

MATLAB code Week 4

Integration: Indefinite, definite and Area between the curves

MATLAB Syntax used:

| | |
|-------------------------------|---|
| <code>int(f,v)</code> | uses the symbolic object <code>v</code> as the variable of integration, rather than the variable determined by <code>symvar</code> |
| <code>rsums(f, [a, b])</code> | <code>rsums(f, a, b)</code> and <code>rsums(f, [a, b])</code> approximates the integral for <code>x</code> from <code>a</code> to <code>b</code> . |
| <code>fill(X,Y,C)</code> | <code>fill(X,Y,C)</code> creates filled polygons from the data in <code>X</code> and <code>Y</code> with vertex color specified by <code>C</code> . |
| <code>char(X)</code> | converts array <code>X</code> of nonnegative integer codes into a character array. |

A. Integration

i) Inbuilt MATLAB function:

```
syms x
f=input('enter the function f(x):');
a=input('enter lower limit of x ');
b=input('enter the upper limit of x');
n=input('number of intervals');
z=int(f,a,b) % direct evaluation
```

ii) As a sum of rectangles by using rsums command :

→ Initialization:

```
value = 0;
dx = (b-a)/n;
```

→ sum of the function values at all the right points

```
for k=1:n
    c = a+k*dx;
    d=subs(f,x,c);
    value = value + d;
end
```

→ value of the sum* length of the sub interval is the approx. value of the integral

```
ivalue = dx*value
ezplot(f,[a b])
```

→ Taking mid point function values

```
rsums(f, a, b)
```

Problems:

- 1) $\sin(x)$ in $[0, 2\pi]$

Output

```
enter the function f(x):sin(x)
enter lower limit of x 0
enter the upper limit of x2*pi
```

number of intervals10

z =

0

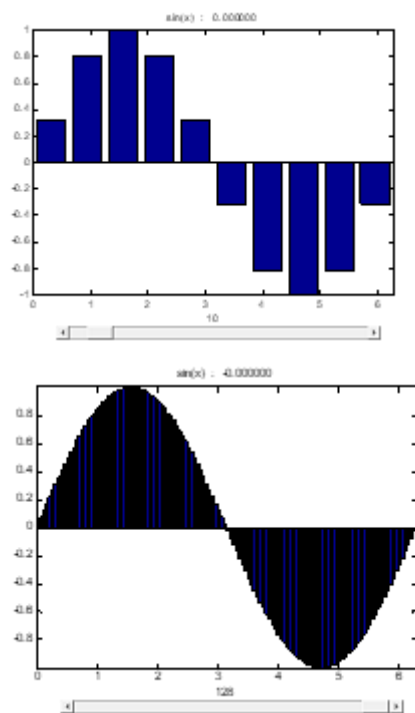
value =

-1.5389e-016

z =

0

Figure Window:



2) $\cos(x)$ in $[-\pi/2, \pi/2]$

Output

enter the function f(x):

$\cos(x)$

enter lower limit of x

$-\pi/2$

enter the upper limit of x

$\pi/2$

number of intervals

10

z =

2

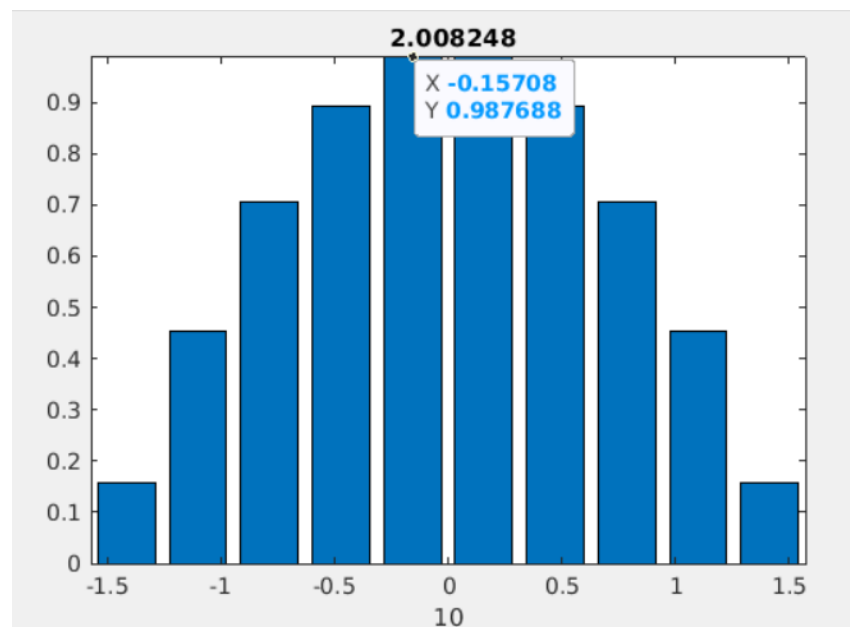
value =

$$\frac{\pi \cdot ((2^{1/2} \cdot (5 - 5^{1/2}))^{1/2})/2 + 5^{1/2} + (2^{1/2} \cdot (5^{1/2} + 5)^{1/2})/2 + 1)}{10}$$

z =

2

Figure Window:



3) $e^x + \tan(x)$

Output

enter the function f(x):

$\exp(x) + \tan(x)$

enter lower limit of x

0

enter the upper limit of x

$\pi/4$

number of intervals

10

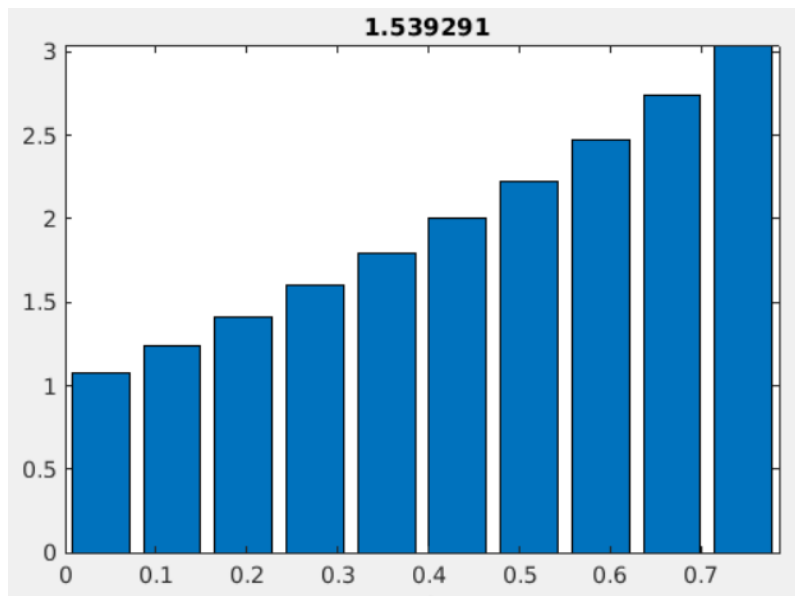
z =

$$\exp(\pi/4) + \log(2)/2 - 1$$

value =

$$\begin{aligned} & (\pi * (\exp(\pi/4) + \exp(\pi/5) + \exp(\pi/8) + \exp(\pi/10) + \exp(\pi/20) + \exp((3*\pi)/20) + \\ & \exp(\pi/40) + \exp((3*\pi)/40) + \exp((7*\pi)/40) + \exp((9*\pi)/40) + \tan(\pi/20) + \\ & \tan((3*\pi)/20) + \tan(\pi/40) + \tan((3*\pi)/40) + \tan((7*\pi)/40) + \tan((9*\pi)/40) + \\ & (5^{(1/2)} * (5 - 2*5^{(1/2)})^{(1/2)})/5 + 2^{(1/2)} + (5 - 2*5^{(1/2)})^{(1/2)})/40 \end{aligned}$$

z =

$$\exp(\pi/4) + \log(2)/2 - 1$$


B. Area between the curves:

```

clc
clear all
close all
syms x
y1=input('ENTER THE Y1 REGION VALUE');
y2=input('ENTER THE Y2 REGION VALUE');
t=solve(y1-y2); %(Y1-Y2=0)
po=double(t)
poi=sort(po)
n=length(poi)
m1=min(poi)
m2=max(poi)

ez1=ezplot(y1,[m1-1,m2+1])
hold on
TA=0
ez2=ezplot(y2,[m1-1,m2+1])
if n>2

```

```

for i=1:n-1
A=int(y1-y2,poi(i),poi(i+1))
TA= TA+abs(A)
x1 = linspace(poi(i),poi(i+1))
yy1 =subs(y1,x,x1)
yy2 = subs(y2,x,x1)

```

%iii) Creating a polygon:

```

xx = [x1,flipr(x1)]
yy = [yy1,flipr(yy2)]
fill(xx,yy,'g')
grid on
end
else

```

```

A=int(y1-y2,poi(1),poi(2))
TA=abs(A)
x1 = linspace(poi(1),poi(2));
yy1 =subs(y1,x,x1)
yy2 = subs(y2,x,x1)
xx = [x1,flipr(x1)]
yy = [yy1,flipr(yy2)]
fill(xx,yy,'g')
end

```

Problems:

4) Find the area of the regions enclosed by the curves, $y = x^2 - 2x$, $y = x$

Output

```

ENTER THE Y1 REGION VALUE
x
ENTER THE Y2 REGION VALUE
x^2-2*x

```

f =

9/2

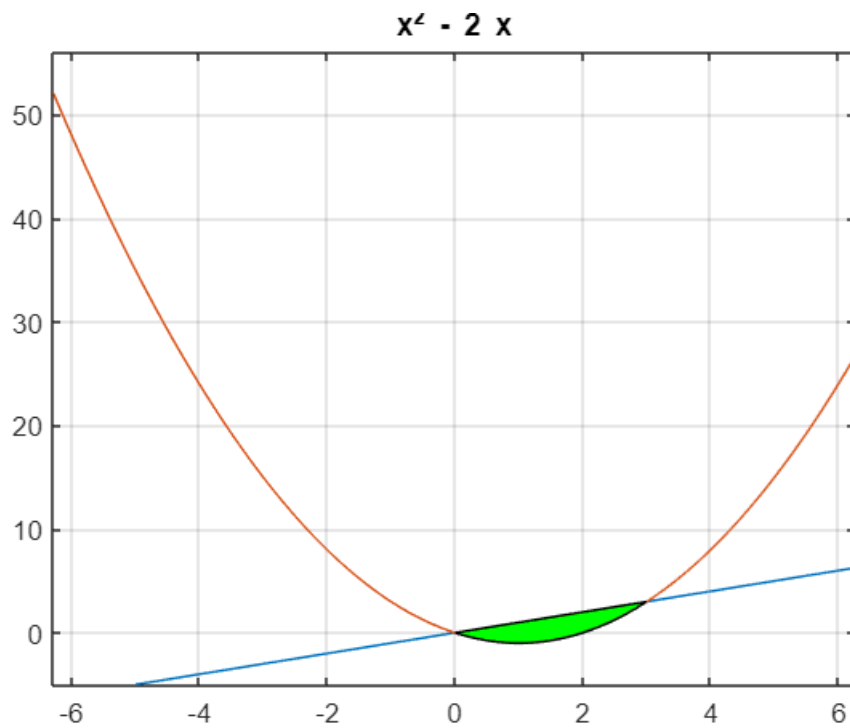
kokler =

0

3

f =

9/2

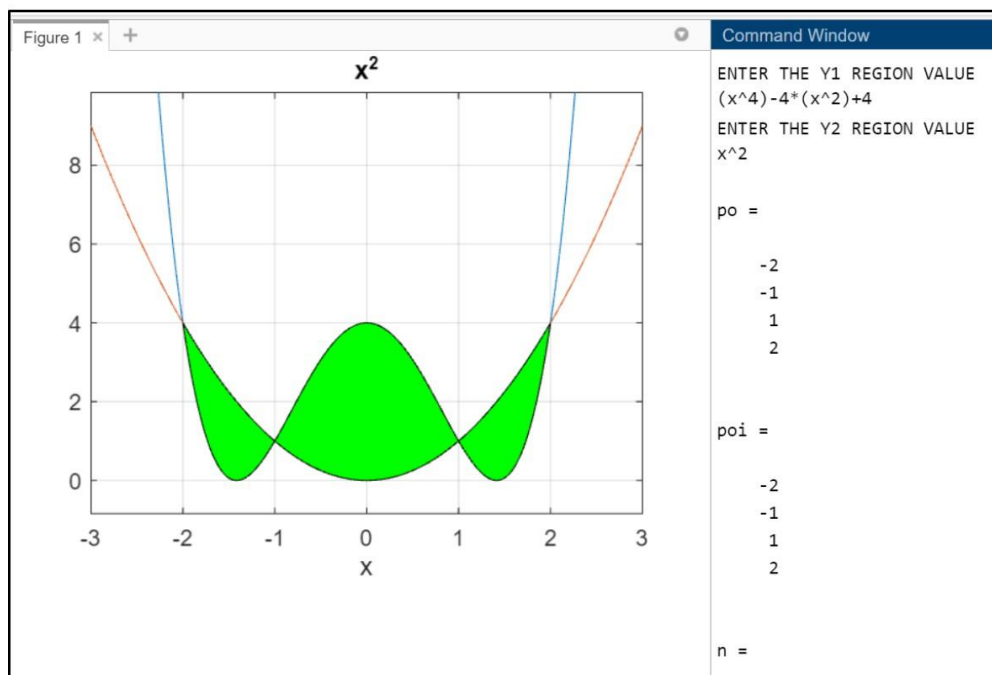


5) Find the area of the regions enclosed by the curves $y = x^4 - 4x^2 + 4$, $y = x^2$

Output:

$$y_1 = x^4 - 4x^2 + 4$$

$$y_2 = x^2$$



MATLAB code Week 5

Volume of Solid of Revolution

Aim: To find the volume of a solid generated by revolving a curve about the x -axis

The solid generated by rotating (or revolving) a plane region about an axis in its plane is called a **solid of revolution**. In this exercise, we will only consider solids of revolution that are generated by rotations about axes that are parallel to the x -axis. The solid of revolutions that are generated about axes that are parallel to the y -axis can be obtained by appropriate modifications to the code.

The volume of solid generated by rotating a curve $y = f(x)$ about x -axis, can be found using **disk method**, which is given by

$$V = \int_a^b \pi [R(x)]^2 dx.,$$

where $R(x)$ is the radius, the distance of the planar region's boundary from the axis of revolution. If the solid is generated by rotating about a line $y = c$ ($f(a) < c < f(b)$) parallel to x -axis, then the volume is:

$$V = \int_a^b \pi [R(x) - c]^2 dx.$$

The definite integration of any function, $f(x)$ between the limits, $[a, b]$ can be evaluated in the MATLAB using `int` command. The syntax is:

```
area = int(f,a,b);
```

We will below demonstrate the evaluation of volume of a solid of revolution using disk method and visualizing it.

```
clc
clear all
close all
%%
syms x;
f = input('Enter the function: ');
fL = input('Enter the interval on which the function is defined: ');
yr = input('Enter the axis of rotation y = c (enter only c value): ');
iL = input('Enter the integration limits: ');
Volume = pi*int((f-yr)^2,iL(1),iL(2));
sprintf('Volume is %3f ', double(Volume))
%% Shading the area between the axis of rot. and function
fx = inline(vectorize(f));
xvals = linspace(fL(1),fL(2),201);
xvalsr = fliplr(xvals);
xivals = linspace(iL(1),iL(2),201);
xivalsr = fliplr(xivals);
xlim = [fL(1) fL(2)+0.5];
ylim = fx(xlim);
figure('Position',[100 200 560 420])
subplot(2,1,1)
hold on;
plot(xvals,fx(xvals),'k-','LineWidth',2);
plot([fL(1) fL(2)],[yr yr],'r-','LineWidth',2);
fill([xivals xivalsr],[fx(xivals) ones(size(xivalsr))*yr],[0.8 0.8 0.8],'FaceAlpha',0.8)
```

```

%% Marking the axis
%plot([fL(1) fL(2)],[yr yr],'r-','LineWidth',2);
legend('Function Plot','Axis of Rotation','Filled Region','Location','Best');
title('Function y=f(x) and Region');
set(gca,'XLim',xlim)
xlabel('x-axis');
ylabel('y-axis');
%% Plotting reflection of the curve about the axis of rot
subplot(2,1,2)
hold on;
plot(xivals,fx(xivals),'b-','LineWidth',2);
plot([iL(1) iL(2)],[yr yr],'r-','LineWidth',2);
fill([xivals xivalsr],[fx(xivals) ones(size(xivalsr))*yr],[0.8 0.8 0.8],'FaceAlpha',0.8)
plot(xivals,-fx(xivals)+2*yr,'m-','LineWidth',2);
fill([xivals xivalsr],[ones(size(xivals))*yr -fx(xivalsr)+2*yr],[1 0.8 0.8],'FaceAlpha',0.8)
title('Rotated Region in xy-Plane');
set(gca,'XLim',xlim)
xlabel('x-axis');
ylabel('y-axis');
%% Solid
[X,Y,Z] = cylinder(fx(xivals)-yr,100);
figure('Position',[700 200 560 420])
Z = iL(1) + Z.*(iL(2)-iL(1));
surf(Z,Y+yr,X,'EdgeColor','none','FaceColor','flat','FaceAlpha',0.6);
hold on;
plot([iL(1) iL(2)],[yr yr],'r-','LineWidth',2);
xlabel('X-axis');
ylabel('Y-axis');
zlabel('Z-axis');
view(21,11);

```

Problems:

- 1) Find the volume of the solid generated by revolving the region bounded by $y = \sqrt{x}$, $0 \leq x \leq 4$ about the line $y = 1$

Output:

Enter the function:

sqrt(x)

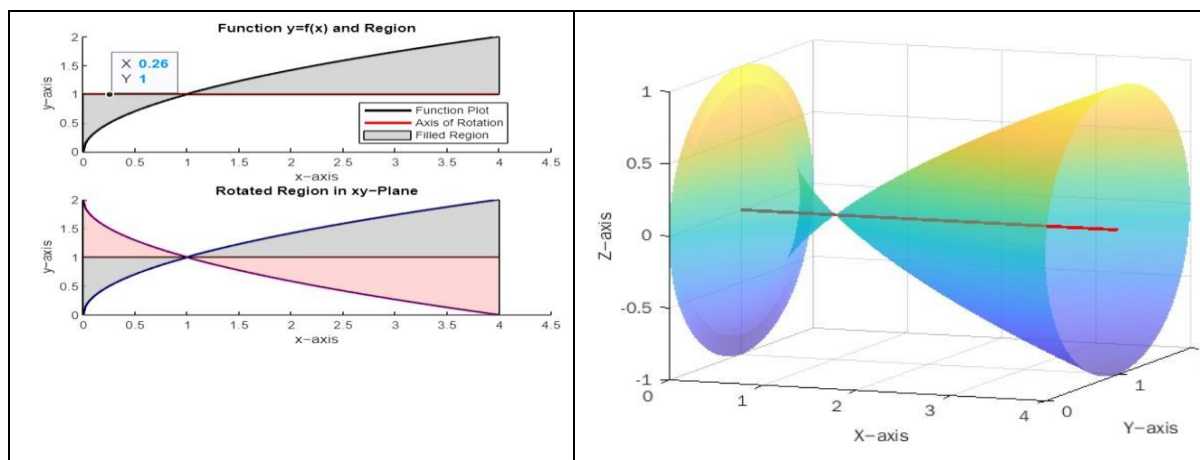
Enter the interval on which the function is defined: [0
4]

Enter the axis of rotation $y = c$ (enter only c value): 1

Enter the integration limits:
[0 4]

ans =

'Volume is 4.188790e+00



- 2) Find the volume of the solid generated by revolving the region bounded by $y = \sin x$, $0 \leq x \leq \pi$ about the line $y = c$, $0 \leq c \leq 1$, $c = 0, 0.2, 0.4, 0.6, 0.8, 1.0$. Can you identify the range or exact value of c that minimize and maximize the volume of the solid?

Output:

For $C=0$

Enter the function:

$\sin(x)$

Enter the interval on which the function is defined: $[0 \pi]$

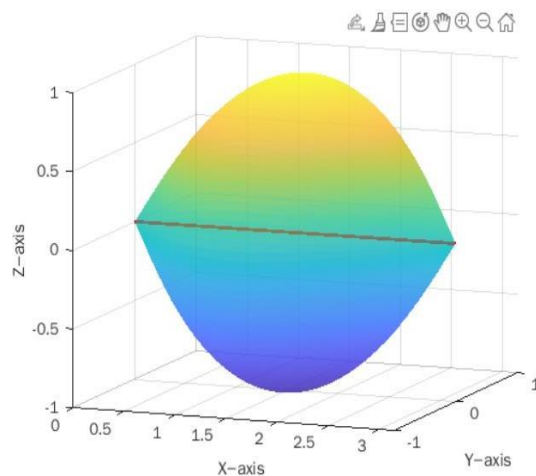
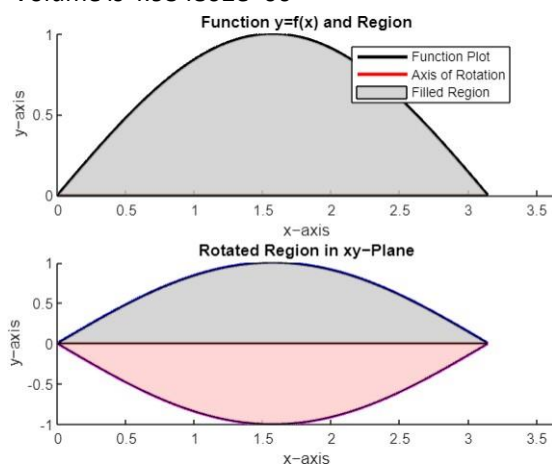
Enter the axis of rotation $y = c$ (enter only c value): 0

Enter the integration limits:

$[0 \pi]$

ans =

'Volume is $4.934802e+00$ '



For $c=0.2$

Enter the function:

$\sin(x)$

Enter the interval on which the function is defined: [0
pi]

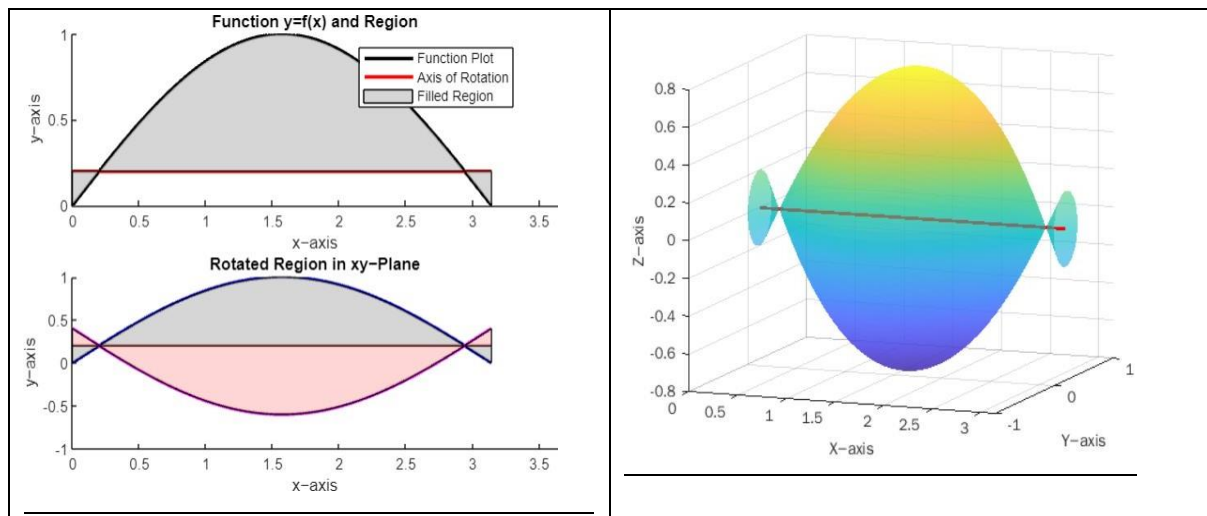
Enter the axis of rotation $y = c$ (enter only c value): 0.2

Enter the integration limits:

[0 pi]

ans =

'Volume is 2.816312e+00 '



For $c=0.4$

f =

$\sin(x)$

fL =

0 3.1416

yr =

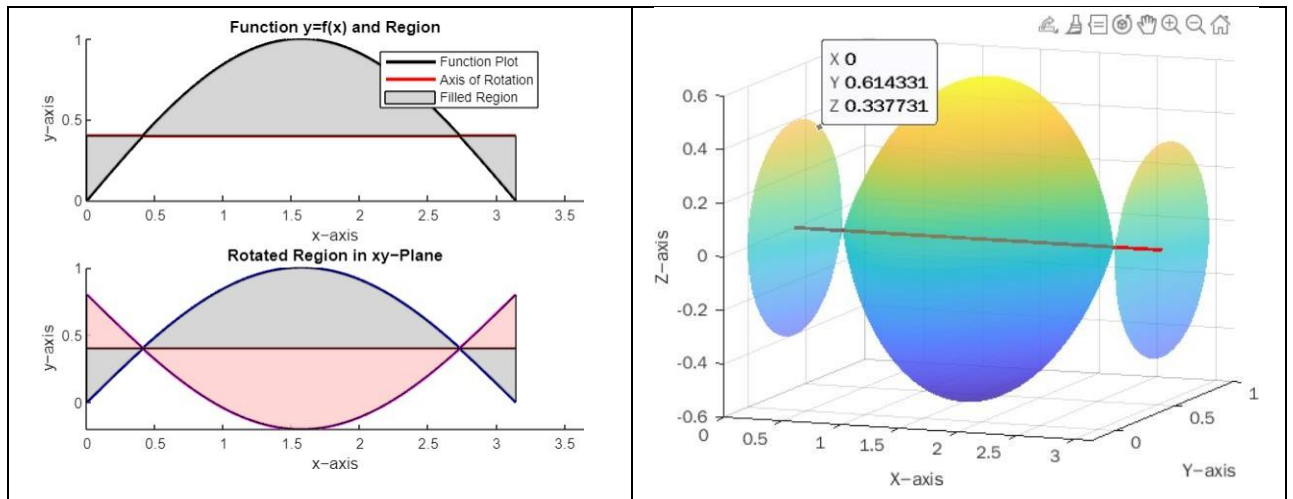
0.4000

iL =

0 3.1416

ans =

'Volume is 1.487391e+00 '



For c=0.6

f

=

s

i

n

(

x

)

f

L

=

0 3.1416

yr =

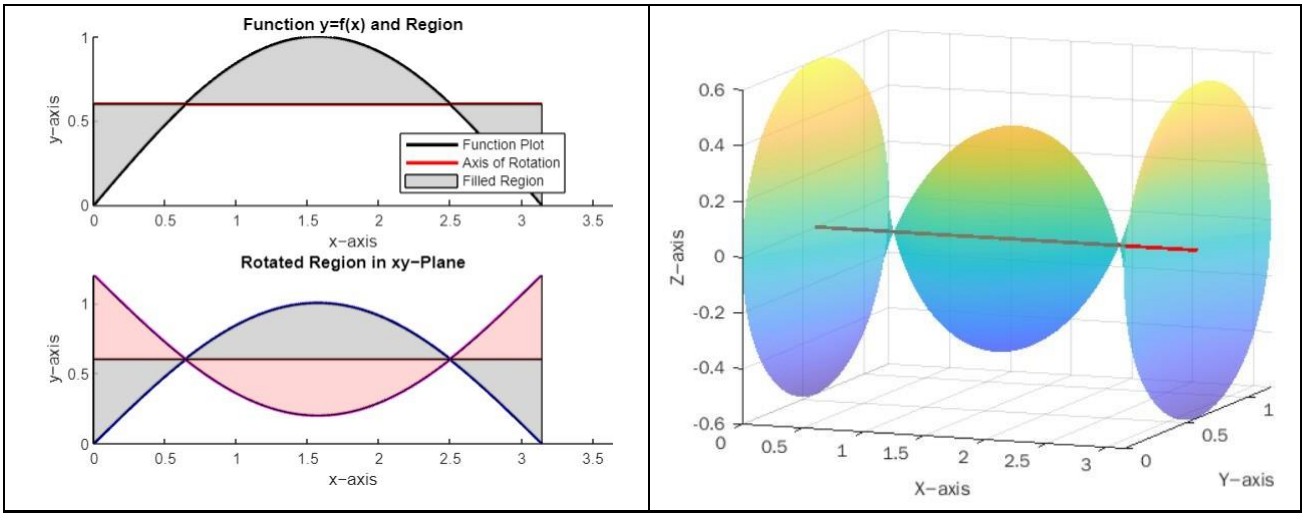
0.6000

iL =

0 3.1416

ans =

'Volume is 9.480374e-01 '



For c=0.8

f

=

s

i

n

(

x

)

f

L

=

0 3.1416

yr =

0.8000

iL =

0 3.1416

ans =

'Volume is 1.198253e+00 '

