MATLAB Experiment -2

Fourier series

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- **Course code-MAT2002**
- **Faculty- Poornima T**
- **SLOTS-L15+L16**

1. Find the Fourier series expansion of the following functions:

a) $f(x)=\begin{cases}-1; -2<x<0\\ 1; 0<x<2\end{cases}$, $f(x+4)=f(x)$

b) $f(x)=\begin{cases}0; -2<x<0\\ 4; 0<x<2\end{cases}$, $f(x+4)=f(x)$

c) $f(x)=e^{-x}$ in the interval $0<x<2\pi$, given that $f(x+2\pi)=f(x)$.

Answer 1.

(A)-

Code:

```
clear all
close all
clc syms x
f =input('Enter the function of x: ');
I=input('Enter the interval of [a,b]: ');
m=input('Enter the number of Harmonics required: ');
a=I(1);b=I(2);
L=(b-a)/2;
a0=(1/L)*int(f,a,b);
```

```
 Fx=a0/2;
for n=1:m
figure;
 an=(1/L)*int(f*cos(n*pi*x/L),a,b);
 bn=(1/L)*int(f*sin(n*pi*x/L),a,b);
 Fx=Fx+an*cos(n*pi*x/L)+bn*sin(n*pi*x/L);
 Fx=vpa(Fx,4); ezplot(Fx,[a,b]);
hold on ezplot(f, [a,b]);
 title ('Fourier Series');
legend('Fourier Series', 'Function Plot');
 hold off
end
 disp(strcat('Fourier series with', num2str(n),'harmonics is:',char(Fx)));
```

Inputs-

Enter the function of x:

-1*(heaviside(x+2)-heaviside(x)) +1*(heaviside(x)-heaviside(x-2))

Enter the interval of [a,b]: [-2 2]

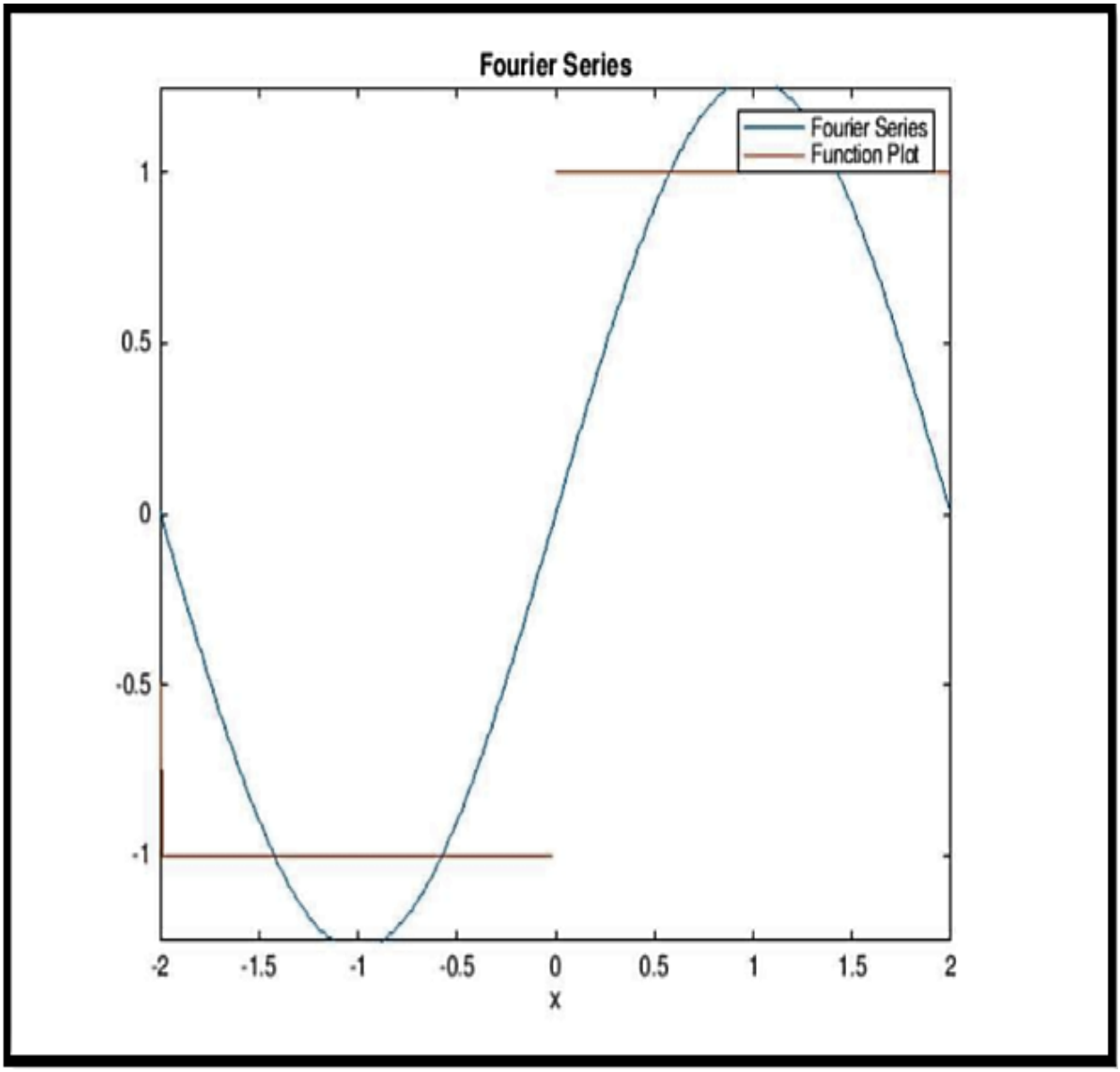
Enter the number of Harmonics required: 8

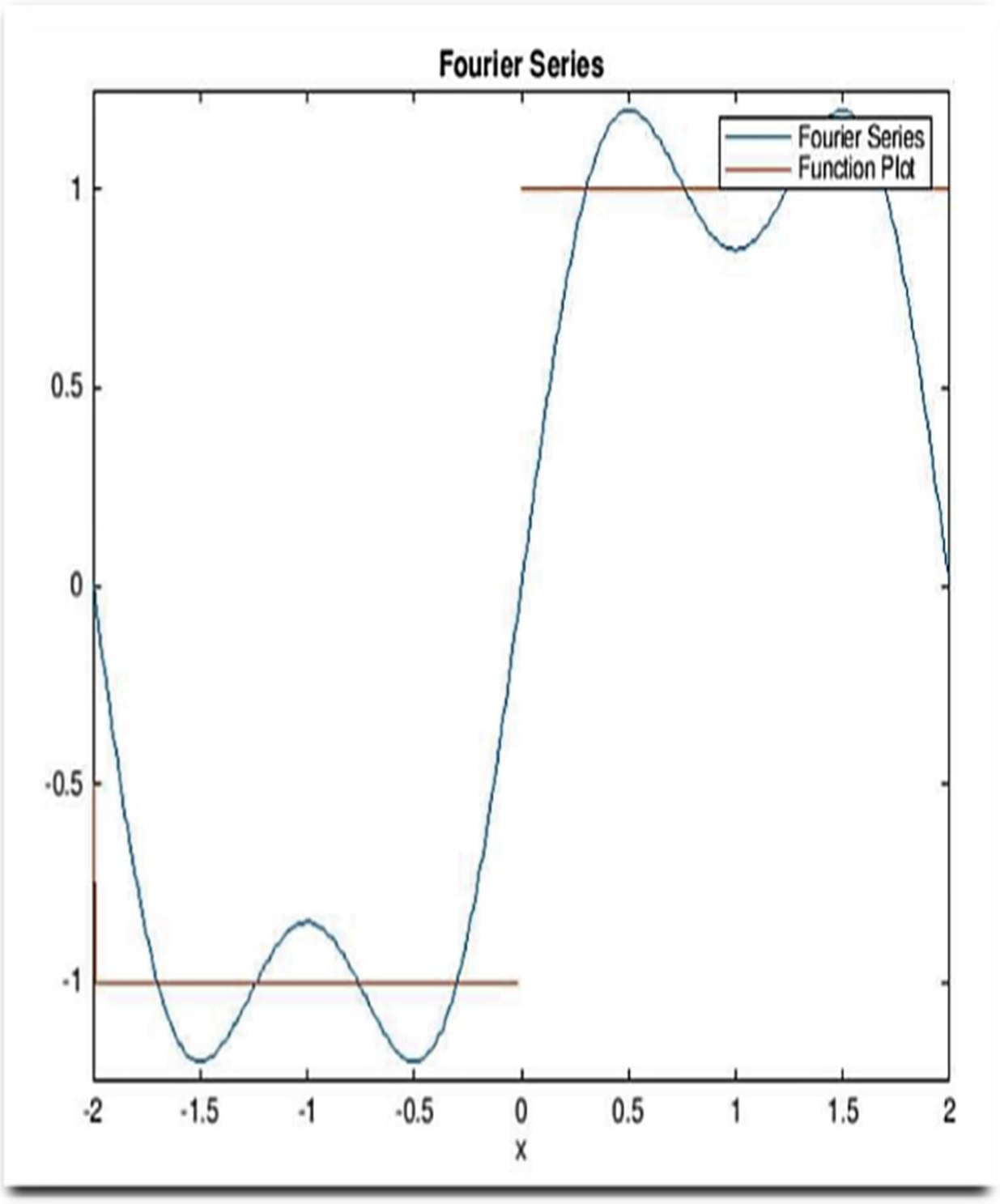
Outputs-

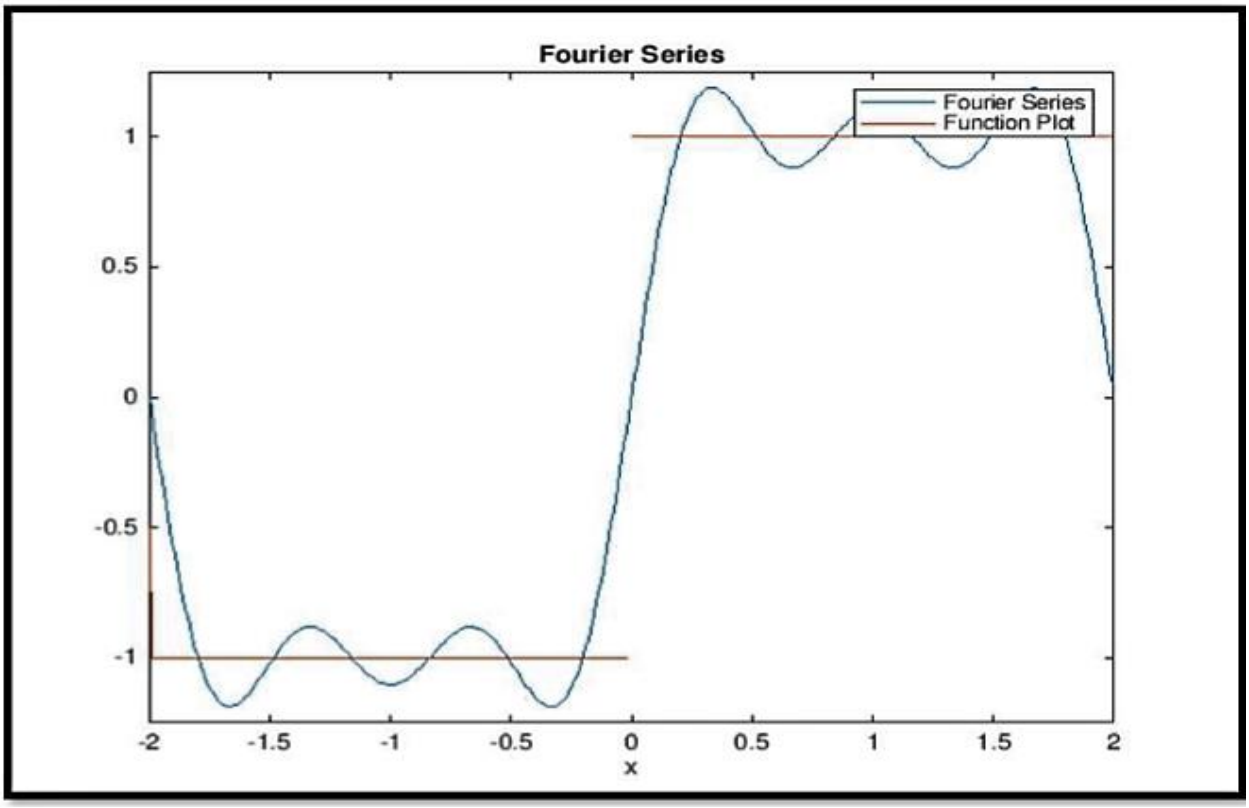
Fourier series with 8 harmonics is:

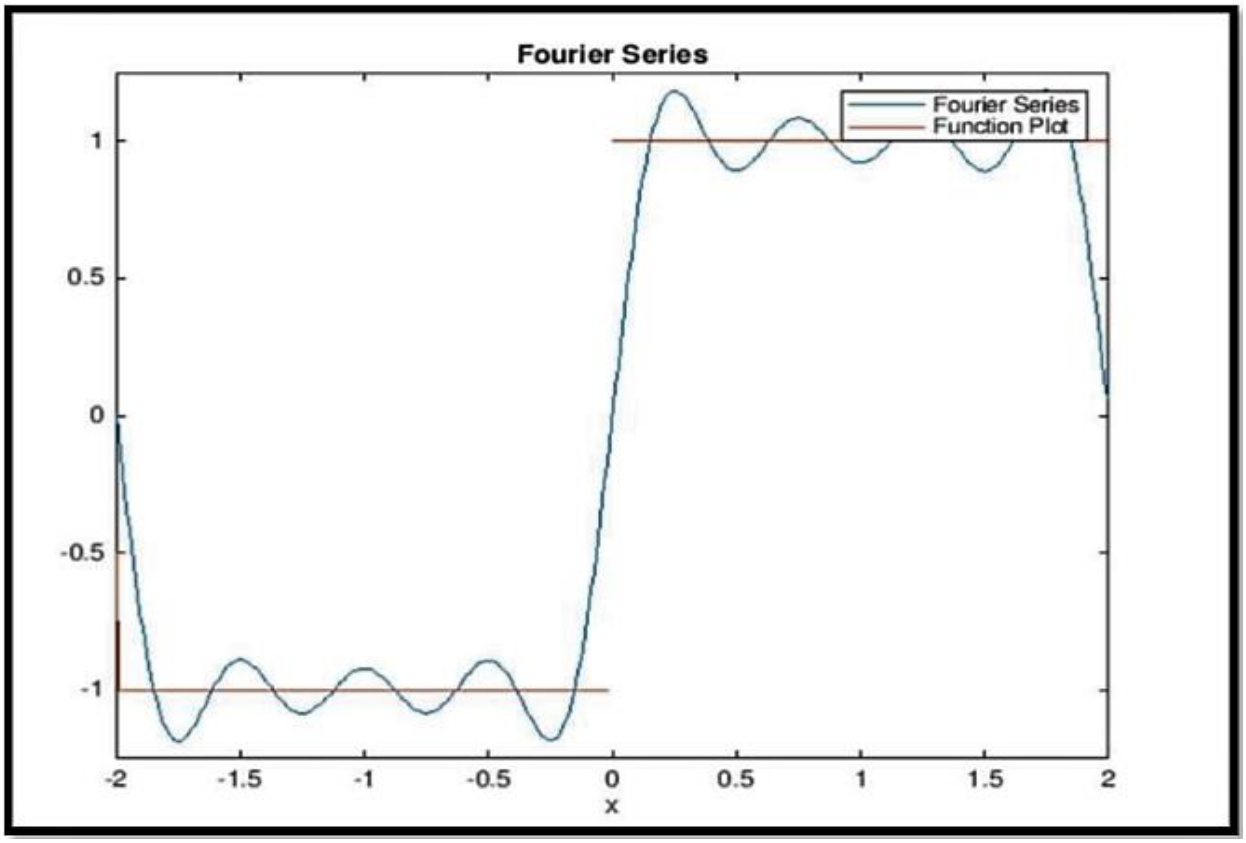
0.4244*sin(4.712*x) + 0.1819*sin(11.0*x) + 1.273*sin(1.571*x) + 0.2546*sin(7.854*x)

Plots:


Fourier Series
Fourier Series
Function Plot
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x


Fourier Series
Fourier Series
Function Plot
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
X


Fourier Series
Fourier Series
Function Plot
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x


Fourier Series
Fourier Series
Function Plot
1
0.5
0
-0.5
-1
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x

Answer 1.

(B)-

Code:

```
clear all
close all
 clc syms x
 f =input('Enter the function of x: ');
 I=input('Enter the interval of [a,b]: ');
 m=input('Enter the number of Harmonics required: ');
 a=I(1);b=I(2);
 L=(b-a)/2;
 a0=(1/L)*int(f,a,b);
 Fx=a0/2;
for n=1:m
figure;
 an=(1/L)*int(f*cos(n*pi*x/L),a,b);
 bn=(1/L)*int(f*sin(n*pi*x/L),a,b);
 Fx=Fx+an*cos(n*pi*x/L)+bn*sin(n*pi*x/L);
Fx=vpa(Fx,4);
ezplot(Fx,[a,b]);
 hold on ezplot(f,[a,b]);
 title('Fourier Series');
legend('Fourier Series', 'Function Plot');
 hold off
 end
disp(strcat('Fourier series with', num2str(n),'harmonics is:',char(Fx)));
```

Inputs…

Enter the function of x: 4*(heaviside(x)-heaviside(x-2))

Enter the interval of [a,b]: [-2 2]

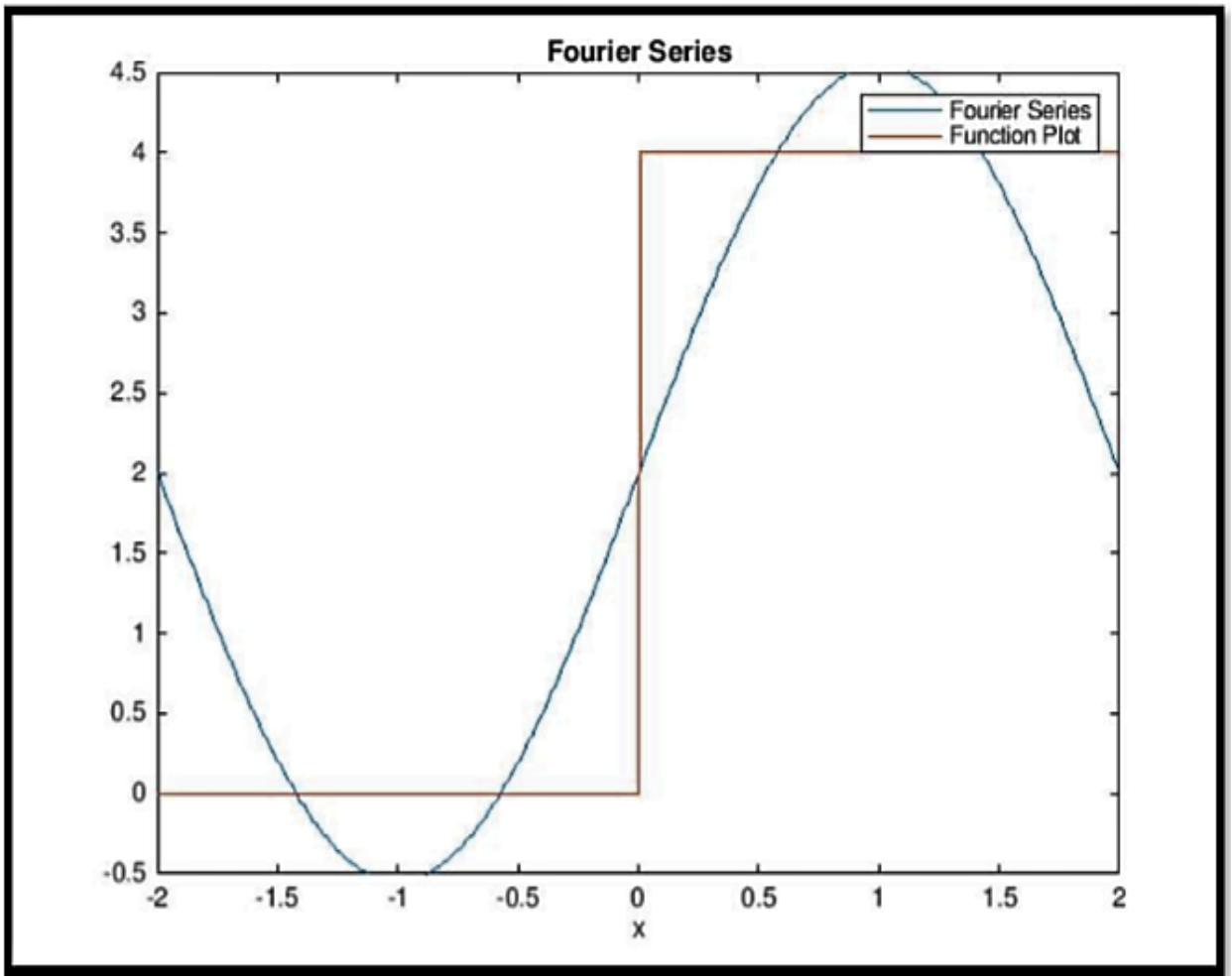
Enter the number of Harmonics required: 6

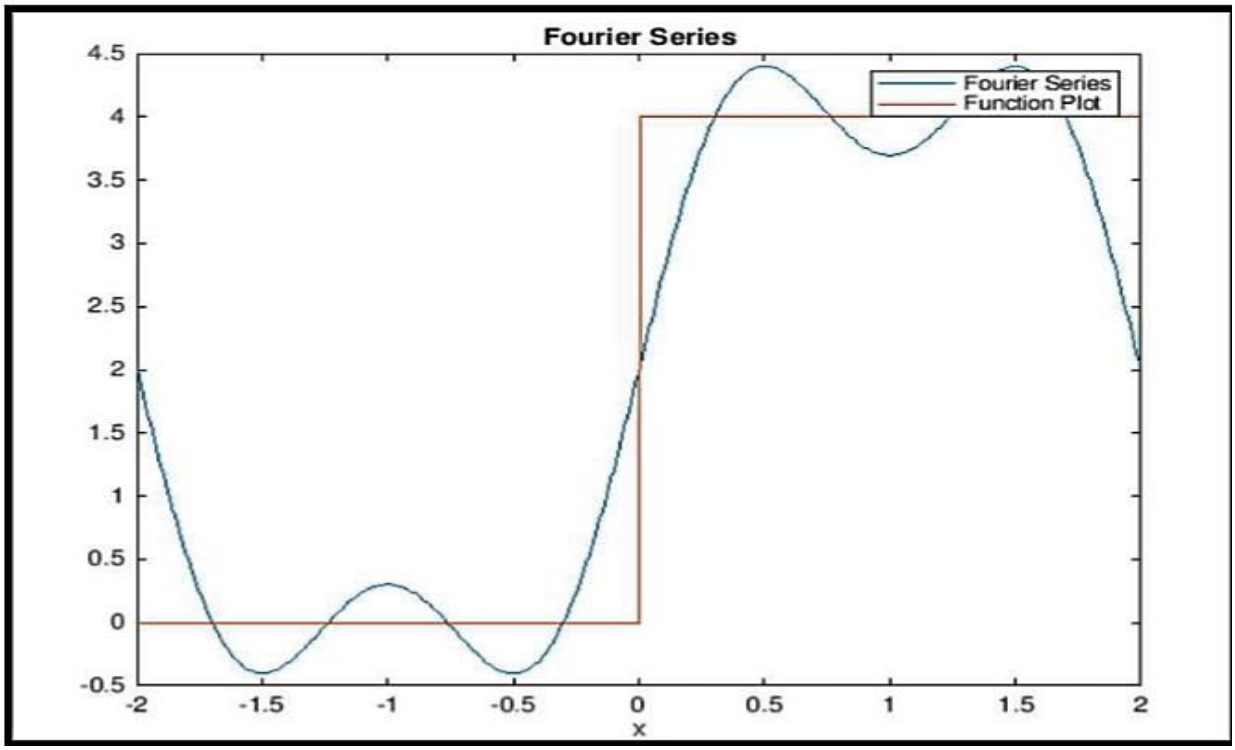
Outputs-

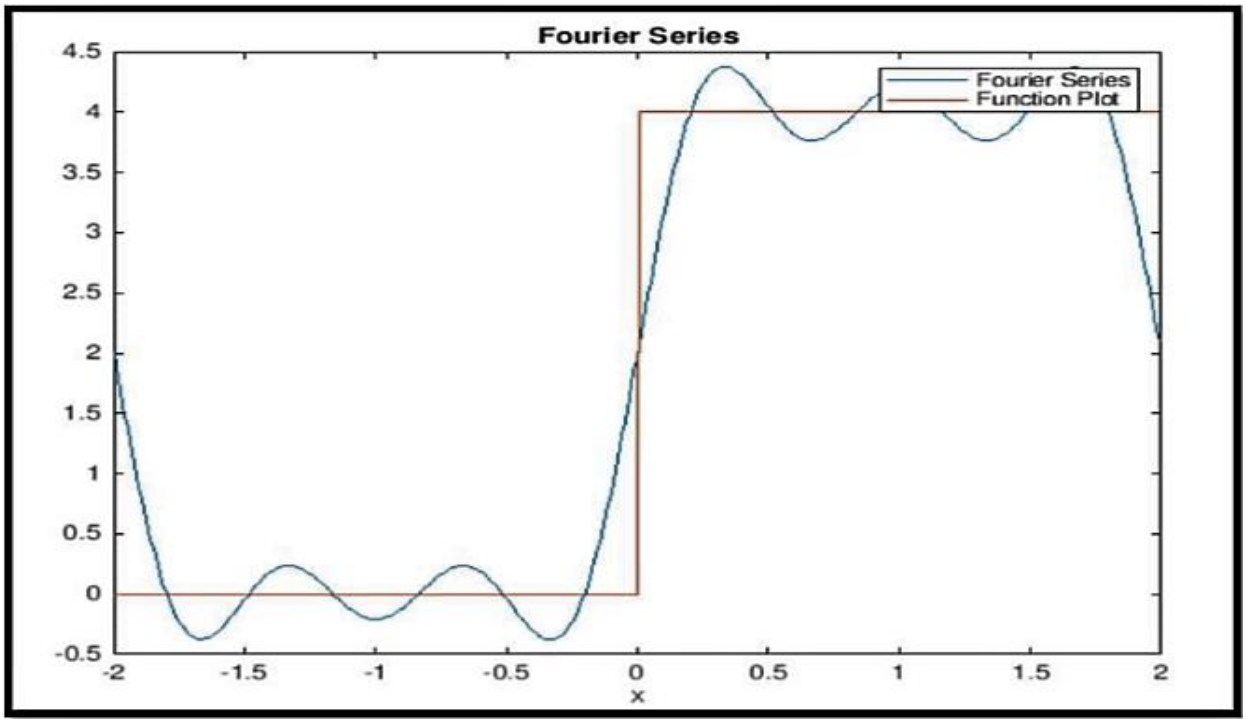
Fourier series with 6 harmonics is:

0.8488*sin(4.712*x) + 2.546*sin(1.571*x) + 0.5093*sin(7.854*x) + 2.0

Plots-




Fourier Series
Fourier Series
Function Plot
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x


Fourier Series
Fourier Series
Function Plot
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
x

Answer 1.

(C) -

Code:

```
clear all
close all
 clc
 syms x
 f =input('Enter the function of x: ');
 I=input('Enter the interval of [a,b]: ');
 m=input('Enter the number of Harmonics required: ');
 a=I(1);b=I(2); L=(b-a)/2; a0=(1/L)*int(f,a,b);
Fx=a0/2;
 for n=1:m
figure;
 an=(1/L)*int(f*cos(n*pi*x/L),a,b);
 bn=(1/L)*int(f*sin(n*pi*x/L),a,b);
Fx=Fx+an*cos(n*pi*x/L)+bn*sin(n*pi*x/L);
Fx=vpa(Fx,4); ezplot(Fx,[a,b]);
 hold on ezplot(f,[a,b]);
 title('Fourier Series');
 legend('Fourier Series', 'Function Plot');
 hold off
end
disp(strcat('Fourier series with', num2str(n),'harmonics is:',char(Fx)));
```

Inputs…

Enter the function of x: exp(-x)

Enter the interval of [a,b]: [0 2*pi]

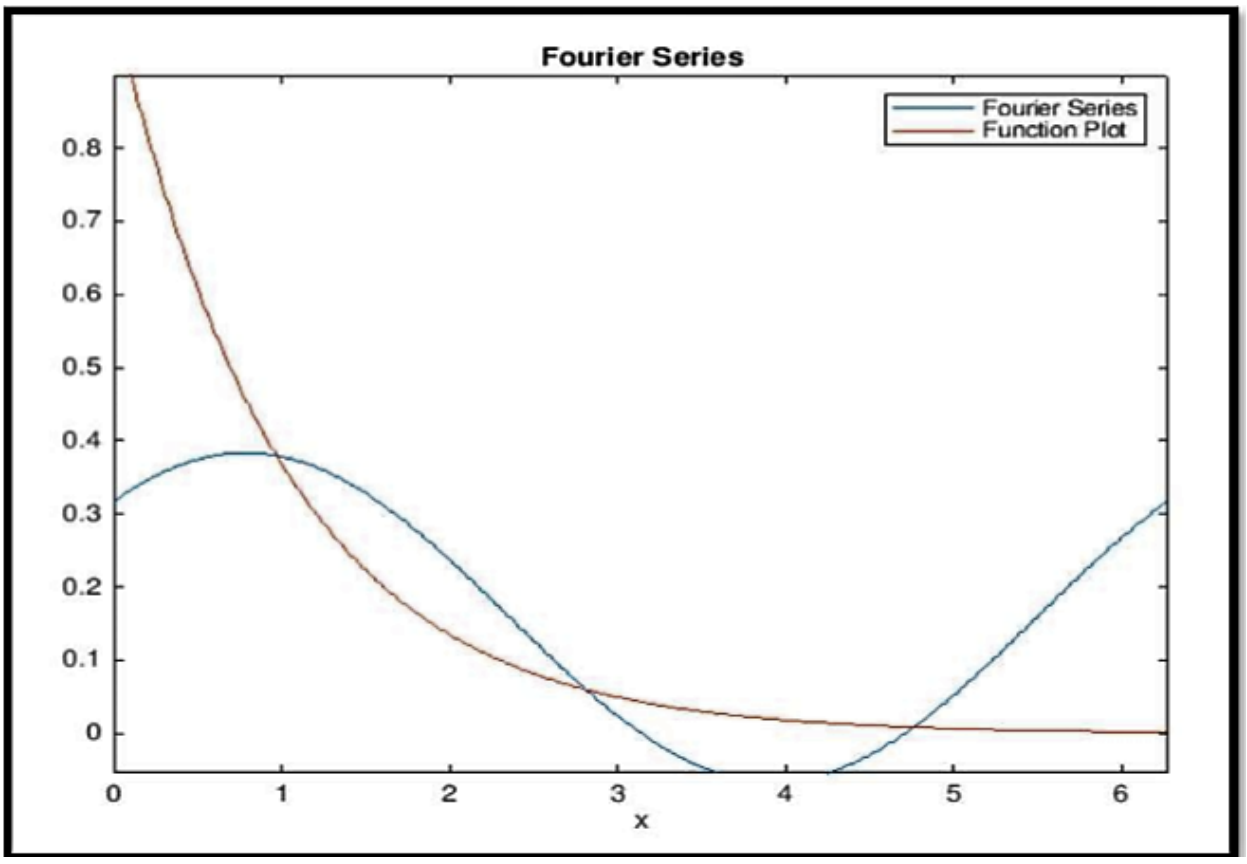
Enter the number of Harmonics required: 4

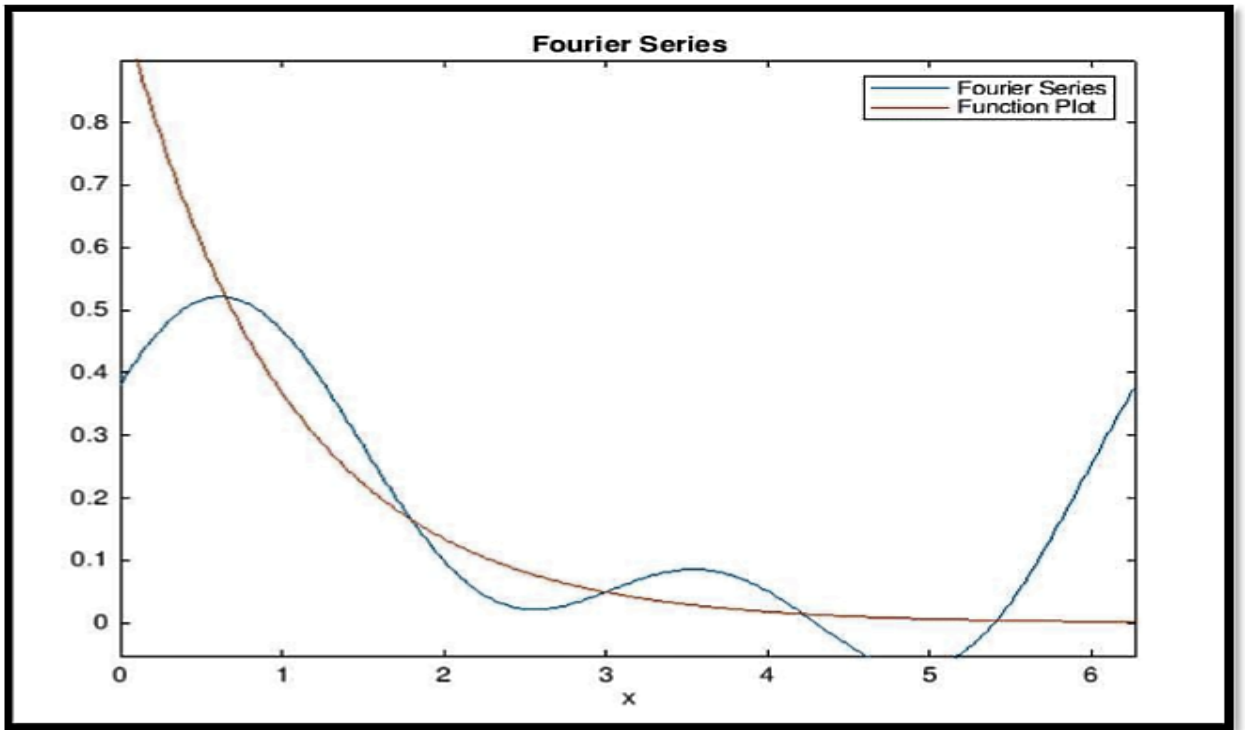
Output…

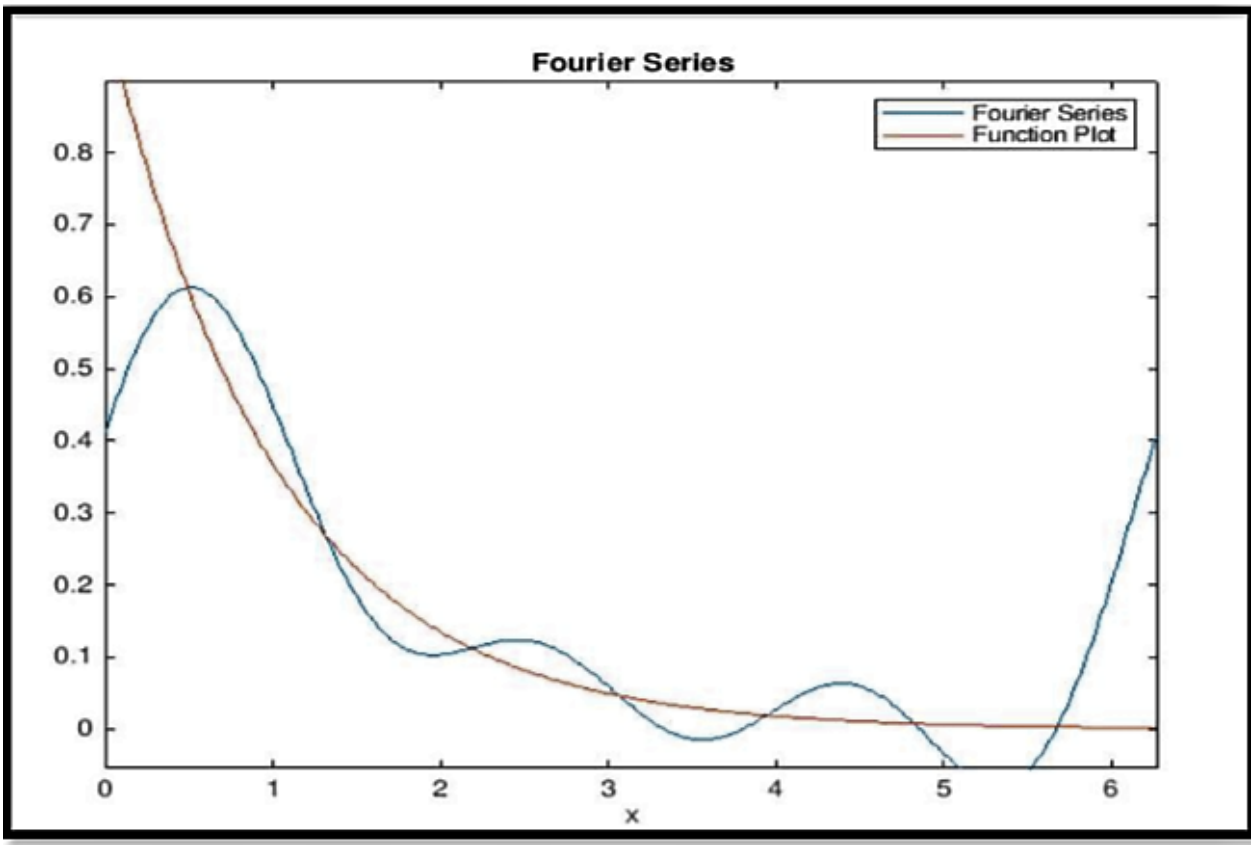
Fourier series with 4 harmonics is:

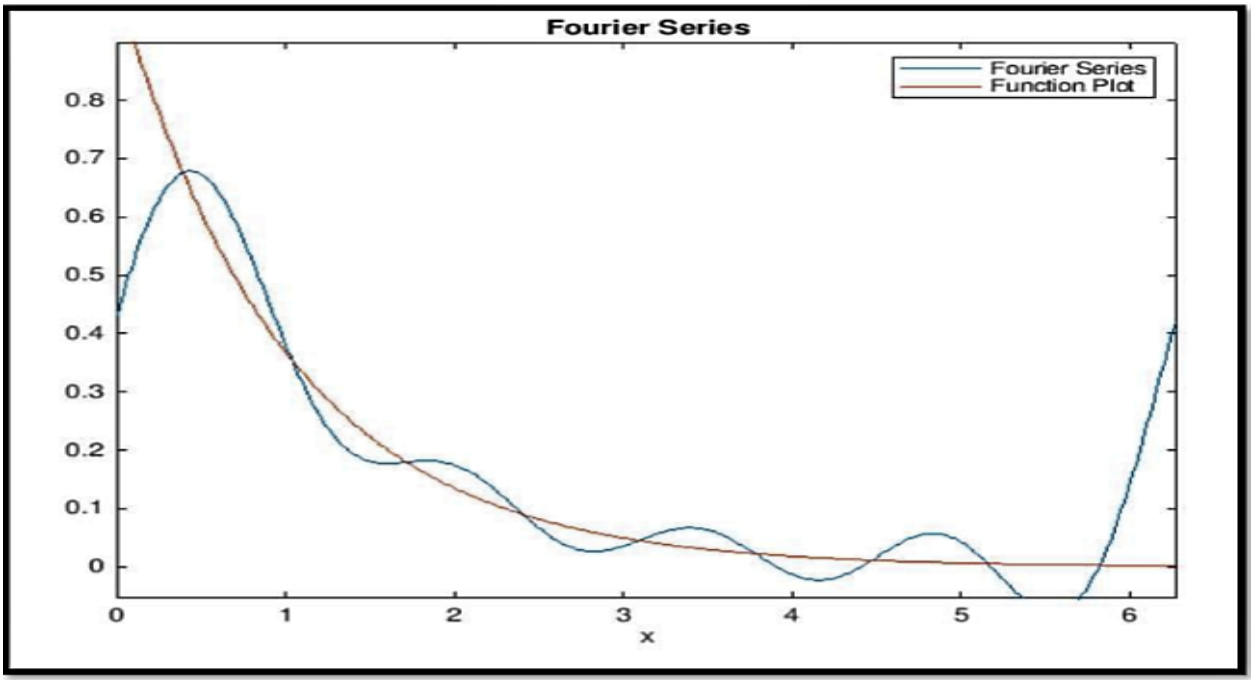
0.06354*cos(2.0*x) + 0.01869*cos(4.0*x) + 0.1271*sin(2.0*x) + 0.07476*sin(4.0*x) + 0.03177*cos(3.0*x) + 0.09531*sin(3.0*x) + 0.1589*cos(x) + 0.1589*sin(x) + 0.1589

Plots:




Fourier Series
Fourier Series
Function Plot
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
x


Fourier Series
Fourier Series
Function Plot
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
x



2. A sinusoidal voltage $E\sin\omega t$, where t is time, is passed through a half-wave rectifier that clips the negative portion of the wave. Find the Fourier series of the resulting periodic function $f(t)=\begin{cases} 0; -\pi/\omega < t < 0 \\ E\sin\omega t; 0 < t < \pi/\omega \end{cases}$, $f(t+2\pi/\omega)=f(t)$, with $E=5$, $\omega=2\pi$.

Answer 2.

Code: -

```
Clear
 close all
 clc
 syms t
f=input('Enter the function of t: ');
I=input('Enter the interval of [a,b]: ');
 m=input('Enter the number of Harmonics required: ');
a=I(1);b=I(2);
```

```
 L=(b-a)/2;
 a0=(1/L)*int(f,a,b);
Ft=a0/2; for n=1:m
figure;
 an=(1/L)*int(f*cos(n*pi*t/L),a,b);
 bn=(1/L)*int(f*sin(n*pi*t/L),a,b);
 Ft=Ft+an*cos(n*pi*t/L)+bn*sin(n*pi*t/L);
 Ft=vpa(Ft,4); ezplot(Ft,[a,b]); hold on ezplot(f,[a,b]);
 title('Fourier Series'); legend('Fourier Series', 'Function Plot');
hold off end disp(strcat('Fourier series with', num2str(n),'harmonics is:',char(Ft)));
```

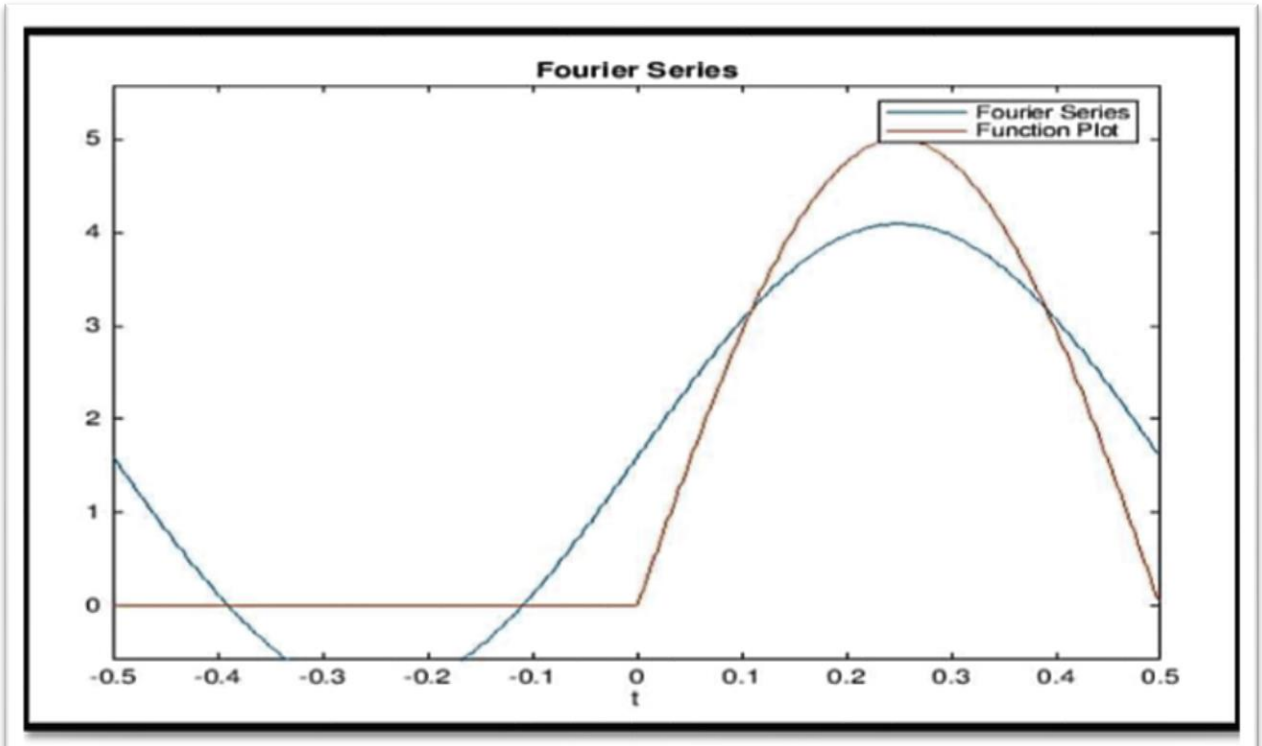
Inputs-

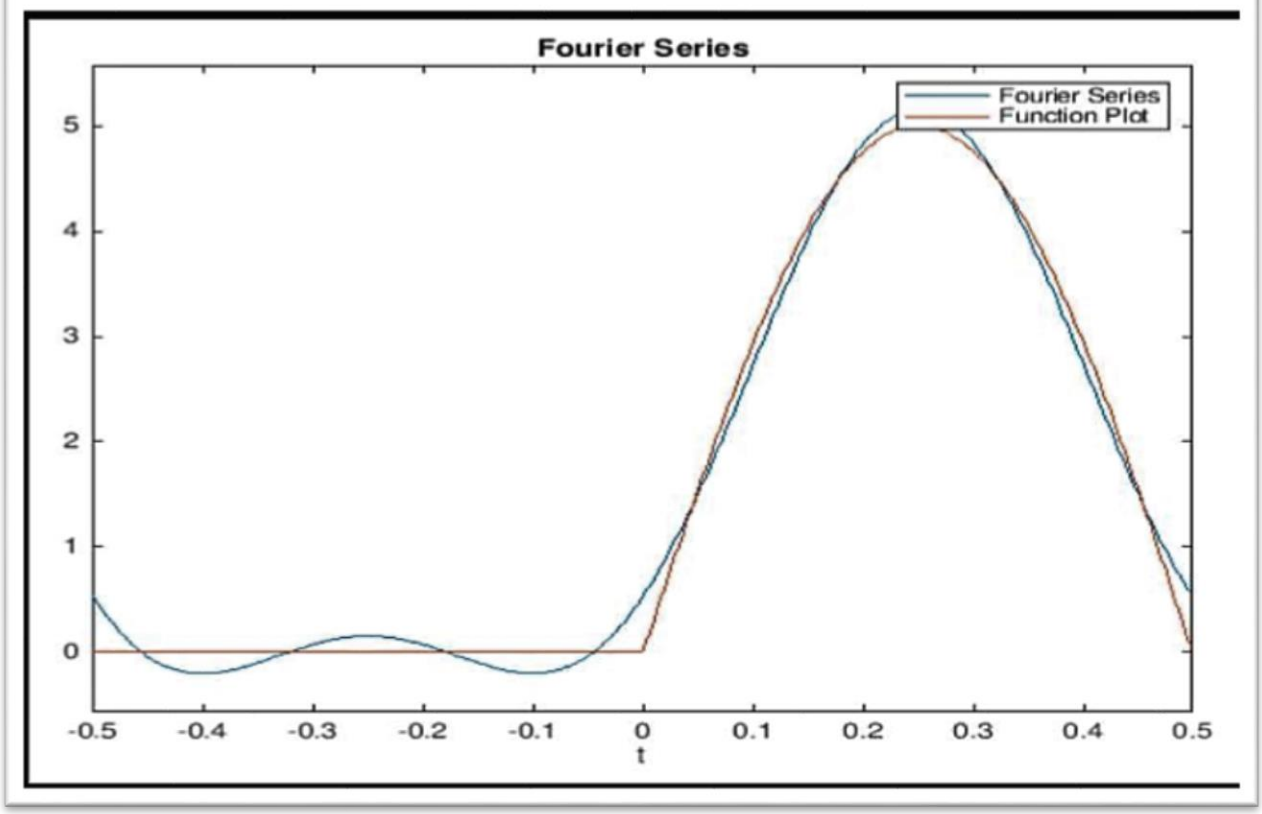
```
Enter the function of t:  5*sin(2*pi*t)*(heaviside(t)-heaviside(t-(1/2)))
 Enter the interval of [a,b]:  [-0.5 0.5]
Enter the number of Harmonics required:  4
```

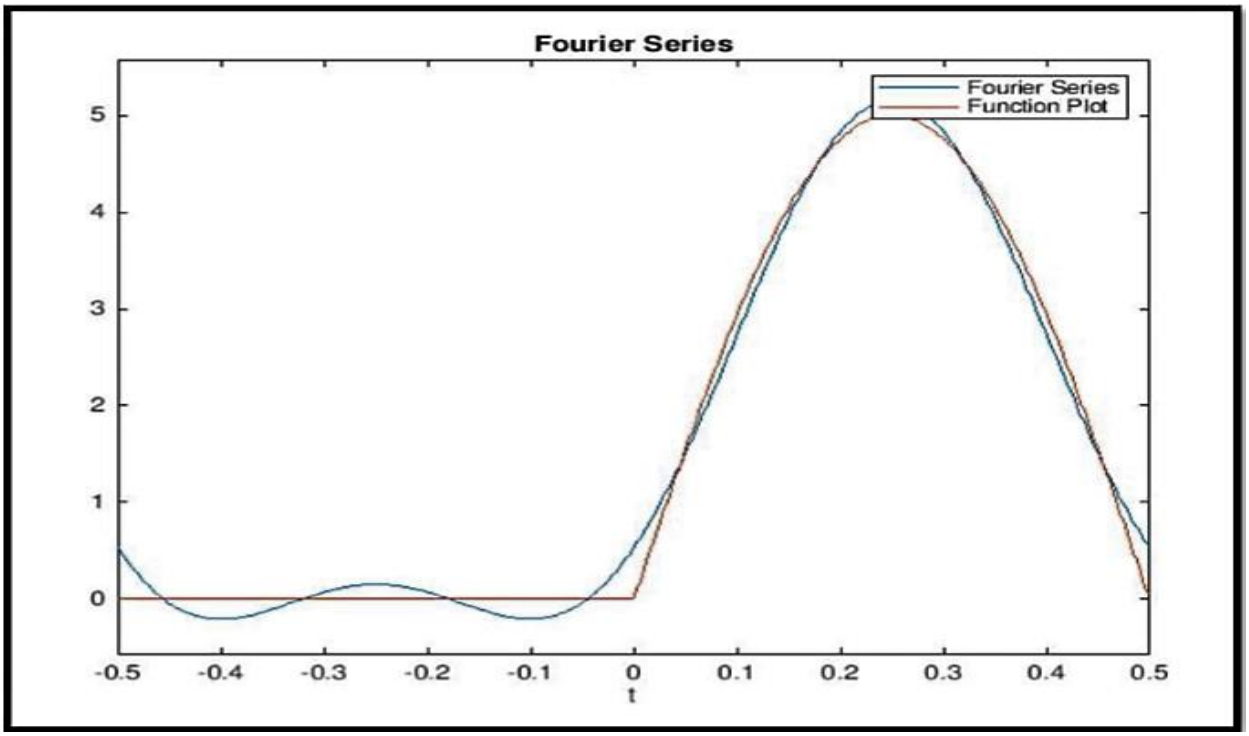
Outputs-

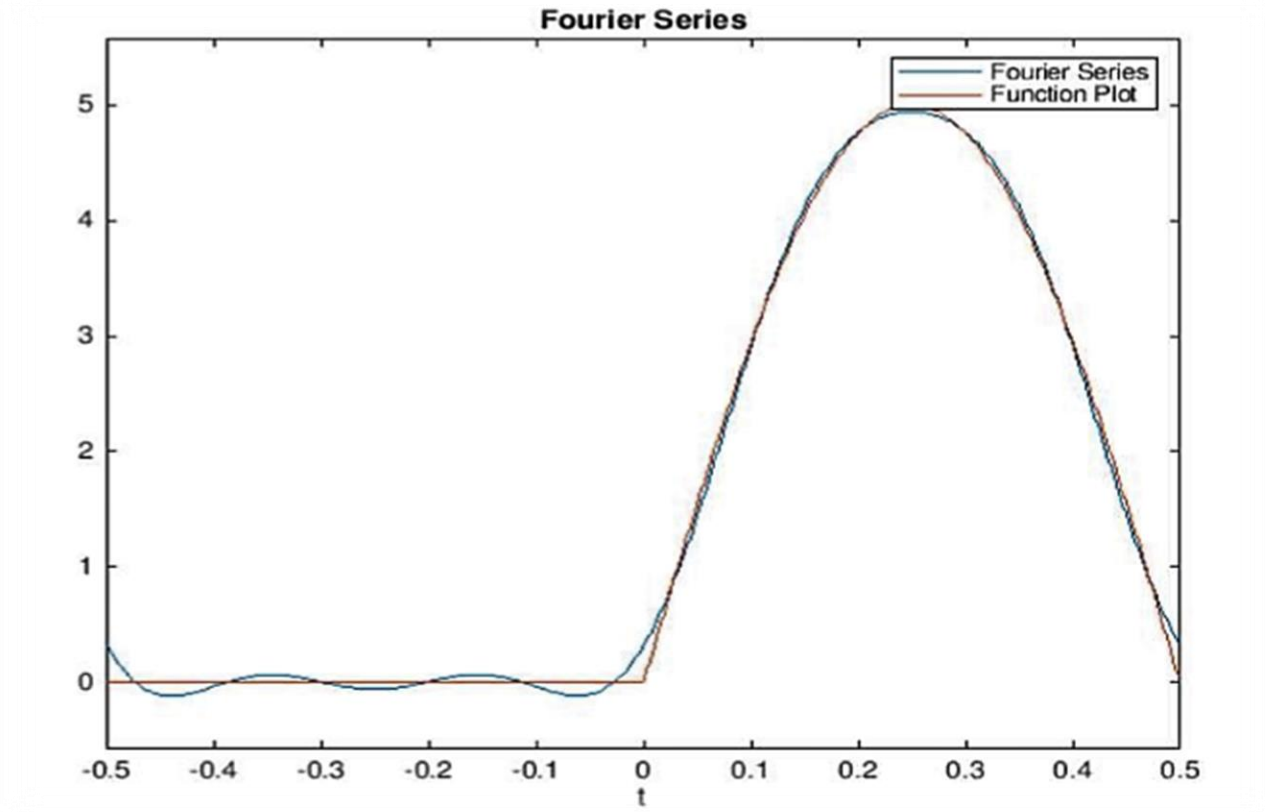
```
Fourier series with4harmonics is:
2.5*sin(6.283*t) - 0.2122*cos(25.13*t) - 1.061*cos(12.57*t) + 1.592
```

Plots-


Fourier Series
Fourier Series
Function Plot
5
4
3
2
1
0
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
t


Fourier Series
Fourier Series
Function Plot
5
4
3
2
1
0
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
t


Fourier Series
Fourier Series
Function Plot
5
4
3
2
1
0
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
t


Fourier Series
Fourier Series
Function Plot
5
4
3
2
1
0
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
t