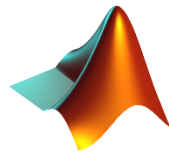


# MAT 2002

MATLAB



## Lab Assessment – 2

L29+L30

FALL SEMESTER 2020–21

by

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## Question 1

### Problem:

Input a function  $f(x)$  which is periodic in the interval  $(a, b)$ . Find fourier series for  $f(x)$  up to  $n$  harmonics and hence plot  $f(x)$  for its fourier series.

Run code for the following:

(i)  $f(x) = x^2$ ,  $a = -\pi$ ,  $b = \pi$  (up to 3 harmonics)

$$(ii) \quad f(x) = \begin{cases} 1 + \frac{2x}{\pi}, & -\pi \leq x \leq 0 \\ 1 - \frac{2x}{\pi}, & 0 \leq x \leq \pi \end{cases} \quad (\text{up to 3 harmonics})$$

### Code in MATLAB Editor:

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

## Input & Output in Command Window along with screenshots of Graphs:

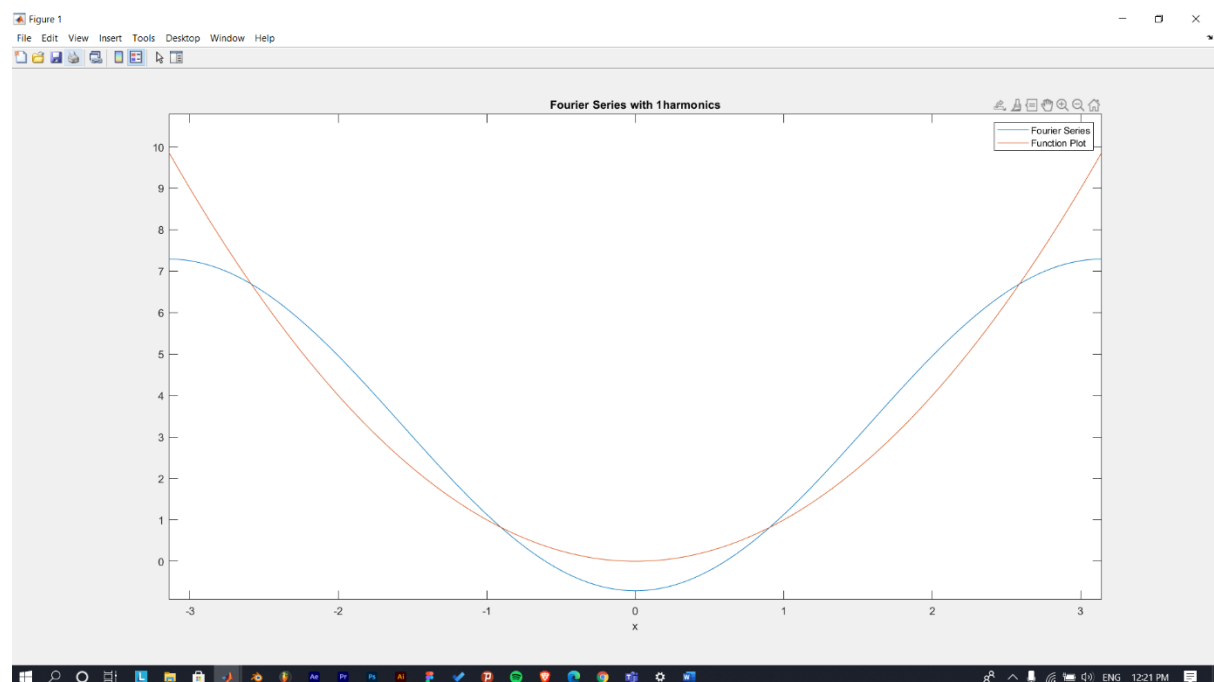
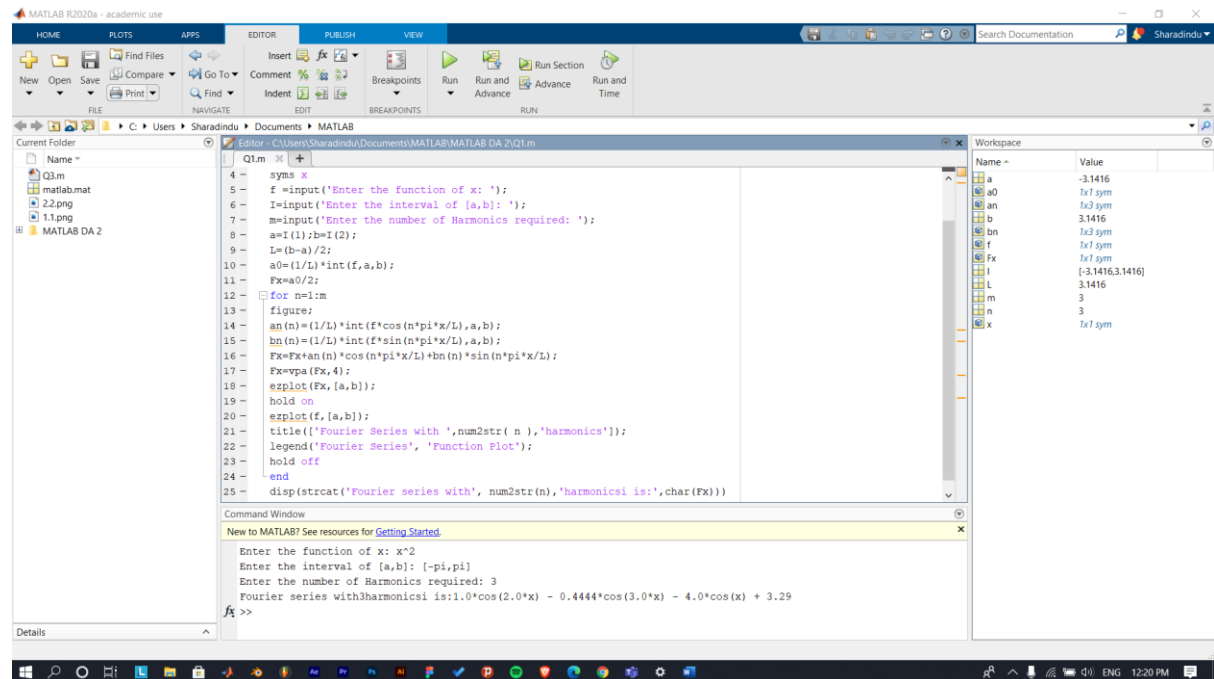
(i)

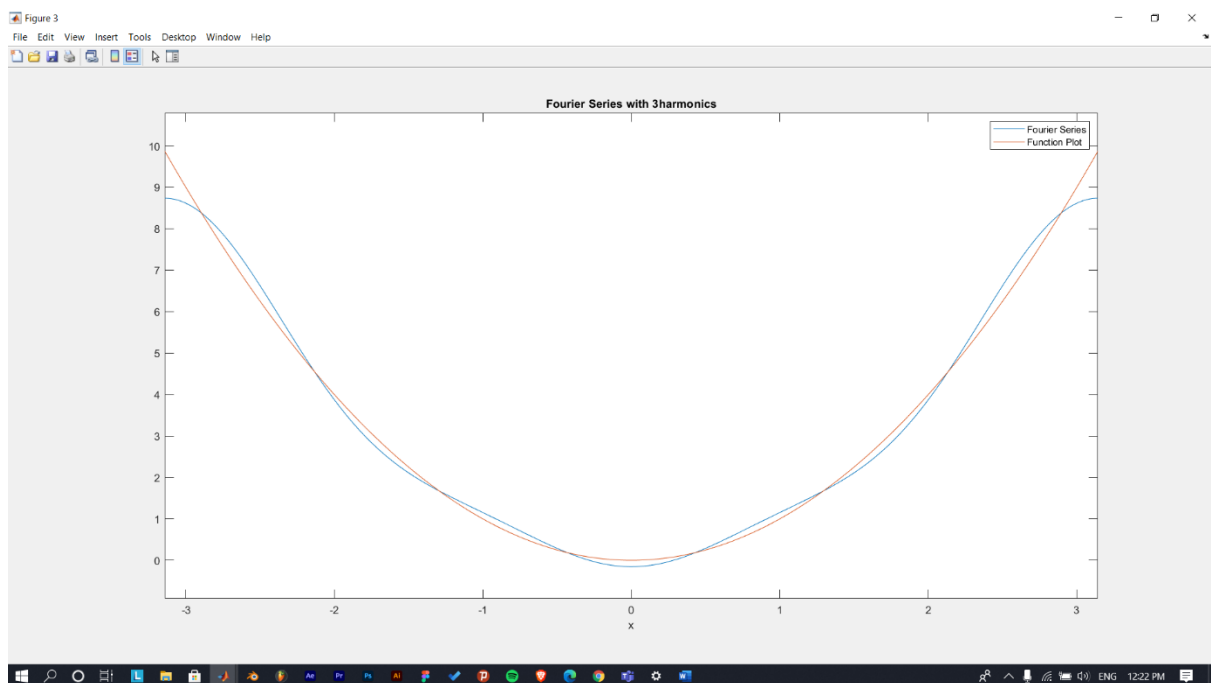
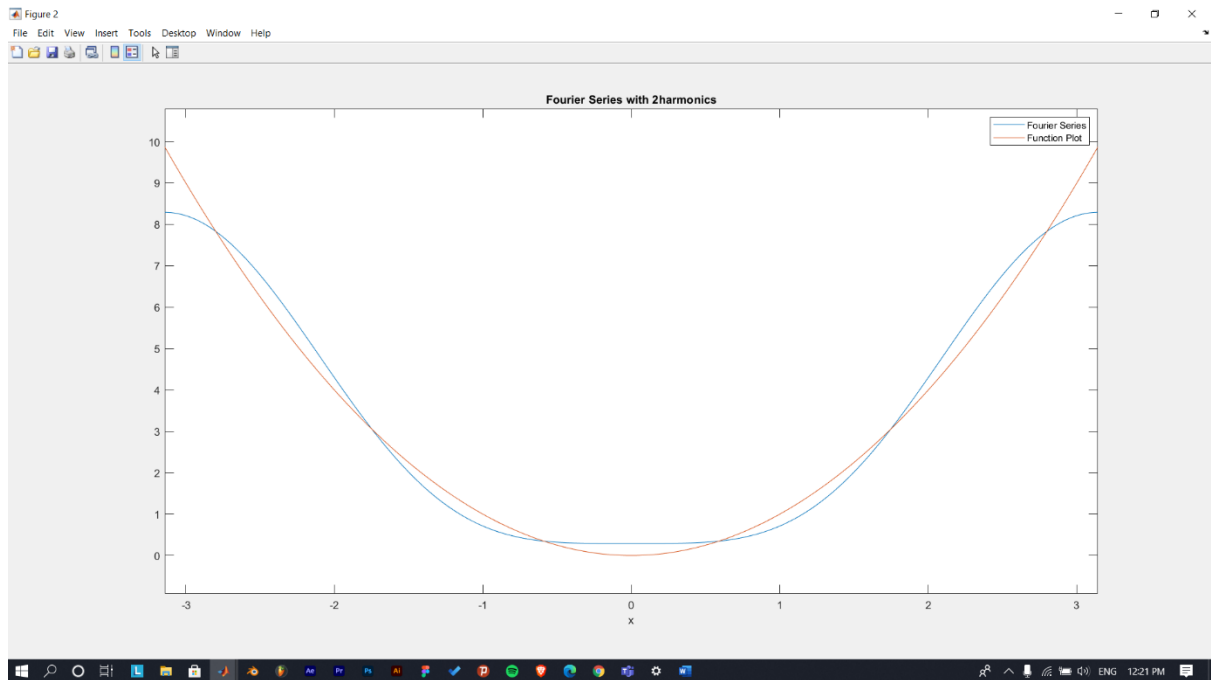
Enter the function of x:  $x^2$

Enter the interval of [a,b]:  $[-\pi, \pi]$

Enter the number of Harmonics required: 3

Fourier series with 3 harmonics is:  $1.0 \cos(2.0x) - 0.4444 \cos(3.0x) - 4.0 \cos(x) + 3.29$



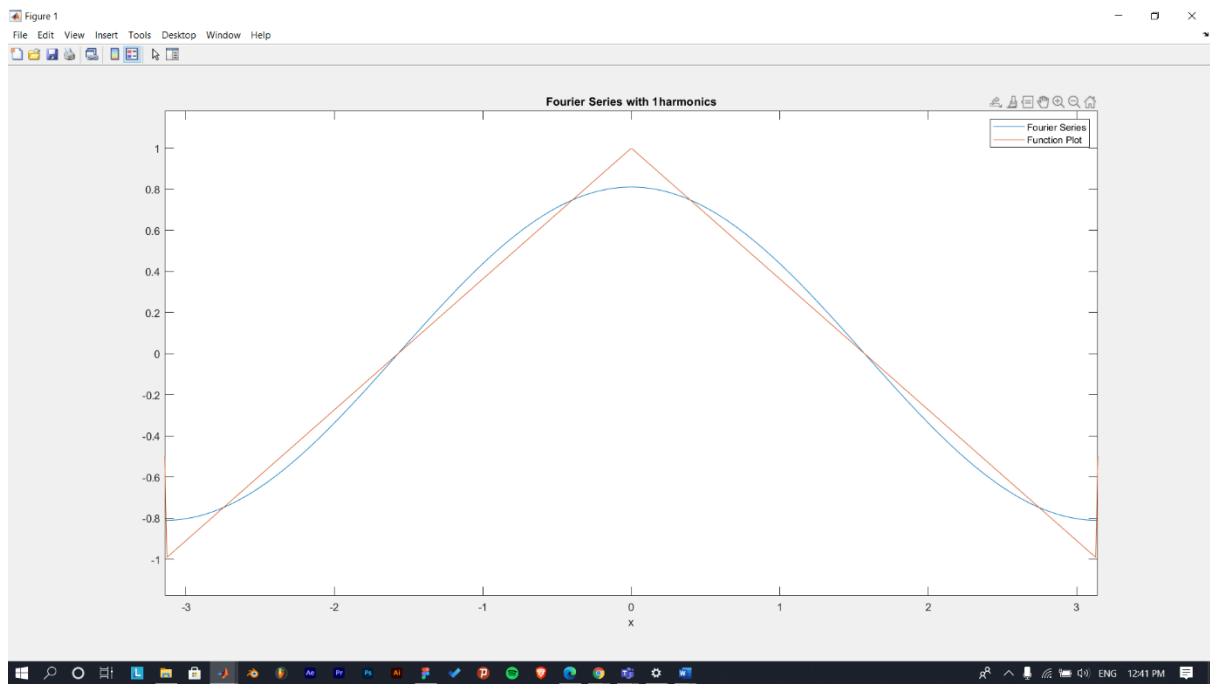
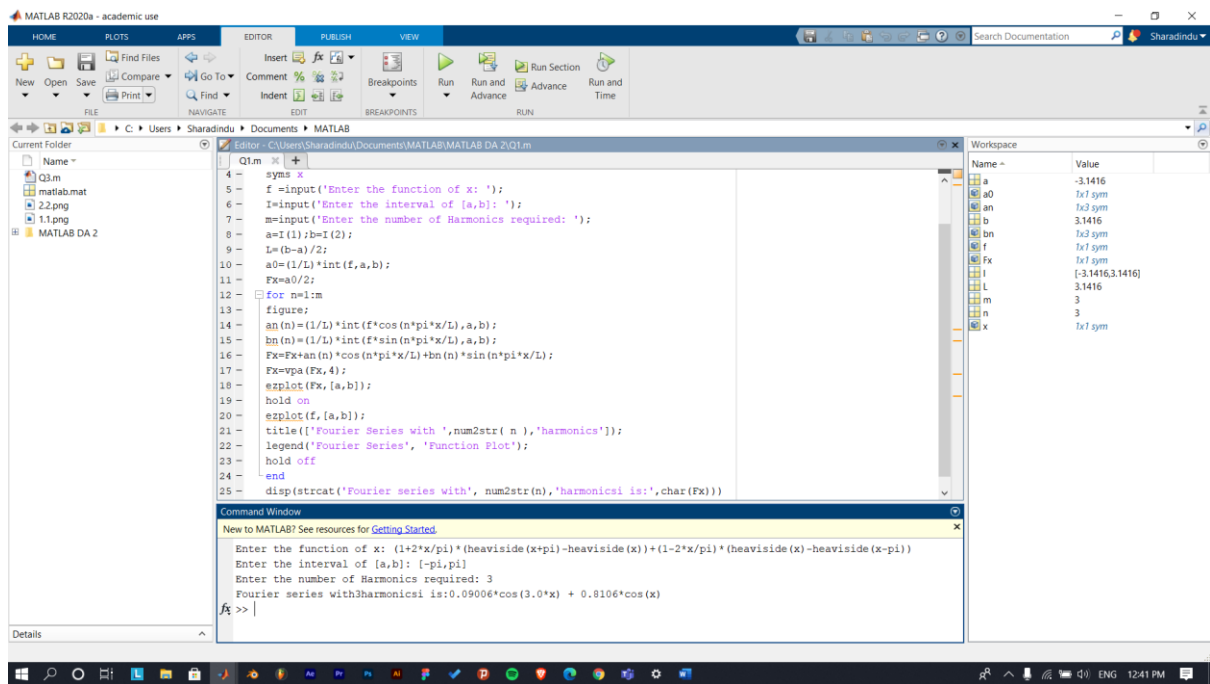


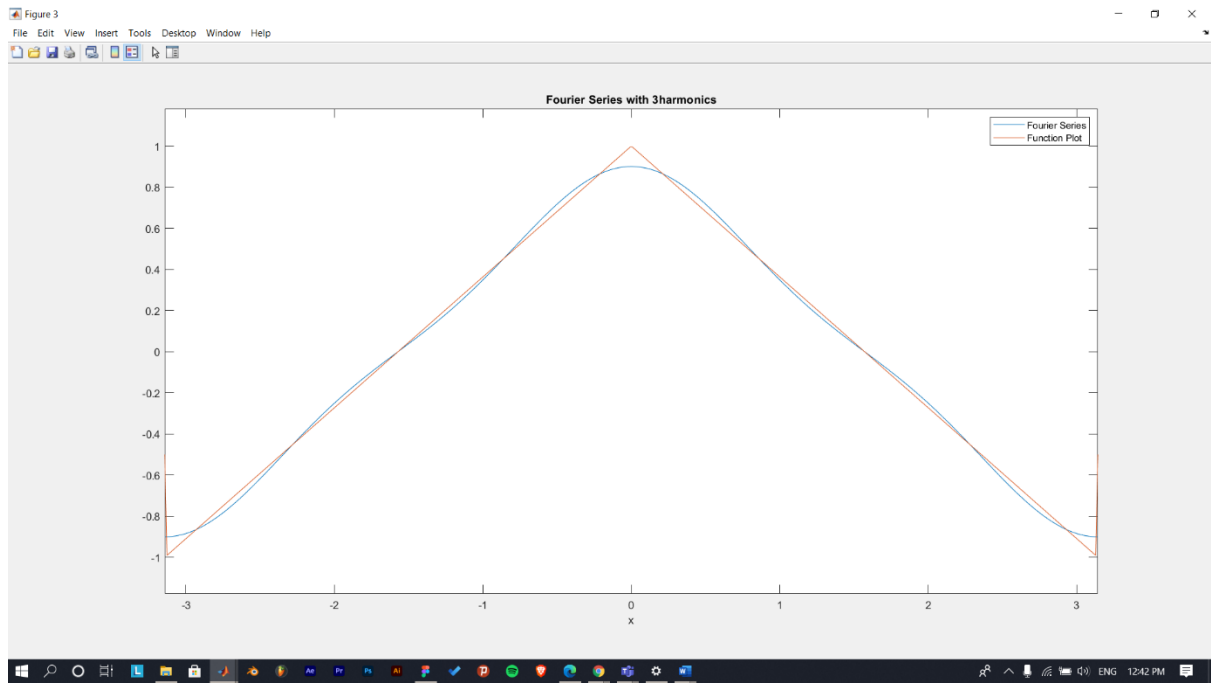
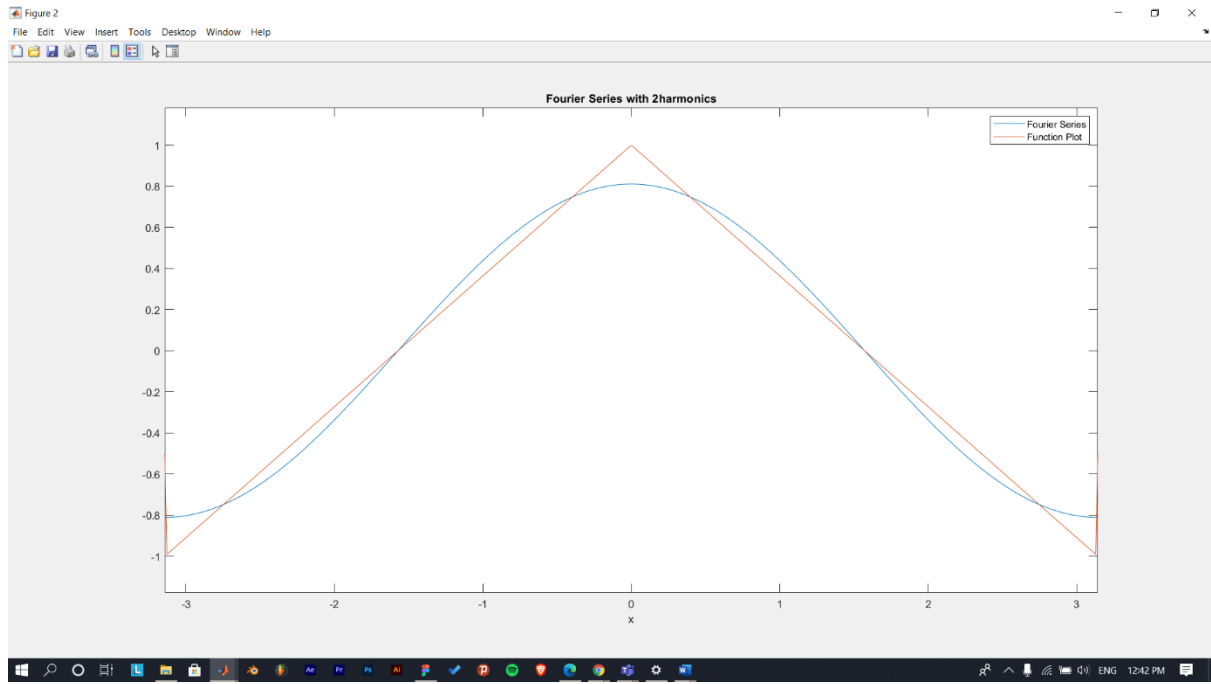
(ii)

Enter the function of x:  $(1+2*x/\pi)*(heaviside(x+\pi)-heaviside(x))+(1-2*x/\pi)*(heaviside(x)-heaviside(x-\pi))$

Enter the interval of [a,b]:  $[-\pi,\pi]$

Enter the number of Harmonics required: 3





## Question 2

### Problem:

Write a code to obtain a fourier series for given set of  $n$  data points. Run the code for the following data (for 4 harmonics):

(i)

$x$	0	1	2	3	4	5	6
$f(x)$	6	15	18	22	17	12	6

(ii)

$x$	0	30	60	90	120	150	180
$f(x)$	0	5224	8097	7850	5499	2626	0

### Code in MATLAB Editor:

```
clc
clear
syms x
X= input ( ' Enter X = ' ) ;
Y= input ( ' Enter Y = ' ) ;
n= length (X) ;
c=(X(n)-X (1))/2 ;
a0 =2 *sum(Y ( 1 : n-1 ))/ (n-1)
a1 =2 *sum(Y ( 1 : n-1 ).*cos (1*pi *X ( 1 : n-1)/c ) ) / ( n-1)
b1 =2 *sum(Y ( 1 : n-1 ).* sin(1 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
a2 =2 *sum(Y ( 1 : n-1 ).*cos (2 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
b2 =2 *sum(Y ( 1 : n-1 ).* sin(2 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
a3 =2 *sum(Y ( 1 : n-1 ).*cos (3*pi *X ( 1 : n-1)/c ) ) / ( n-1)
b3 =2 *sum(Y ( 1 : n-1 ).* sin(3 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
a4 =2 *sum(Y ( 1 : n-1 ).*cos (4 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
b4 =2 *sum(Y ( 1 : n-1 ).* sin(4 *pi*X ( 1 : n-1)/c ) ) / ( n-1)
fs ( x ) = a0 /2+ a1 *cos(1 *pi *x/c ) + b1 * sin (1 *pi *x/c )
+ a2 *cos (2 *pi *x/c ) + b2 * sin (2 *pi *x/c )+a3 *cos(3 *pi
*x/c ) + b3* sin(3 *pi *x/c)
+ a4 *cos (4 *pi *x/c ) + b4 * sin (4 *pi *x/c );
stem (X , Y )
hold on
grid on
ezplot(fs , [ X ( 1 ) X ( n ) ] )
title ( ' for example, Fourier Series fs ( x ) upto 2nd harmonic
is: ' )
legend ( ' Data ' , ' fs ( x ) ' )
```

## Input & Output in Command Window (along with screenshots of graph as example):

(i)

Enter X = [0 pi/3 2\*pi/3 pi 4\*pi/3 5\*pi/3]

Enter Y = [6 15 18 22 17 12]

a0 =  
31.2000

a1 =  
-6.5889

b1 =  
-1.7013

a2 =  
-3.0111

b2 =  
1.0515

a3 =  
-3.0111

b3 =  
-1.0515

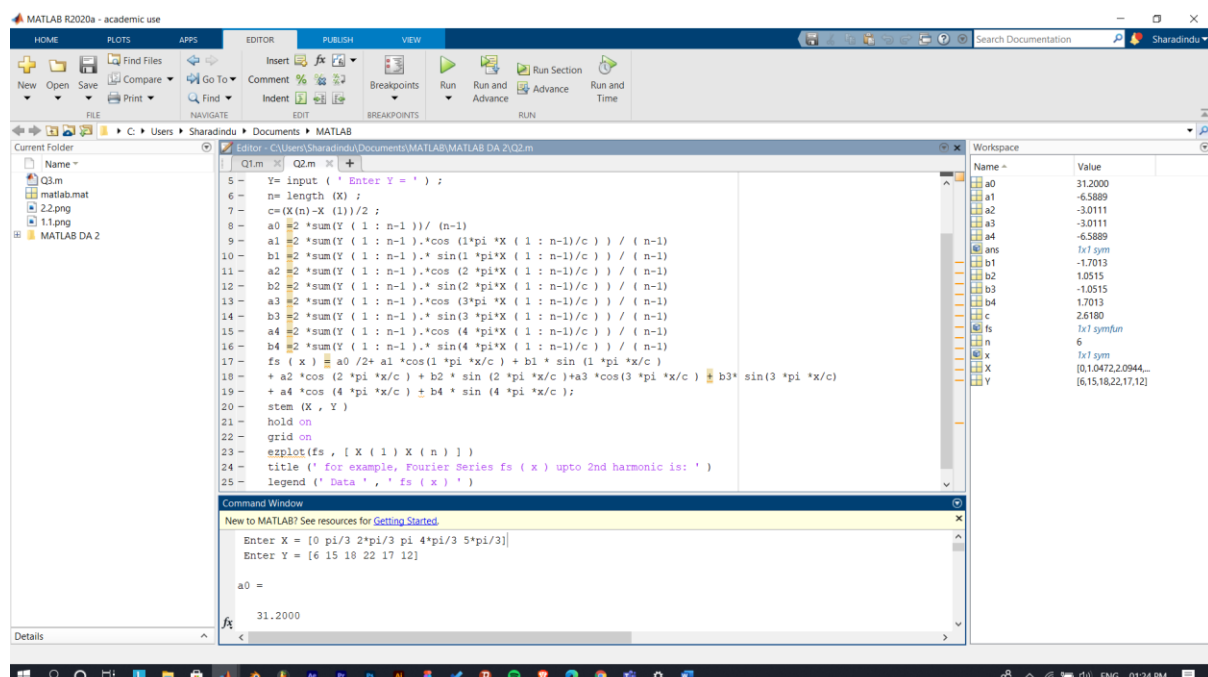
a4 =  
-6.5889

b4 =  
1.7013

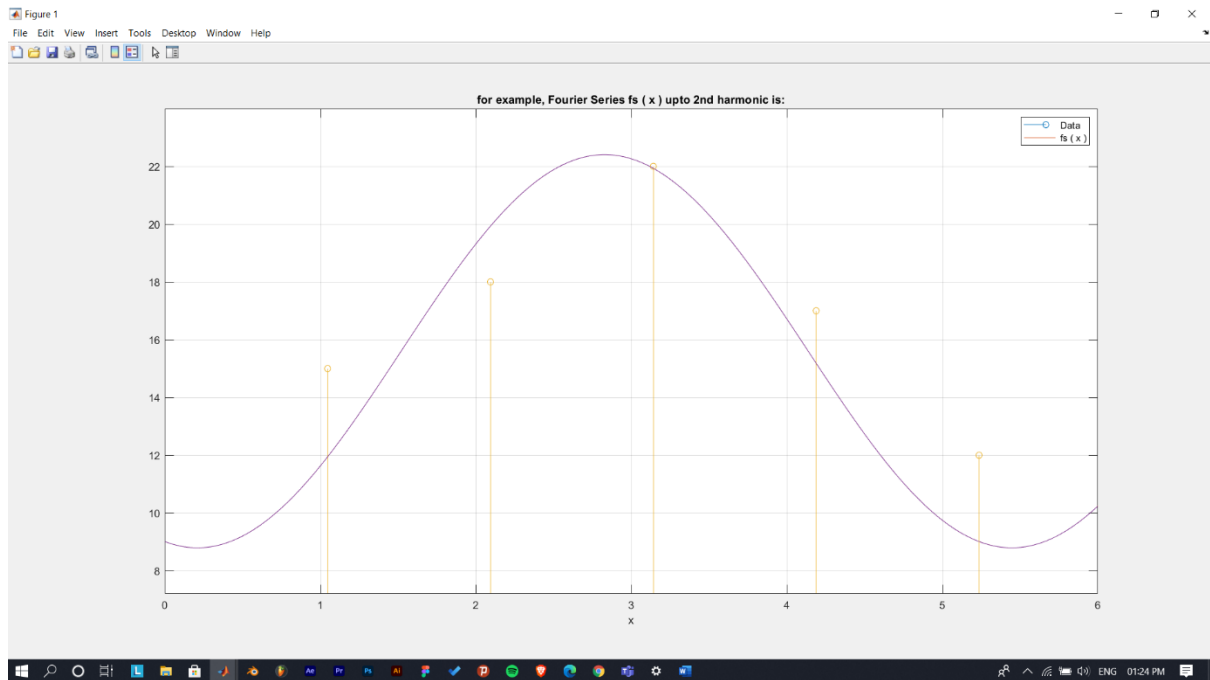
fs(x) =  
$$\frac{78}{5} - \frac{(239436916469791 \cdot \sin((6 \cdot x)/5))}{140737488355328} - \frac{(3709195267446615 \cdot \cos((6 \cdot x)/5))}{562949953421312}$$

ans =

$$(4735364881273667 \cdot \sin((12 \cdot x)/5)) / 4503599627370496 -$$
  
$$(6780497141591929 \cdot \cos((18 \cdot x)/5)) / 2251799813685248 -$$
  
$$(6780497141591955 \cdot \cos((12 \cdot x)/5)) / 2251799813685248 -$$
  
$$(2367682440636805 \cdot \sin((18 \cdot x)/5)) / 2251799813685248$$







**(ii)**

Enter X = [0 pi/6 2\*pi/6 3\*pi/6 4\*pi/6 5\*pi/6 pi]

Enter Y = [0 5224 8097 7850 5499 2626 0]

a0 =  
9.7653e+03

a1 =  
-3.5743e+03

b1 =  
1.5000e+03

a2 =  
-957.6667

b2 =  
1.0611e-12

a3 =  
-701.3333

b3 =  
-1.4033e-12

a4 =  
-957.6667

b4 =  
1.8190e-12

fs(x) =  
(6596876249771225\*sin(2\*x))/4398046511104 - (10723\*cos(2\*x))/3 +  
14648/3

ans =

(5254199565265579\*sin(4\*x))/4951760157141521099596496896 -  
(2104\*cos(6\*x))/3 - (2873\*cos(4\*x))/3 -  
(6948770760787715\*sin(6\*x))/4951760157141521099596496896

