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Reg. No.: 19BCE2074

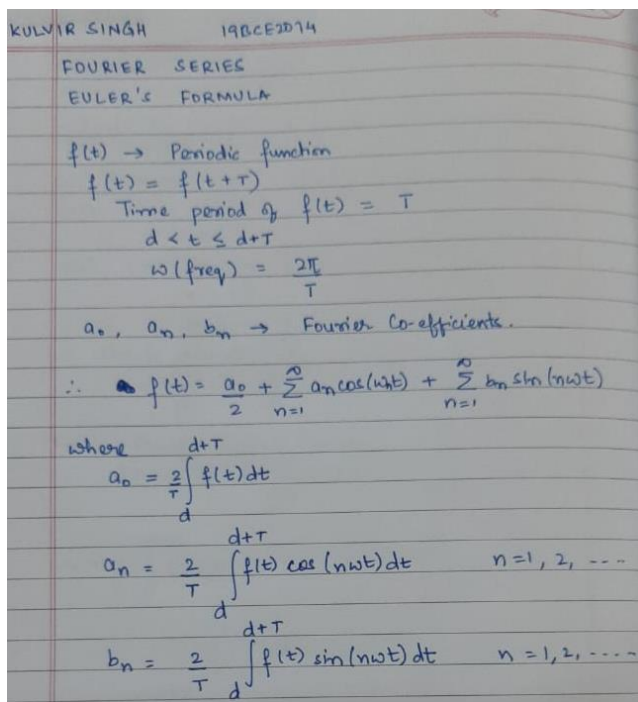
E-Record 1

Experiment 1A – Fourier Series Expansion

Aim:

Find the Fourier series of the function $f(t) = \begin{cases} 0, & \text{if } -2 < t < -1 \\ 1, & \text{if } -1 < t < 1 \\ 0, & \text{if } 1 < t < 2 \end{cases}$

Mathematical Background:



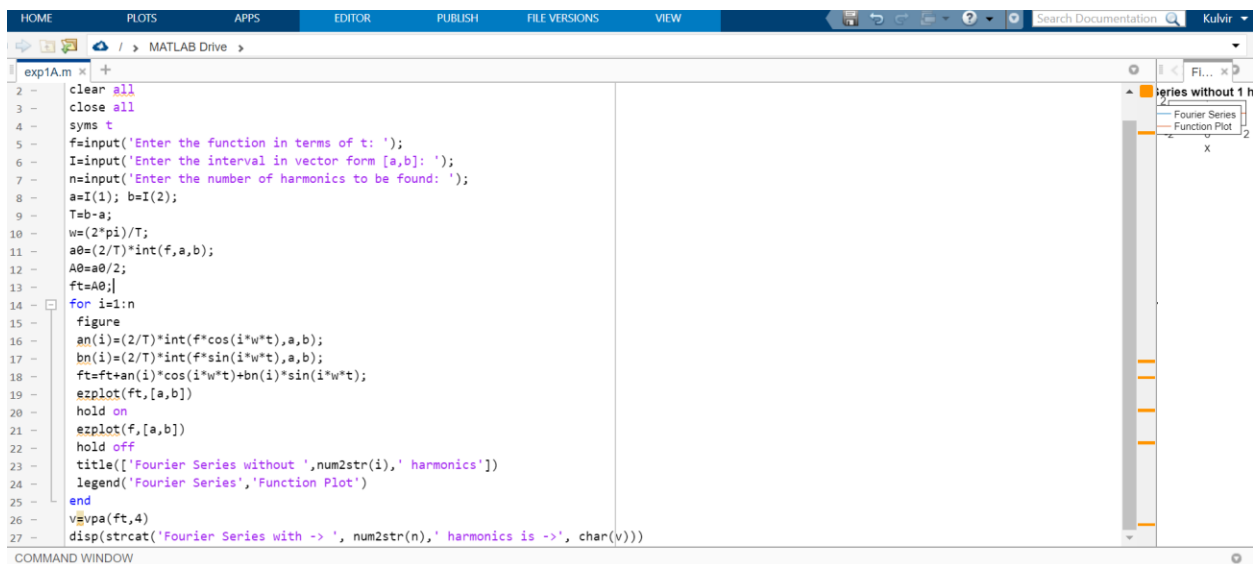
MATLAB Code:

```
clc
clear all
close all
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```

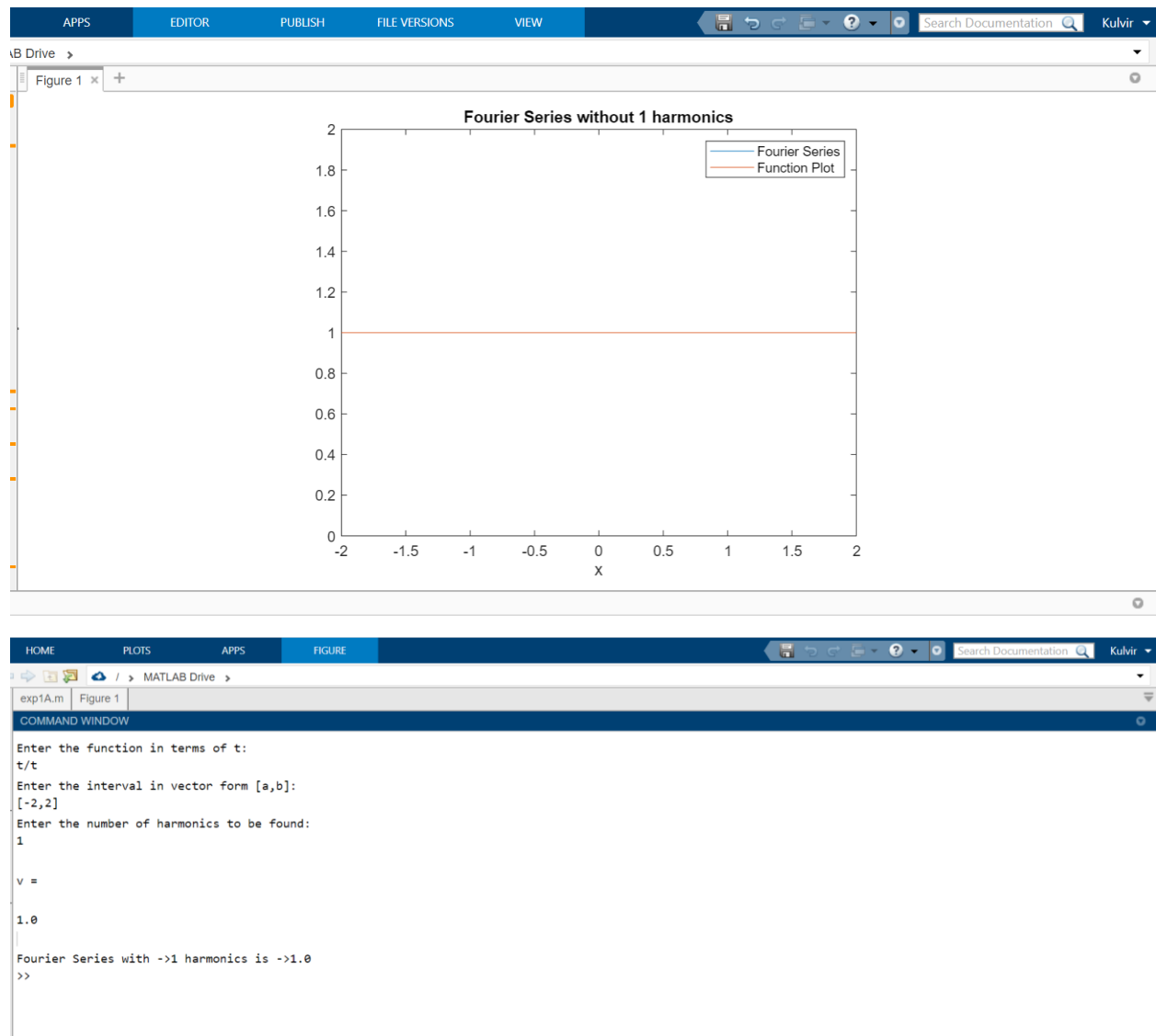
```

syms t
f=input('Enter the function in terms of t: ');
I=input('Enter the interval in vector form [a,b]: ');
n=input('Enter the number of harmonics to be found: ');
a=I(1); b=I(2);
T=b-a;
w=(2*pi)/T;
a0=(2/T)*int(f,a,b);
A0=a0/2;
ft=A0;
for i=1:n
    figure
    an(i)=(2/T)*int(f*cos(i*w*t),a,b);
    bn(i)=(2/T)*int(f*sin(i*w*t),a,b);
    ft=ft+an(i)*cos(i*w*t)+bn(i)*sin(i*w*t);
    ezplot(ft,[a,b])
    hold on
    ezplot(f,[a,b])
    hold off
    title(['Fourier Series without ',num2str(i),' harmonics'])
    legend('Fourier Series','Function Plot')
end
v=vpa(ft,4)
disp(strcat('Fourier Series with -> ', num2str(n),' harmonics is ->', char(v)))

```



Output:



Experiment 1B – Harmonic Analysis

Aim:

Find the first two harmonics for the following data

t	0	$\pi/2$	π	$3\pi/2$
f(t)	1	2	3	4

Mathematical Background:

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HARMONIC ANALYSIS

For Discrete Values, $f(t)$ can be reduced as follows:

if $T = 2\pi$

(ie) $-\pi = t_0, t_1, t_2, \dots, t_n = \pi$
[a, b]

\therefore No. of points = $N+1$
No. of intervals = N
 $h = \frac{b-a}{N} = \frac{2\pi}{N}$

From Fourier Series expansion.

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos(nt) + \sum_{n=1}^{\infty} b_n \sin(nt)$$

$(n=1, 2, \dots)$

$$a_0 = \frac{1}{\pi} \int_d^{d+2\pi} f(t) dt = \frac{1}{\pi} \sum_{i=0}^N h f(t_i)$$
$$\therefore a_0 = \frac{2}{N} \sum_{i=0}^N f(t_i)$$
$$a_n = \frac{1}{\pi} \int_d^{d+2\pi} f(t) \cos(nt) dt$$
$$\therefore a_n = \frac{2}{N} \sum_{i=0}^N f(t_i) \cos(nt_i)$$
$$b_n = \frac{1}{\pi} \int_d^{d+2\pi} f(t) \sin(nt) dt$$
$$\therefore b_n = \frac{2}{N} \sum_{i=0}^N f(t_i) \sin(nt_i)$$

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MATLAB Code:

```
clc
clear all
close all
syms x
t=input('Enter the value of t in row vector:');
f=input('Enter the f values in row vector:');
m=input('No. of harmonics to be found:');
N=numel(t);
h=2*pi/N;
c=input('Enter nonzero if t is not in radian:');
a0=(2/N)*sum(f);
if c==0
theta=t;
else
theta=t(1)+(0:N-1)*h
end
F_s=a0/2;
figure

A0=a0/2;
for i=1:m
yc=f.*cos(i*theta);
ys=f.*sin(i*theta);
an(i)=(2/N)*sum(yc);
bn(i)=(2/N)*sum(ys);
F_s=F_s+an(i)*cos(i*x)+bn(i)*sin(i*x);
subplot(1,m,1);
plot(t,f, '*r')
hold on
ezplot(F_s,[t(1),t(N)])
hold off
end
F_t=vpa(F_s,5)
```

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exp1B.m x +

```

1 -   clc
2 -   clear all
3 -   close all
4 -   syms x
5 -   t=input('Enter the value of t in row vector:');
6 -   f=input('Enter the f values in row vector:');
7 -   m=input('No. of harmonics to be found:');
8 -   N=numel(t);
9 -   h=2*pi/N;
10 -  c=input('Enter nonzero if t is not in radian:');
11 -  a0=(2/N)*sum(f);
12 -  if c==0
13 -      theta=t;
14 -  else
15 -      theta=t(1)+(0:N-1)*h
16 -  end
17 -  F_s=a0/2;
18 -  figure
19
20 -  A0=a0/2;
21 -  for i=1:m
22 -      yc=f.*cos(i*theta);
23 -      ys=f.*sin(i*theta);
24 -      an(i)=(2/N)*sum(yc);
25 -      bn(i)=(2/N)*sum(ys);
26 -

```

COMMAND WINDOW

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```

6 -  c=input('Enter nonzero if t is not in radian:');
1 -  a0=(2/N)*sum(f);
2 -  if c==0
3 -      theta=t;
4 -  else
5 -      theta=t(1)+(0:N-1)*h
6 -  end
7 -  F_s=a0/2;
8 -  figure
9
10 -  A0=a0/2;
1 -  for i=1:m
2 -      yc=f.*cos(i*theta);
3 -      ys=f.*sin(i*theta);
4 -      an(i)=(2/N)*sum(yc);
5 -      bn(i)=(2/N)*sum(ys);
6 -      F_s=F_s+an(i)*cos(i*x)+bn(i)*sin(i*x);
7 -      subplot(1,m,1);
8 -      plot(t,f,'*r')
9 -      hold on
10 -  ezplot(F_s,[t(1),t(N)])
1 -  hold off
2 -  end
3 -  F_t=vpa(F_s,5)

```

Output:

```

PLOTS APPS FIGURE
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exp1B.m Figure 1
COMMAND WINDOW
Enter the value of t in row vector:
[0 pi/2 pi 3*pi/2]
Enter the f values in row vector:
[1 2 3 4]
No. of harmonics to be found:
2
Enter nonzero if t is not in radian:
0
F_t =
4.8986e-16*sin(2.0*x) - 1.0*cos(2.0*x) - 1.0*cos(x) - 1.0*sin(x) + 2.5
>>

```

