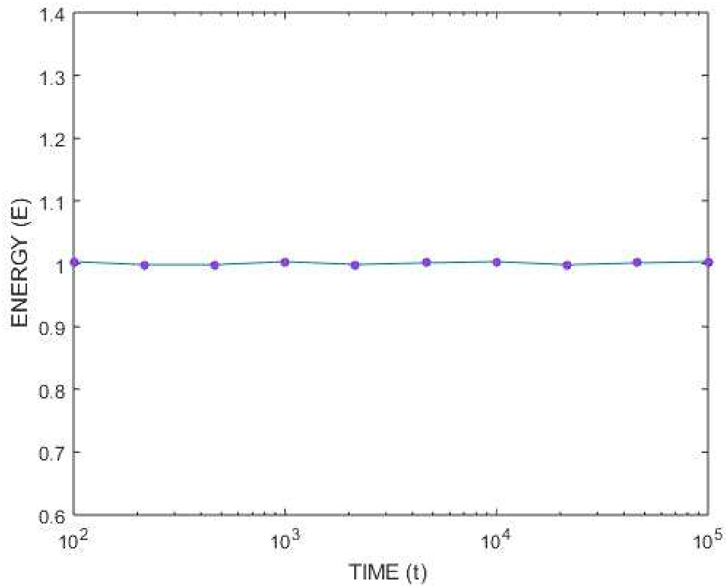
SECTION 2:-

PART-1 WITH FIXED INCREMENT OF 0.1

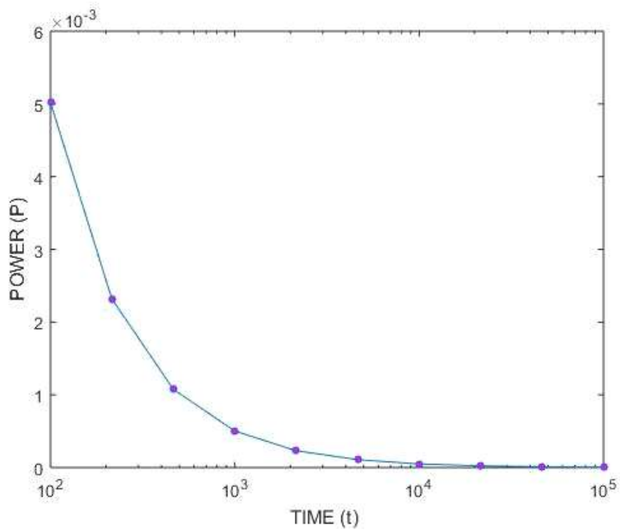
```
clc
close all
clear all

Nt = logspace(2,5,10);

for nx = 1:length(Nt)
    t = -Nt(nx):0.1:Nt(nx);
    xt = exp(-abs(t));
    plot(t,xt);
    ylabel('EQUATION:- ( e^-|t| )');
    xlabel('TIME (t) ');
    drawnow;pause(0.2);
    egx(nx) = trapz(t,xt.^2);
end
```




```
figure;
semilogx(Nt,egx,'o-','MarkerSize',4,'MarkerFaceColor','m');
ylabel('ENERGY (E)');
xlabel('TIME (t) ');
ylim([0.6,1.4]);
```



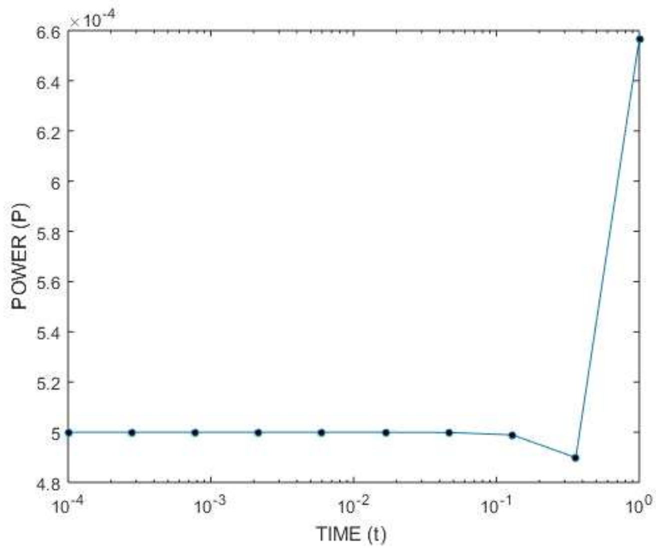

```
figure;
powx=egx./(2*Nt);
semilogx(Nt,powx,'o-','MarkerSize',4,'MarkerFaceColor','m');
ylabel('POWER (P)');
xlabel('TIME (t) ');
```

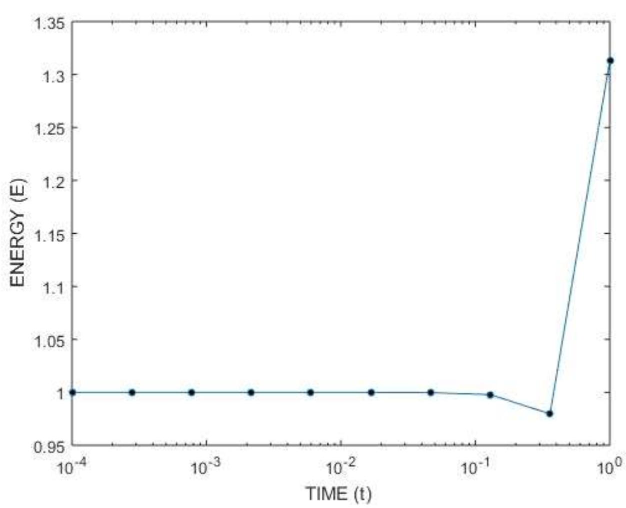


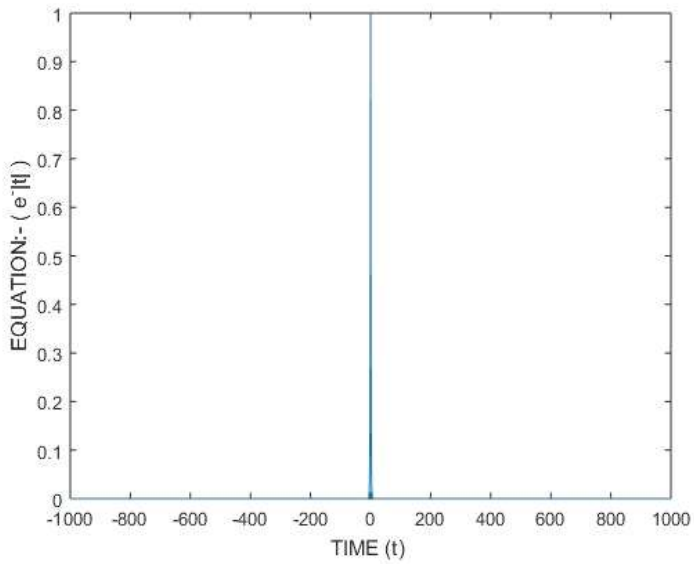
PART 2:- WITH VARYING INCREMENT

```
clc
close all
clear all

Nt = 1000;
```

```
inc = logspace(-4,0,10);
for nx = 1:length(inc)
    t = -Nt:inc(nx):Nt;
    xt = exp(-abs(t));
    plot(t,xt);
    ylabel('EQUATION:- ( e^-|t| )');
    xlabel('TIME (t) ');
    drawnow;pause(0.2);
    egx(nx) = trapz(t,xt.^2);
end
figure;
powx=egx./(2*Nt);
semilogx(inc,powx,'o-','MarkerSize',4,'MarkerFaceColor','k');
ylabel('POWER (P)');
xlabel('TIME (t) ');
figure;
semilogx(inc,egx,'o-','MarkerSize',4,'MarkerFaceColor','k');
ylabel('ENERGY (E)');
xlabel('TIME (t) ');
```







DISCUSSIONS ON PROBLEM 1 (SECTION 3):-

In this problem we are finding the energy and power of the signal x(t) = e^-|t| where t belongs to real numbers . The energy of a continuous signal is given by E = integral(-inf to inf(|x(t)|^2)) and power of the signal is given by P = limit(T->inf 1/2*T integral(-inf to inf(|x(t)|^2))) . The two codes are basically the same where in first code we are using an fixed increment whereas in second code we are using a varying increment . First a logspace is created between 10^2 and 10^5 using the logspace(2,5,10) function . The points are got using a for loop . Then the function is plotted using the plot() function . Trapz() function is used to calculate the area under the graph using egx(nx) = trapz(t,xt.^2);
The xlabel and ylabel functions are used to write on the graph using the plot function . The semilogx has attributes Markersize and MarkerFace color which are used to give thickness and colour to the point .

PROBLEM 2:-

2) *x(t) = cos(pi*t/2+pi/4) where t belongs to real nos*

SECTION 1:-

(2) $x(t) = \cos\left(\frac{\pi}{2}t + \frac{\pi}{4}\right)$

$$E = \lim_{T\to\infty} \int_{-T}^{T} |x(t)|^2 \, dt$$

$$= \lim_{T\to\infty} \int_{-T}^{T} \cos^2\left(\frac{\pi}{2}t + \frac{\pi}{4}\right) dt$$

Since $\cos()$ is a periodic function, the value of $\cos^2()$ is almost equal to infinity.

$$\text{Power} = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} \cos^2\left(\frac{\pi}{2}t + \frac{\pi}{4}\right) dt$$

$$\left\{\cos^2\theta = \frac{1+\cos 2\theta}{2}\right\}$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T} 1 + \frac{\cos\left(\pi t + \frac{\pi}{2}\right)}{2} \, dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} \left(1 - \frac{\sin \pi t}{2}\right) dt$$

$$= \lim_{T\to\infty} \frac{1}{4T} \left[\left(t + \frac{\cos(\pi t)}{\pi}\right)\right]_{-T}^{T}$$

$$= \lim_{T\to\infty} \frac{1}{4T}(2T)$$

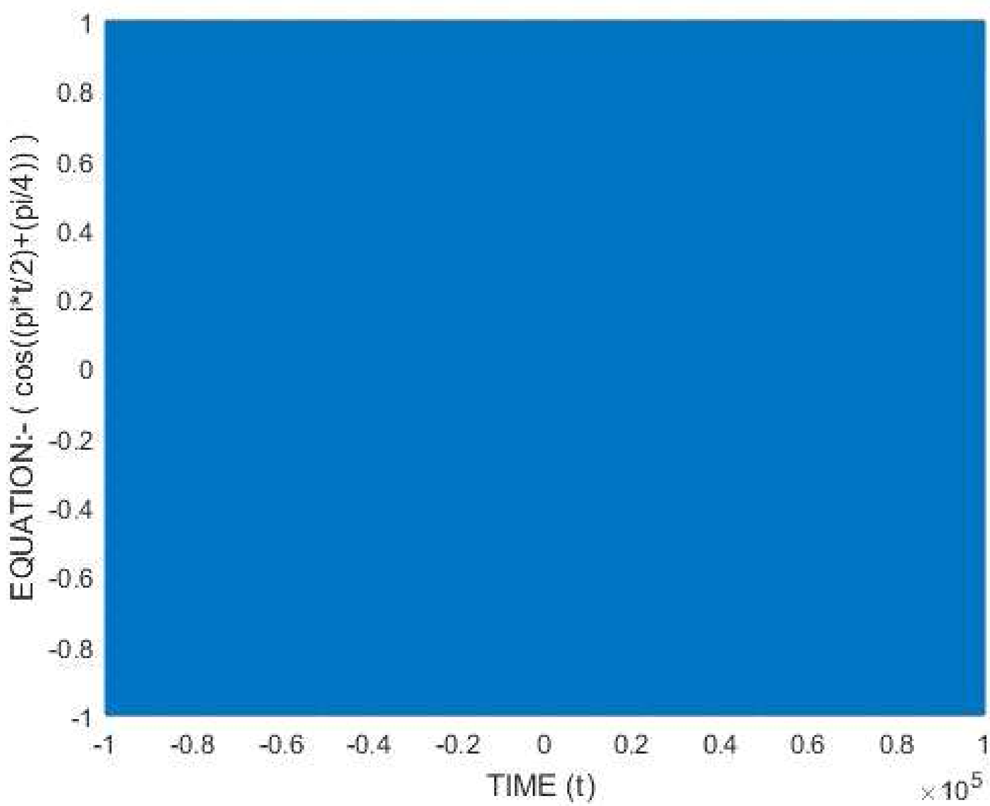
$$= \frac{1}{2} \qquad \text{power} = \frac{1}{2}$$

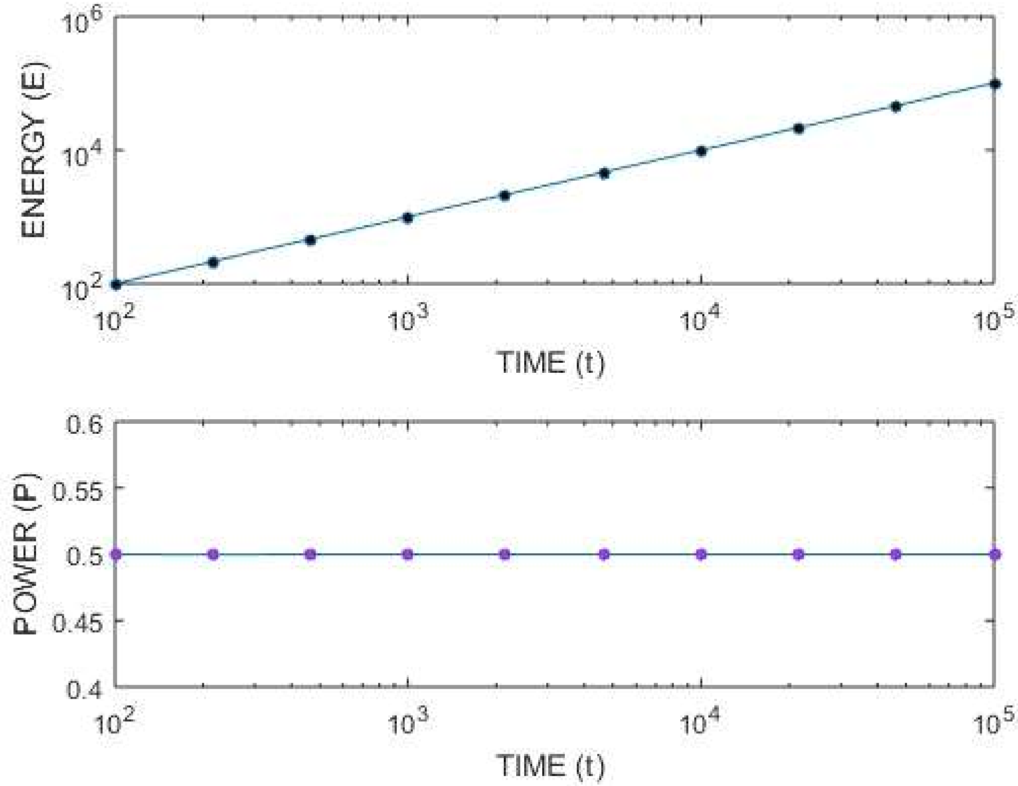
* Since $E = \infty$ and $P = \frac{1}{2}$ it is an power ~~energy~~ signal

SECTION 2:-

```
clc
close all
clear all

Nt = logspace(2,5,10);
for nx = 1:length(Nt)
    t = -Nt(nx):0.1:Nt(nx);
    xt = cos((pi*t/2)+(pi/4));
    plot(t,xt);
    ylabel('EQUATION:- ( cos((pi*t/2)+(pi/4)) )');
    xlabel('TIME (t) ');
    drawnow;pause(0.2);
    egx(nx) = trapz(t,xt.^2);
end
powx = egx./(2*Nt);
figure;
subplot(2,1,1);
loglog(Nt,egx,'o-','MarkerSize',4,'MarkerFaceColor','k');
```

```
ylabel('ENERGY (E)');
xlabel('TIME (t) ');
subplot(2,1,2);
semilogx(Nt,powx,'o-','MarkerSize',4,'MarkerFaceColor','m');
ylabel('POWER (P)');
xlabel('TIME (t) ');
ylim([0.4,0.6]);
```





DISCUSSIONS ON PROBLEM 2 (SECTION 3):-

In this problem we are finding the energy and power of the signal x(t) = cos((pi*t/2)+(pi/4))where t belongs to real numbers . The energy of a continuous signal is given by E = integral(-inf to inf(|x(t)|^2)) and power of the signal is given by P = limit(T->inf 1/2*T integral(-inf to inf(|x(t)|^2))). First a logspace is created between 10^2 and 10^5 using the logspace(2,5,10) function . The points are got using a for loop . Then the function is plotted using the plot() function . Trapz() function is used to calculate the area under the graph using egx(nx) = trapz(t,xt.^2); Here were are using the subplot() function to plot two graphs in the same graph . subplot(2,1,1) is used to plot the graph in the first position of the main graph and subplot(2,1,2) is used to plot the graph in the second position .
The xlabel and ylabel functions are used to write on the graph using the plot function . The semilogx has attributes Markersize and MarkerFace color which are used to give thickness and colour to the point .

PROBLEM 3:-

3) *x(t) = (1+j)*e^(j*pi*t/2) where t lies between 0 and 10 .*

SECTION 1:-

(3) $x(t) = (1+j)\, e^{j\pi t/2} \qquad 0 < t < 10$

$$E = \int_0^{10} \left|(1+j)\, e^{j\pi t/2}\right|^2 dt$$

$$E = \int_0^{10} |(1+j)|^2 \, |e^{j\pi t/2}|^2 \, dt$$

$$|e^{j\pi t/2}|^2 = |\cos \pi t + j \sin \pi t|$$

$$(|1+j|)^2 = \left(\sqrt{1^2+1^2}\right)^2 = (\sqrt{2})^2 = 2$$

$$\Rightarrow E = 2 \int_0^{10} \cos|\pi t + j \sin \pi t|^2 \, dt$$

$$= 2 \int_0^{10} \sqrt{\cos^2 \pi t + \sin^2 \pi t}$$

$$= 2 \int_0^{10} 1 \, dt$$

$$= 2 \times [t]_0^{10} = 2 \times 10 = 20$$

$$\Rightarrow E = 20 \text{ Joules}$$

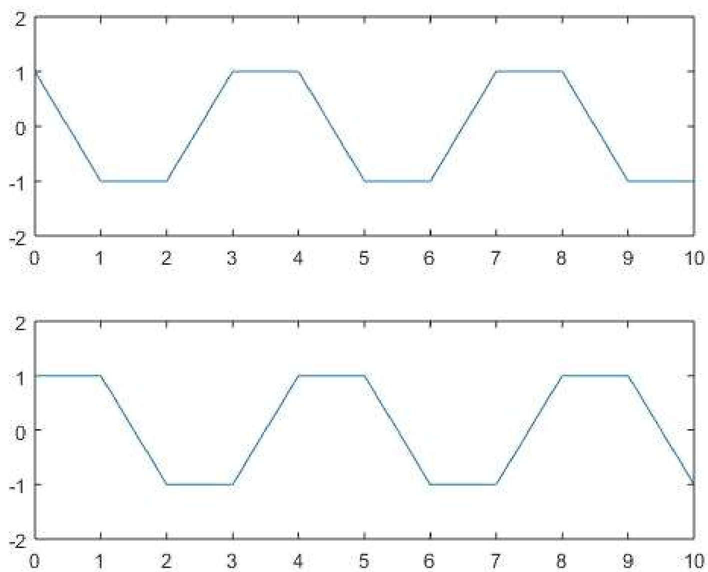
$$P = \lim_{T \to \infty} \frac{1}{2T} \int_{-\infty}^{\infty} |x(t)|^2 \, dt$$

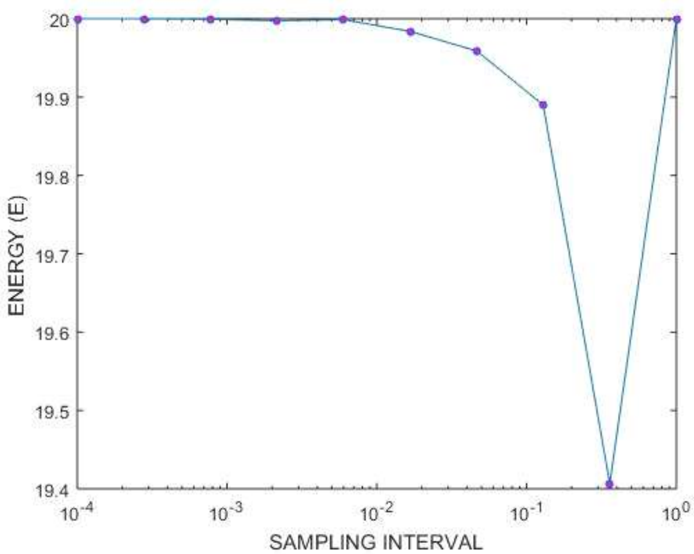
$$= \lim_{T \to \infty} \frac{E}{2T} = \frac{E}{\infty} = 0$$

$\therefore$ Power = 0 watts

SECTION 2:-

```
clc
close all
clear all

Nt = 10;
inc = logspace(-4,0,10);
for nx = 1:length(inc)
    t = 0:inc(nx):Nt;
    xt = (1+1i)*exp(1i*pi*t/2);
    subplot(2,1,1);
    plot(t,real(xt));
    subplot(2,1,2);
    plot(t,imag(xt));
    drawnow;pause(0.1);
    egx(nx) = trapz(t,abs(xt).^2);
end
figure;
semilogx(inc,egx,'o-','MarkerSize',4,'MarkerFaceColor','m');
xlabel('SAMPLING INTERVAL');
ylabel('ENERGY (E) ');
```





DISCUSSIONS ON PROBLEM 3 (SECTION 3):-

In this problem we are finding the energy and power of the signal x(t) = (1+1i)*exp(1i*pi*t/2) where t belongs to real numbers . The energy of a continuous signal is given by E = integral(-inf to inf(|x(t)|^2)) and power of the signal is given by P = limit(T->inf 1/2*T integral(-inf to inf(|x(t)|^2))). First a logspace is created between 10^-4 and 10^0 using the logspace(-4,0,10) function . The points are got using a for loop . Then the function is plotted using the subplot() function . Trapz() function is used to calculate the area under the graph using egx(nx) = trapz(t,abs(xt).^2); Here were are using the subplot() function to plot two graphs in the same graph . subplot(2,1,1) is used to plot the graph in the first position of the main graph and subplot(2,1,2) is used to plot the graph in the second position .The real part is plotted in the first position and the imaginary part is plotted in the second position using the commands

```
subplot(2,1,1);
plot(t,real(xt));
subplot(2,1,2);
plot(t,imag(xt));
```

The xlabel and ylabel functions are used to write on the graph using the plot function . The semilogx has attributes Markersize and MarkerFace color which are used to give thickness and colour to the point .

PROBLEM 4:-

4) *x(n) = cos(2*pi*ko*n/N) where n lies between 0 and N-1 both inclusive*

SECTION 1:-

1) $x(n) = \cos\frac{2\pi k_0 n}{N} \quad , \; 0 \le n \le N-1$

$$E = \sum_{n=-N}^{N} |x(n)|^2 = \sum_{n=0}^{N-1} \left(\cos\frac{2\pi k_0 n}{N}\right)^2$$

$$= \sum_{n=0}^{N-1} \left[\frac{1+\cos\frac{4\pi k_0 n}{N}}{2}\right]$$

$$= \frac{\sum_{0}^{N-1} 1}{2} + \sum_{n=0}^{N-1} \frac{\cos\frac{4\pi k_0 n}{N}}{2}$$

$$= \frac{N}{2} + \frac{1}{2}\sum_{n=0}^{N-1} \cos\frac{4\pi k_0 n}{N}$$

$$= \frac{N}{2} + \frac{1}{2}\, Re\left(\sum_{n=0}^{N-1} \left(e^{j\frac{4\pi k_0}{N}}\right)^n\right) \rightarrow ①$$

Let $② = \frac{1}{2} Re\left(\sum_{n=0}^{N-1} \left(e^{j\frac{4\pi k_0}{N}}\right)^n\right)$

$\rightarrow$ It is A G.P with $a = \text{first term} = 1$, $r = N$.

$$= \frac{1}{2}\, Re\left(\frac{1-e^{j\frac{4\pi k_0 N}{N}}}{1-e^{j\frac{4\pi k_0}{N}}}\right)$$

$$= \frac{1}{2}\left(\frac{1-\cos(4\pi k_0)}{1-\cos\left(\frac{4\pi k_0}{N}\right)}\right)$$

But $\cos(4\pi k_0) = 1$

$\Rightarrow \; = \frac{1}{2}(1-1) = 0$

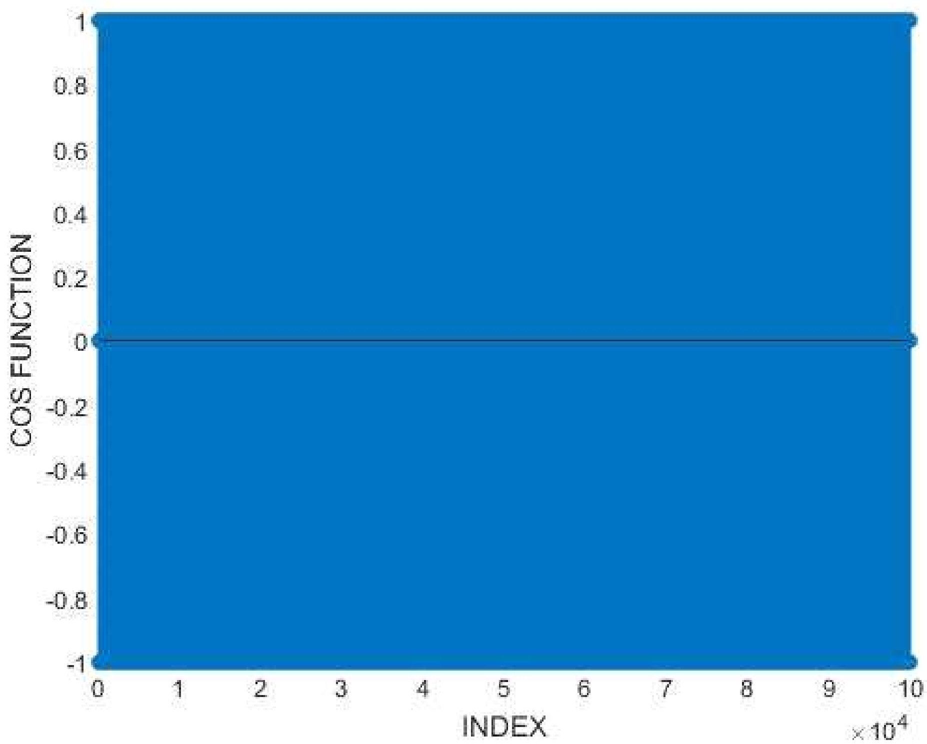
Putting ② in ①

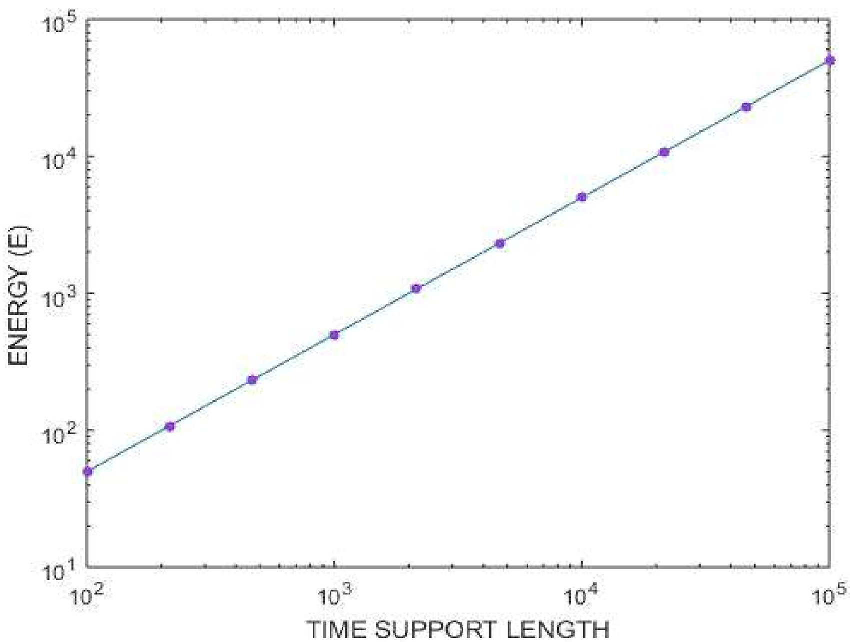
$$E = \frac{N}{2} + \frac{1}{2}(0) = \frac{N}{2}$$

$\Rightarrow$ Energy $= \frac{N}{2}$ J

SECTION 2:-

```
clc
close all
clear all

Nt = logspace(2,5,10);
for nx = 1:length(Nt)
    n = 0:Nt(nx)-1;
    k=floor(Nt(nx)/4);
    xt=cos(2*pi*k*n/Nt(nx));
    stem(n,xt);
    xlabel('INDEX');
    ylabel('COS FUNCTION');
    drawnow;pause(0.1);
    egx(nx) = sum(abs(xt).^2);
end
figure;
loglog(Nt,egx,'o-','MarkerSize',4,'MarkerFaceColor','m');
xlabel('TIME SUPPORT LENGTH');
ylabel('ENERGY (E) ');
```





DISCUSSIONS ON PROBLEM 4 (SECTION 3):-

In this problem we are finding the energy of the signal x(n) = cos(2 *pi*k0*n/N) where 0<=n<=N-1 . The energy of a discrete signal is given by E = summation(n=-N to N(|x(n)|^2)) . First a logspace is created between 10^2 and 10^5 using the logspace(2,5,10) function .Floor() function rounds the given integer to lower values . Sum() is used to calculate the summation of the energy The points are got using a for loop . Then the function is plotted using the stem() function The xlabel and ylabel functions are used to write on the graph using the plot function . The loglog has attributes Markersize and MarkerFace color which are used to give thickness and colour to the point .

PROBLEM 5:-

4) *x(t) = tan(pi*t/2) where t lies between 0<t<1/2*

SECTION 1:-

$$x(t) = \tan\left(\frac{\pi}{2}t\right) \qquad 0 < t < \frac{1}{2}$$

$$E = \int_0^{1/2} \left|\tan\left(\frac{\pi}{2}t\right)\right|^2 dt \qquad (\tan^2\theta = \sec^2\theta - 1)$$

$$= \int_0^{1/2} \left(\sec^2\left(\frac{\pi}{2}t\right) - 1\right) dt \qquad \left(\int \sec^2\theta \, d\theta = \tan\theta\right)$$

$$= \left[\frac{\tan\frac{\pi}{2}t}{\pi/2} - t\right]_0^{1/2} = \tan\left(\frac{\pi}{4}\right)\frac{2}{\pi} - \frac{1}{2}$$

$$= \frac{2}{\pi} - \frac{1}{2}$$

$$\Rightarrow E = \frac{2}{\pi} - \frac{1}{2}$$

$$\therefore \text{Power} = \lim_{T\to\infty} \frac{E}{2T} = \frac{\frac{2}{\pi}-\frac{1}{2}}{2T}$$

$$= 0$$

$$\therefore \text{Energy} = \frac{2}{\pi} - \frac{1}{2} \text{ and Power} = 0$$

Therefore it is an energy signal.

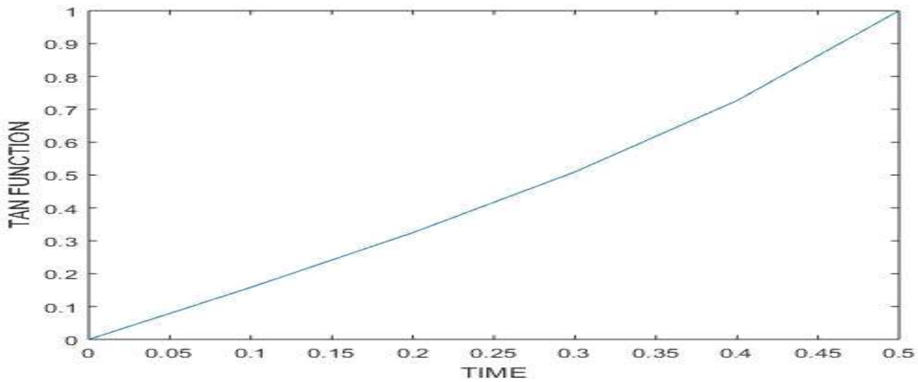
$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-\infty}^{\infty} |x(t)|^2 \, dt$$

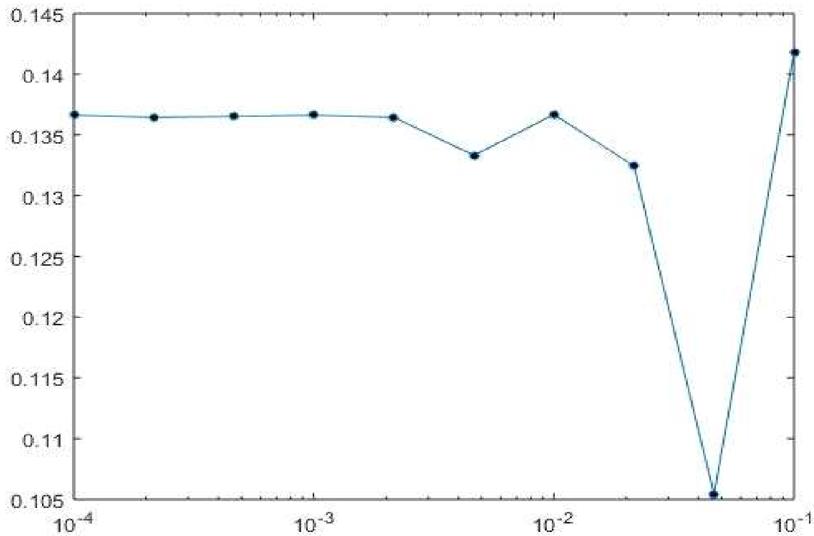
$$= \lim_{T\to\infty} \frac{E}{2T} = \frac{E}{\infty} = 0$$

$$\therefore \text{Power} = 0 \text{ watts}$$

SECTION 2:-

```
clc
close all
clear all

Nt = 1/2;
inc = logspace(-4,-1,10);
for nx = 1:length(inc)
    t = 0:inc(nx):1/2;
    xt=tan(pi/2*t);
    plot(t,xt);.
    xlabel('TIME');
    ylabel('TAN FUNCTION');
    drawnow;pause(0.1);
    egx(nx) = trapz(t,xt.^2);
end
figure;
semilogx(inc,egx,'o-','MarkerSize',4,'MarkerFaceColor','k');
```





DISCUSSIONS ON PROBLEM 5 (SECTION 3):-

In this problem we are finding the energy and power of the signal x(t) = tan(pi/2*t) where t lies between 0 and 1/2 . The energy of a continuous signal is given by E = integral(-inf to inf(|x(t)|^2)) and power of the signal is given by P = limit(T->inf 1/2*T integral(-inf to inf(|x(t)|^2))). First a logspace is created between 10^-4 and 10^-1 using the logspace(-4,-1,10) function . The points are got using a for loop . Then the function is plotted using the plot() function . Trapz() function is used to calculate the area under the graph using egx(nx) = trapz(t,xt.^2);

```
figure;
semilogx(inc,egx,'o-','MarkerSize',4,'MarkerFaceColor','k');
```

The figure is plotted using semilogx function .
The MarkerSize and MarkerFaceColor are attributes which are used to give thickness to line and colour to point .
The xlabel and ylabel functions are used to write on the graph using the plot function . The semilogx has attributes Markersize and MarkerFace color which are used to give thickness and colour to the point .