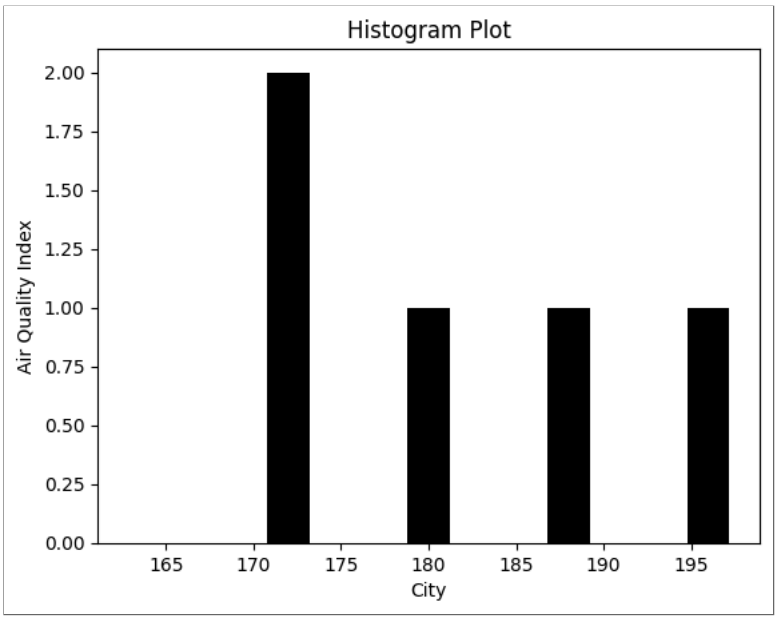
In [ ]:

```
Q.1 Attempt any TWO of the following. [10]
(a) Draw the horizontal bar graph for the following data in Maroon colour.
City                 Pune   Mumbai   Nasik   Nagpur   Thane
Air Quality Index     168     190      170     178      195
```

In [7]:

```
import matplotlib.pyplot as plt
air=[168,190,170,178,195]
range=(160,200)
bins=5
plt.hist(air,bins,range,color='black',histtype='bar',rwidth=0.3)
plt.xlabel('City')
plt.ylabel('Air Quality Index')
plt.title('Histogram Plot')
plt.show()
```

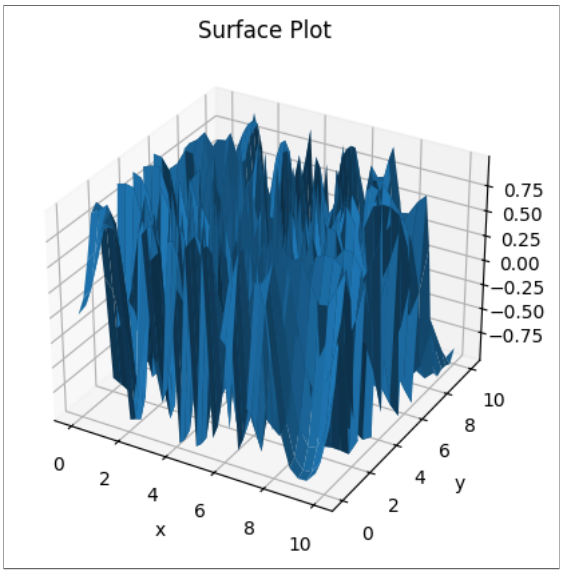


In [ ]:

```
(b) Using python, generate 3D surface Plot for the function f(x) = sin(x**2+y**2) in the interv
```

In [8]:

```
from pylab import*
def f(x,y):
    return np.sin(x**2+y**2)
x=np.linspace(0,10,30)
y=np.linspace(0,10,30)
X,Y=np.meshgrid(x,y)
Z=f(X,Y)
ax=plt.axes(projection='3d')
ax.plot_surface(X,Y,Z)
xlabel('x')
ylabel('y')
title('Surface Plot')
show()
```



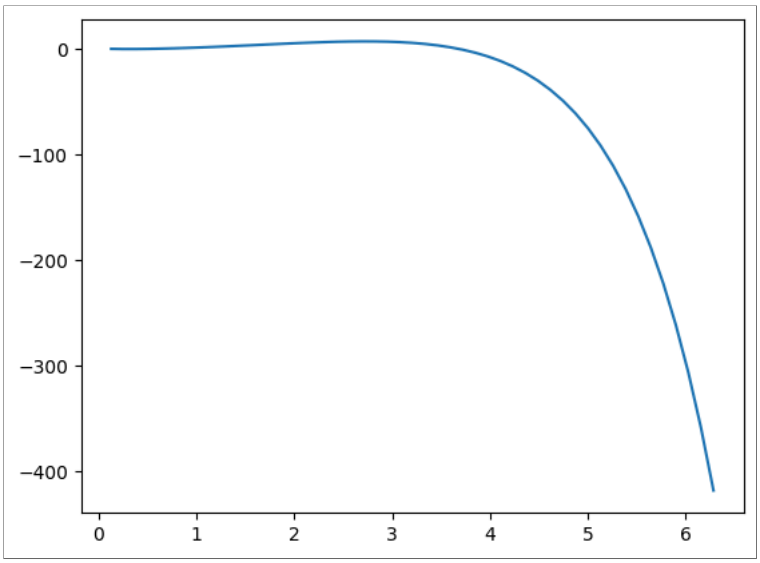
In [ ]:

```
(c) Using Python, plot the graph of function f(x) = sin(x)-e^x + 3x^2 -log10(x) on the Interval
```

In [9]:

```
import matplotlib.pyplot as plt
import numpy as np
x=np.linspace(0,2*np.pi)
f=np.sin(x)-np.exp(x)+3*x**2-np.log10(x)
plt.plot(x,f)
plt.show()
```

```
C:\Users\siddhi\AppData\Local\Temp\ipykernel_8352\446144361.py:4: RuntimeWarn
ing: divide by zero encountered in log10
  f=np.sin(x)-np.exp(x)+3*x**2-np.log10(x)
```



In [ ]:

```
Q.2 Attempt any TWO of the following. [10]
(a) Using python, rotate the line segment by 180◦ having end points (1, 0) and (2, -1).
```

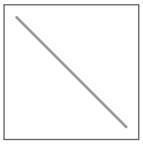
In [41]:

```
from sympy import*
```

In [11]:

```
S=Segment(Point(1,0),Point(2,-1))
S.rotate(pi)
```

Out[11]:



In [ ]:

```
(b) Write a Python program to draw a polygon with vertices (0, 0),(2, 0),(2, 3) and (1, 6) and
it by 180◦
```

In [12]:

```
A=Point(0,0)
B=Point(2,0)
C=Point(2,3)
D=Point(1,6)
P=Polygon(A,B,C,D)
P.rotate(pi)
```

Out[12]:

In [ ]:

```
(c) Using python, generate triangle with vertices (0, 0),(4, 0),(2, 4), check whether the triar
isosceles triangle.
```

In [13]:

```
T=Triangle(Point(0,0),Point(4,0),Point(2,4))
T.is_isosceles()
```

Out[13]:

```
True
```

In [ ]:

```
Q.3 Attempt the following.
(a) Attempt any ONE of the following. [7]
(i) Write a Python program to solve the following LPP:
Max Z = x + y
subject to
2x − 2y ≥ 1
x + y ≥ 2
x ≥ 0, y ≥ 0.
```

In [14]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(2*x-2*y>=1)
model+=(x+y>=2)
```

```
model+=x+y
model
```

Out[14]:

```
Lp-Problem:
MAXIMIZE
1*x + 1*y + 0
SUBJECT TO
_C1: 2 x - 2 y >= 1

_C2: x + y >= 2

VARIABLES
x Continuous
y Continuous
```

In [15]:

```
model.solve()
```

Out[15]:

```
-2
```

In [ ]:

```
(ii) Write a python program to display the following LPP by using pulp module and simplex
method. Find its optimal solution if exist.
Min Z = x + y
subject to
x ≥ 6
y ≥ 6
x + y ≤ 11
x ≥ 0, y ≥ 0.
```

In [16]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMinimize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(x>=6)
model+=(y>=6)
model+=(x+y<=11)
model+=x+y
model
```

Out[16]:

```
Lp-Problem:
MINIMIZE
1*x + 1*y + 0
SUBJECT TO
_C1: x >= 6

_C2: y >= 6

_C3: x + y <= 11

VARIABLES
x Continuous
y Continuous
```

In [17]:

```
model.solve()
```

Out[17]:

```
-1
```

In [ ]:

```
(b) Attempt any ONE of the following. [8]
(i) Apply Python program in each of the following transformations on the point P[4, -2]
(I) Refection through Y-axis.
(II) Scaling in X-coordinate by factor 7.
(III) Shearing in Y direction by 3 units
(IV) Reflection through the line y = -x.
```

In [18]:

```
P=Point(4,-2)
```

In [19]:

```
P.transform(Matrix([[-1,0,0],[0,1,0],[0,0,1]]))
```

Out[19]:

$\text{Point2D}(-4, -2)$

In [20]:

```
P.scale(7,0)
```

Out[20]:

$\text{Point2D}(28, 0)$

In [21]:

```
P.transform(Matrix([[1,0,0],[7,1,0],[0,0,1]]))
```

Out[21]:

$\text{Point2D}(-10, -2)$

In [22]:

```
x,y=symbols('x,y')
P.reflect(Line(x+y+0))
```

Out[22]:

$\text{Point2D}(2, -4)$

In [ ]:

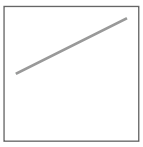
```
(ii) Find the combined transformation by using Python program for the following sequence of
transformations:-
(I) Rotation about origin through an angle 60◦
(II) Scaling in X-coordinate by 7 units.
(III) Uniform scaling by 4 units.
(IV) Reflection through the line y = x..
```

In [24]:

```
S=Segment(Point(0,0),Point(2,4))
S.rotate(pi/3)
```

```
S.scale(7,0)
S.scale(4,4)
x,y=symbols('x,y')
S.reflect(Line(x-y+0))
```

Out[24]:

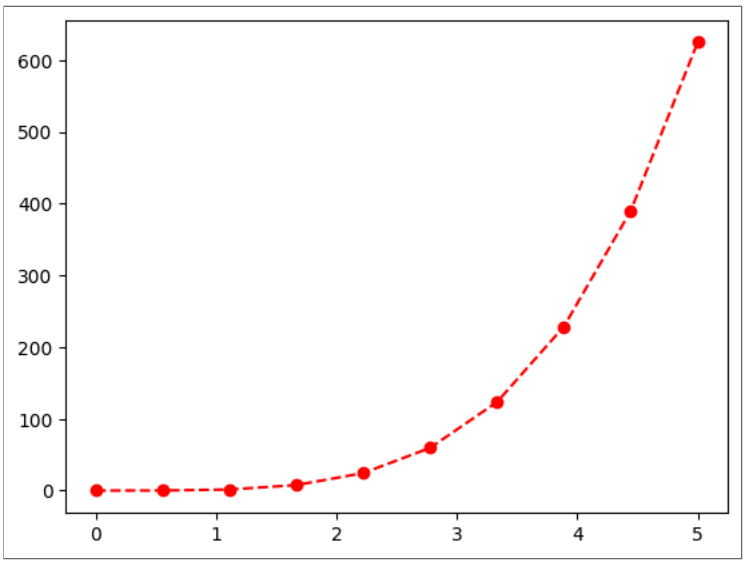


In [ ]:

```
Q.1 Attempt any TWO of the following. [10]
(a) Plot the graph of f(x) = x^4
in [0, 5] with red dashed line with circle markers.
```

In [29]:

```
import matplotlib.pyplot as plt
import numpy as np
x=np.linspace(0,5,10)
f=x**4
plt.plot(x,f,'--r',marker='o')
plt.show()
```



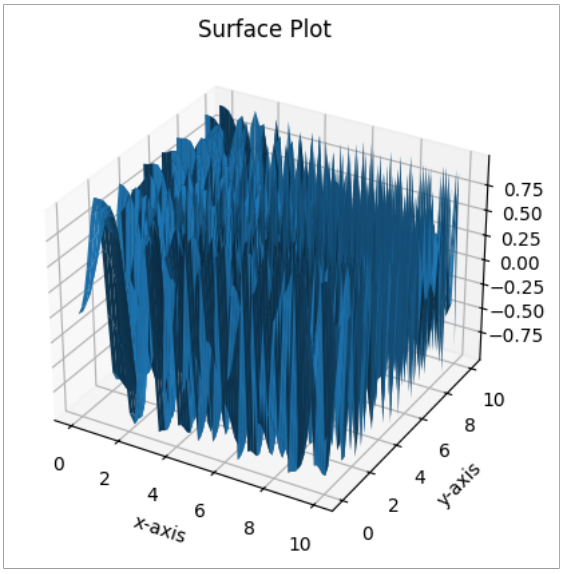
In [ ]:

```
(b) Using python, generate 3D surface Plot for the function f(x) = sin(x^2 + y^2)
in the interval [0, 10].
```

In [33]:

```
from pylab import*
import numpy as np
def f(x,y):
    return np.sin(x**2+y**2)
x=np.linspace(0,10)
y=np.linspace(0,10)
X,Y=np.meshgrid(x,y)
Z=f(X,Y)
ax=axes(projection='3d')
ax.plot_surface(X,Y,Z)
xlabel('x-axis')
ylabel("y-axis")
```

```
title("Surface Plot")
show()
```



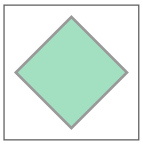
In [ ]:

```
(c) Write a python program to draw rectangle with vertices [1, 0], [2, 1], [1, 2] and [0, 1], i
about the origin by π/2 radians.
```

In [44]:

```
R=Polygon(Point(1,0),Point(2,1),Point(1,2),Point(0,1))
R.rotate(pi/2)
```

Out[44]:



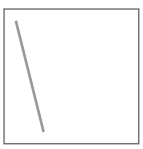
In [ ]:

```
(a) Write a Python program to reflect the line segment joining the points A[5, 3] & B[1, 4] thr
line y = x + 1.
```

In [45]:

```
x,y=symbols('x,y')
S=Segment(Point(5,3),Point(1,4))
S.reflect(Line(x-y+1))
```

Out[45]:



In [ ]:

```
(b) Using sympy declare the points P(5, 2), Q(5, -2), R(5, 0), check whether these points are c
Declare the ray passing through the points P and Q, find the length of this ray between P and Q
Also find slope of this ray.
```

In [46]:

```
P=Point(5,2)
Q=Point(5,-2)
R=Point(5,0)
Point.is_collinear(P,Q,R)
```

Out[46]:

True

In [50]:

```
R=Ray(Point(5,2),Point(5,-2))
R.length
```

Out[50]:

∞

In [51]:

```
R.slope
```

Out[51]:

∞

In [ ]:

```
(c) Write a Python program in 3D to rotate the point (1, 0, 0) through X Plane in anticlockwise
direction (Rotation through Z axis) by an angle of 90◦
```

In [73]:

```
A=Point(1,0,0)
A.transform(Matrix([[0,1,0,0],[-1,0,0,0],[0,0,1,0],[0,0,0,1]]))
```

Out[73]:

$\mathrm{Point3D}(0, -1, 0)$

In [ ]:

```
Q.3 Attempt the following.
(a) Attempt any ONE of the following. [7]
(i) Write a Python program to solve the following LPP:
Min Z = 3.5x + 2y
subject to x + y ≥ 5
x ≥ 4
y ≤ 2
x ≥ 0, y ≥ 0.
```

In [53]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMinimize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(x+y>=5)
model+=(x>=4)
model+=(y<=2)
model+=3.5*x+2*y
model
```

Out[53]:

```
Lp-Problem:
MINIMIZE
3.5*x + 2*y + 0.0
SUBJECT TO
_C1: x + y >= 5

_C2: x >= 4

_C3: y <= 2

VARIABLES
x Continuous
y Continuous
```

In [54]:

```
model.solve()
```

Out[54]:

```
1
```

In [55]:

```
model.objective.value()
```

Out[55]:

```
16.0
```

In [56]:

```
x.value()
```

Out[56]:

```
4.0
```

In [57]:

```
y.value()
```

Out[57]:

```
1.0
```

In [ ]:

```
(ii) Write a python program to display the following LPP by using pulp module and simplex
method. Find its optimal solution if exist.
Max Z = x + 2y + z
subject to x + 2y + 2z ≤ 1
3x + 2y + z ≥ 8
x ≥ 0, y ≥ 0, z ≥ 0.
```

In [58]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
z=LpVariable(name='z',lowBound=0)
model+=(x+2*y+2*z<=1)
model+=(3*x+2*y+z>=8)
```

```
model+=x+2*y+z
model
```

Out[58]:

```
Lp-Problem:
MAXIMIZE
1*x + 2*y + 1*z + 0
SUBJECT TO
_C1: x + 2 y + 2 z <= 1

_C2: 3 x + 2 y + z >= 8

VARIABLES
x Continuous
y Continuous
z Continuous
```

In [59]:

```
model.solve()
```

Out[59]:

```
-1
```

In [ ]:

```
(b) Attempt any ONE of the following. [8]
(i) Apply Python program in each of the following transformations on the point P[4, -2]
(I) Refection through Y-axis.
(II) Scaling in X-coordinate by factor 5.
(III) Rotation about origin through an angle π/2
(IV) Shearing in X direction by 7/2 units.
```

In [60]:

```
P=Point(4,-2)
```

In [61]:

```
P.transform(Matrix([[-1,0,0],[0,1,0],[0,0,1]]))
```

Out[61]:

$\text{Point2D}(-4, -2)$

In [62]:

```
P.scale(5,0)
```

Out[62]:

$\text{Point2D}(20, 0)$

In [63]:

```
P.rotate(pi/2)
```

Out[63]:

$\text{Point2D}(2, 4)$

In [64]:

```
P.transform(Matrix([[1,7/2,0],[0,1,0],[0,0,1]]))
```

Out[64]:

$\text{Point2D}(4, 12)$

In [ ]:

```
(ii) Find the combined transformation of the line segment between the points A[7, -2] & B[6, 2]
by using Python program for the following sequence of transformations:-
(I) Rotation about origin through an angle π/3
(II) Scaling in X- coordinate by 7 units.
(III) Uniform scaling by -4 units.
(IV) Reflection through the line X- axis.
```

In [65]:

```
A=Point(7,-2)
B=Point(6,2)
S=Segment(A,B)
S.rotate(pi/3)
S.scale(7,0)
S.scale(-4,-4)
points=S.points
p=points[0]
q=points[1]
p1=p.transform(Matrix([[1,0,0],[0,-1,0],[0,0,1]]))
q1=q.transform(Matrix([[1,0,0],[0,-1,0],[0,0,1]]))
Segment(p1,q1)
```

Out[65]:

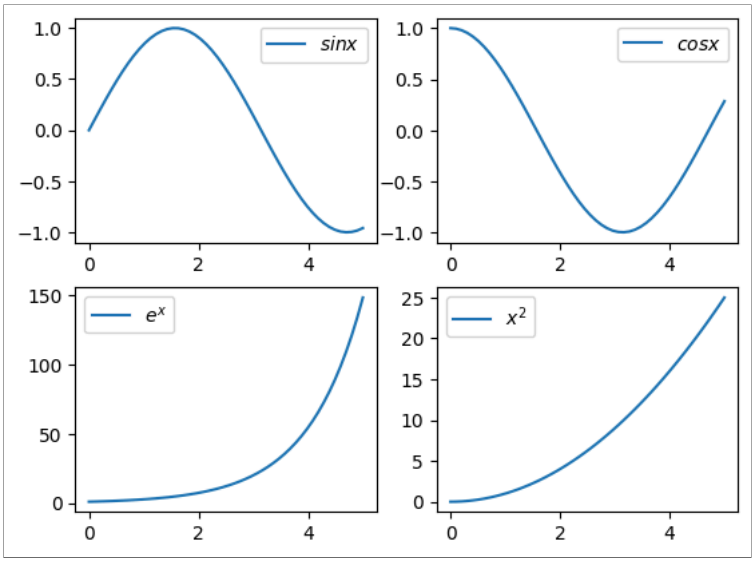
In [ ]:

```
Q.1 Attempt any TWO of the following. [10]
(a) Plot the graphs of sin x, cos x, e^x and x^2
in [0, 5] in one figure with (2 × 2) subplots.
```

In [67]:

```
from pylab import*
import numpy as np
from math import*
x=np.linspace(0,5)
y1=np.sin(x)
y2=np.cos(x)
y3=np.exp(x)
y4=x**2
subplot(2,2,1)
plot(x,y1,label="$ sin x $")
legend()
subplot(2,2,2)
plot(x,y2,label="$ cos x $")
legend()
subplot(2,2,3)
plot(x,y3,label="$ e^x $")
legend()
subplot(2,2,4)
plot(x,y4,label="$ x^2 $")
```

```
legend()
show()
```

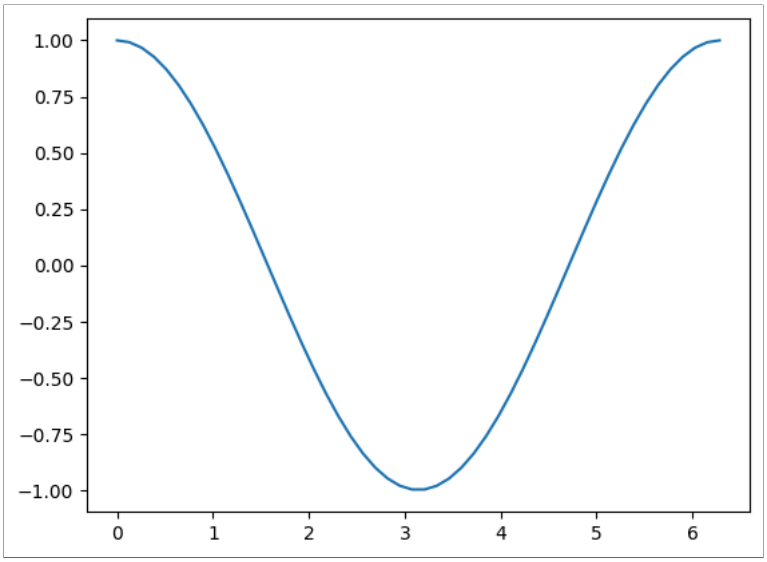


In [ ]:

(b) Using Python plot the graph of function f(x) = cos(x) in the interval [0, 2π].

In [68]:

```
import matplotlib.pyplot as plt
import numpy as np
x=np.linspace(0,2*np.pi)
f=np.cos(x)
plt.plot(x,f)
plt.show()
```



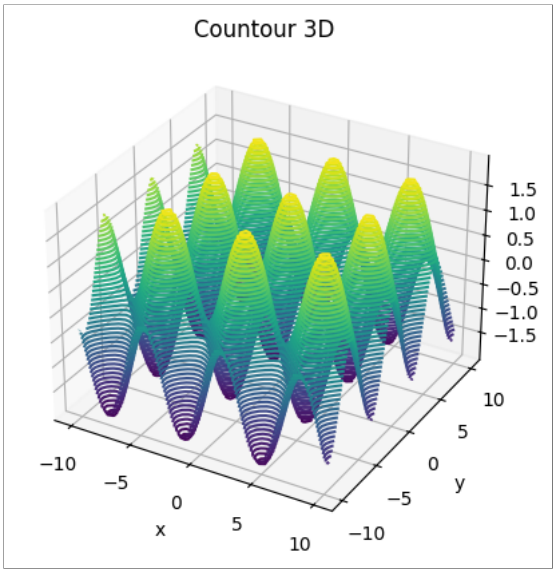
In [ ]:

(c) Write a Python program to generate 3D plot of the functions z = sin x + cos y in -10 < x, y

In [69]:

```
from pylab import*
import numpy as np
def f(x,y):
    return np.sin(x)+np.cos(y)
x=np.linspace(-10,10)
```

```
y=np.linspace(-10,10)
X,Y=np.meshgrid(x,y)
Z=f(X,Y)
ax=axes(projection='3d')
ax.contour3D(X,Y,Z,50)
xlabel('x')
ylabel('y')
title("Countour 3D")
show()
```



In [ ]:

```
(a) Write a Python program in 3D to rotate the point (1, 0, 0) through XZ Plane in anticlockwis
direction (Rotation through Y axis) by an angle of 90◦
```

In [72]:

```
A=Point(1,0,0)
A.transform(Matrix([[0,0,-1,0],[0,1,0,0],[1,0,0,0],[0,0,0,1]]))
```

Out[72]:

$\mathrm{Point3D}(0, 0, 1)$

In [ ]:

```
(b) Using python, generate triangle with vertices (0, 0),(4, 0),(1, 4), check whether the triar
Scalene triangle.
```

In [74]:

```
T=Triangle(Point(0,0),Point(4,0),Point(1,4))
T.is_scalene()
```

Out[74]:

True

In [ ]:

```
(c) Write a Python program to find the area and perimeter of the ΔABC, where A[0, 0], B[6, 0],
```

In [79]:

```
T=Triangle(Point(0,0),Point(6,0),Point(4,4))
T.area
```

Out[79]:

12

In [80]:

```
T.perimeter
```

Out[80]:

$2\sqrt{5} + 4\sqrt{2} + 6$

In [ ]:

```
Q.3 Attempt the following.
(a) Attempt any ONE of the following. [7]
(i) Write a Python program to solve the following LPP:
Max Z = 150x + 75y
subject to
4x + 6y ≤ 24
5x + 3y ≤ 15
x ≥ 0, y ≥ 0.
```

In [83]:

```
from pulp import*
model=LpProblem(name='Lp-Problem',sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(4*x+6*y<=24)
model+=(5*x+3*y<=15)
model+=150*x+75*y
model
```

Out[83]:

```
Lp-Problem:
MAXIMIZE
150*x + 75*y + 0
SUBJECT TO
_C1: 4 x + 6 y <= 24

_C2: 5 x + 3 y <= 15

VARIABLES
x Continuous
y Continuous
```

In [84]:

```
model.solve()
```

Out[84]:

```
1
```

In [85]:

```
model.objective.value()
```

Out[85]:

```
450.0
```

In [86]:

```
x.value()
```

Out[86]:

```
3.0
```

In [87]:

```
y.value()
```

Out[87]:

```
0.0
```

In [ ]:

```
(ii) Write a python program to display the following LPP by using pulp module and simplex
method. Find its optimal solution if exist.
Max Z = 3x + 5y + 4z
subject to
2x + 3y ≤ 8
2y + 5z ≤ 10
3x + 2y + 4z ≤ 15
x ≥ 0, y ≥ 0, z ≥ 0.
```

In [88]:

```
from pulp import*
model=LpProblem(name='Lp-Problem',sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
z=LpVariable(name='z',lowBound=0)
model+=(2*x+3*y<=8)
model+=(2*y+5*z<=10)
model+=(3*x+2*y+4*z<=15)
model+=3*x+5*y+4*z
model
```

Out[88]:

```
Lp-Problem:
MAXIMIZE
3*x + 5*y + 4*z + 0
SUBJECT TO
_C1: 2 x + 3 y <= 8

_C2: 2 y + 5 z <= 10

_C3: 3 x + 2 y + 4 z <= 15

VARIABLES
x Continuous
y Continuous
z Continuous
```

In [89]:

```
model.solve()
```

Out[89]:

```
1
```

In [90]:

```
model.objective.value()
```

Out[90]:

18.658536500000004

In [91]:

```
x.value()
```

Out[91]:

2.1707317

In [92]:

```
y.value()
```

Out[92]:

1.2195122

In [93]:

```
z.value()
```

Out[93]:

1.5121951

In [ ]:

```
(b) Attempt any ONE of the following. [8]
(i) Apply Python program in each of the following transformations on the point P[4, -2]
(I) Refection through Y-axis.
(II) Scaling in X-coordinate by factor 3.
(III) Rotation about origin through an angle π.
(IV) Shearing in both X and Y direction by -2 and 4 units respectively.
```

In [94]:

```
P=Point(4,-2)
```

In [95]:

```
P.transform(Matrix([[-1,0,0],[0,1,0],[0,0,1]]))
```

Out[95]:

$\mathrm{Point2D}(-4, -2)$

In [96]:

```
P.scale(3,0)
```

Out[96]:

$\mathrm{Point2D}(12, 0)$

In [97]:

```
P.rotate(pi)
```

Out[97]:

$\text{Point2D}(-4, 2)$

In [98]:

```
P.transform(Matrix([[1,-2,0],[4,1,0],[0,0,1]]))
```

Out[98]:

$\text{Point2D}(-4, -10)$

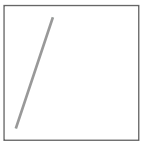
In [ ]:

```
(ii) Find the combined transformation of the line segment between the points A[4, -1] & B[3, 2]
by using Python program for the following sequence of transformations:-
(I) Rotation about origin through an angle π/4
(II) Shearing in Y direction by 4 units.
(III) Scaling in X- coordinate by 5 units.
(IV) Reflection through y- axis.
```

In [99]:

```
A=Point(4,-1)
B=Point(3,2)
S=Segment(A,B)
S.rotate(pi/4)
points=S.points
p=points[0]
q=points[1]
p1=p.transform(Matrix([[1,0,0],[4,1,0],[0,0,1]]))
q1=q.transform(Matrix([[1,0,0],[4,1,0],[0,0,1]]))
Segment(p1,q1)
S.scale(5,0)
p1=p.transform(Matrix([[-1,0,0],[0,1,0],[0,0,1]]))
q1=q.transform(Matrix([[-1,0,0],[0,1,0],[0,0,1]]))
Segment(p1,q1)
```

Out[99]:



In [ ]:

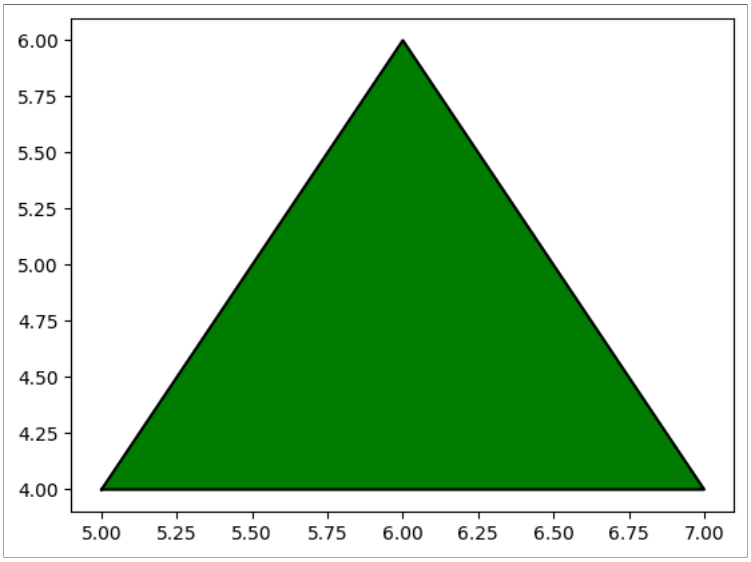
```
Q.1 Attempt any TWO of the following. [10]
(a) Write a python program to Plot 2DX-axis and Y-axis black color and in the same diagram plot
green triangle with vertices [5, 4], [7, 4], [6, 6].
```

In [1]:

```
import matplotlib.pyplot as plt
x=[5,7,6,5]
y=[4,4,6,4]
plt.plot(x,y,'black')
plt.fill(x,y,color='green')
```

Out[1]:

```
[<matplotlib.patches.Polygon at 0x21d30bbdb10>]
```



In [ ]:

```
(b) Write a program in python to rotate the point through YZ-plane in anticlockwise direction.
tation through Y-axis by an angle of 90◦.)
```

In [35]:

```
from sympy import*
import numpy as np
```

In [3]:

```
A=Point(1,0,0)
A.transform(Matrix([[1,0,0,0],[0,0,-1,0],[0,1,0,0],[0,0,0,1]]))
```

Out[3]:

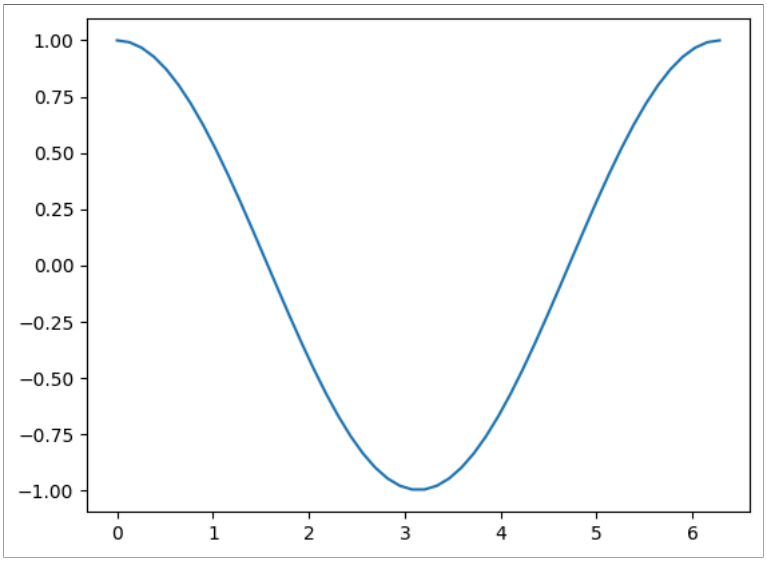
$$\text{Point3D}(1, 0, 0)$$

In [ ]:

```
(c) Using Python plot the graph of function f(x) = cos(x) on the interval [0, 2π].
```

In [4]:

```
import matplotlib.pyplot as plt
import numpy as np
x=np.linspace(0,2*np.pi)
f=np.cos(x)
plt.plot(x,f)
plt.show()
```



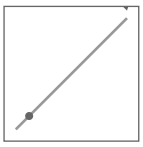
In [ ]:

```
Q.2 Attempt any TWO of the following. [10]
(a) Write a python program to rotate the ray by 90◦ having starting point (1, 0) and (2, -1).
```

In [5]:

```
R=Ray(Point(1,0),Point(2,-1))
R.rotate(pi/2)
```

Out[5]:



In [ ]:

```
(b) Using sympy, declare the points A(0, 7), B(5, 2). Declare the line segment passing through
Find the length and midpoint of the line segment passing through points A and B.
```

In [8]:

```
A=Point(0,7)
B=Point(5,2)
S=Segment(A,B)
```

In [9]:

```
S.length
```

Out[9]:

$$5\sqrt{2}$$

In [10]:

```
S.midpoint
```

Out[10]:

$$\text{Point2D}\left(\frac{5}{2}, \frac{9}{2}\right)$$

In [ ]:

```
(c) Write a python program to find the area and perimeter of ΔABC where A(0, 0), B(5, 0), C(3,
```

In [11]:

```
A=Point(0,0)
B=Point(5,0)
C=Point(3,3)
T=Triangle(A,B,C)
```

In [12]:

```
T.area
```

Out[12]:

$$\frac{15}{2}$$

In [13]:

```
T.perimeter
```

Out[13]:

$$\sqrt{13}+3\sqrt{2}+5$$

In [ ]:

```
Q.3 Attempt the following.
(a) Attempt any ONE of the following. [7]
(i) Write a Python program to solve the following LPP:
Max Z = 150x + 75y
subject to 4x + 6y ≤ 24
5x + 3y ≤ 15
x ≥ 0, y ≥ 0.
```

In [14]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(4*x+6*y<=24)
model+=(5*x+3*y<=15)
model+=150*x+75*y
model
```

Out[14]:

```
Lp-Problem:
MAXIMIZE
150*x + 75*y + 0
SUBJECT TO
_C1: 4 x + 6 y <= 24

_C2: 5 x + 3 y <= 15

VARIABLES
x Continuous
y Continuous
```

In [15]:

```
model.solve()
```

Out[15]:

```
1
```

In [16]:

```
model.objective .value()
```

Out[16]:

```
450.0
```

In [17]:

```
x.value()
```

Out[17]:

```
3.0
```

In [18]:

```
y.value()
```

Out[18]:

```
0.0
```

In [ ]:

```
(ii) Write a python program to display the following LPP by using pulp module and simplex
method. Find its optimal solution if exist.
Max Z = 4x + y + 3z + 5w
subject to 4x + 6y - 5z - 4w ≥ 20
-3x - 2y + 4z + w ≤ 10
-8x - 3y + 3z + 2w ≤ 20
x ≥ 0, y ≥ 0, z ≥ 0, w ≥ 0.
```

In [19]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
z=LpVariable(name='z',lowBound=0)
w=LpVariable(name='w',lowBound=0)
model+=(4*x+6*y-5*z-4*w>=20)
model+=(-3*x-2*y+4*z+w<=10)
model+=(-8*x-3*y+3*z+2*w<=20)
model+=4*x+y+3*z+5*w
model
```

Out[19]:

```
Lp-Problem:
MAXIMIZE
5*w + 4*x + 1*y + 3*z + 0
SUBJECT TO
_C1: - 4 w + 4 x + 6 y - 5 z >= 20

_C2: w - 3 x - 2 y + 4 z <= 10

_C3: 2 w - 8 x - 3 y + 3 z <= 20

VARIABLES
w Continuous
x Continuous
y Continuous
z Continuous
```

In [20]:

```
model.solve()
```

Out[20]:

```
-2
```

In [ ]:

```
(b) Attempt any ONE of the following. [8]
(i) Write a python program to apply the following transformations on the point (-2, 4) :
(I) Shearing in Y direction by 7 units.
(II) Scaling in X and Y direction by 7/2 and 7 units respectively.
(III) Shearing in X and Y direction by 4 and 7 units respectively.
(IV) Rotation about origin by an angle 60◦
```

In [21]:

```
P=Point(-2,4)
```

In [22]:

```
P.transform(Matrix([[1,0,0],[7,1,0],[0,0,1]]))
```

Out[22]:

$\text{Point2D}(26, 4)$

In [23]:

```
P.scale(7/2,7)
```

Out[23]:

$\text{Point2D}(-7, 28)$

In [25]:

```
P.transform(Matrix([[1,4,0],[7,1,0],[0,0,1]]))
```

Out[25]:

$\text{Point2D}(26, -4)$

In [26]:

```
P.rotate(pi/3)
```

Out[26]:

$\mathrm{Point2D}(-2\sqrt{3}-1, 2-\sqrt{3})$

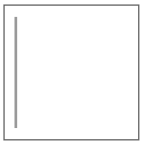
In [ ]:

```
(ii) Write a python program to find the combined transformation of the line segment between the
points A[5, 3] & B[1, 4] for the following sequence of transformations:
(I) Rotate about origin through an angle π/2
(II) Uniform scaling by -3.5 units.
(III) Scaling in Y- axis by 5 units.
(IV) Shearing in X and Y direction by 3 and 4 units respectively.
```

In [27]:

```
A=Point(5,3)
B=Point(1,4)
S=Segment(A,B)
S.rotate(pi/2)
S.scale(-3.5,-3.5)
S.scale(0,5)
points=S.points
p=points[0]
q=points[1]
p1=p.transform(Matrix([[1,3,0],[4,1,0],[0,0,1]]))
q1=q.transform(Matrix([[1,3,0],[4,1,0],[0,0,1]]))
Segment(p1,q1)
```

Out[27]:



In [ ]:

```

```

In [ ]:

```
Q.1 Attempt any TWO of the following. [10]
(a) Write a python program in 3D to rotate the point (1, 0, 0) through XY plane in clockwise di
(Rotation through Z-Axis by an angle of 90◦)
```

In [28]:

```
Q=Point(1,0,0)
Q.transform(Matrix([[0,-1,0,0],[1,0,0,0],[0,0,1,0],[0,0,0,1]]))
```

Out[28]:

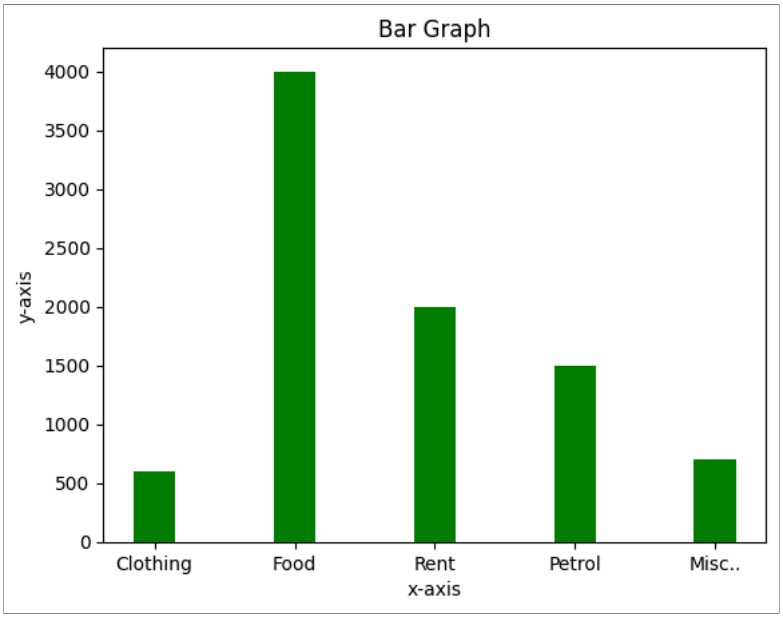
$\mathrm{Point3D}(0, 1, 0)$

In [ ]:

```
(b) Represent the following information using a bar graph (in green color )
Item                clothing   Food   rent   Petrol   Misc.
expenditure in Rs     600     4000   2000    1500     700
```

In [30]:

```
import matplotlib.pyplot as plt
length=[1,2,3,4,5]
height=[600,4000,2000,1500,700]
tick_label=['Clothing','Food','Rent','Petrol','Misc..']
plt.bar(length,height,tick_label=tick_label,width=0.3,color=['green'])
plt.xlabel('x-axis')
plt.ylabel('y-axis')
plt.title('Bar Graph')
plt.show()
```

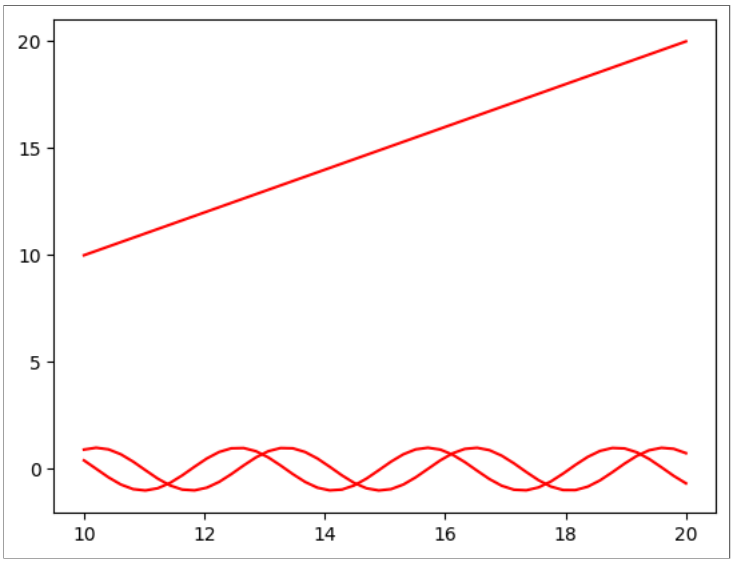


In [ ]:

```
(c) Write a python program to plot the 3D line graph whose parametric equation is (cos(2x),sin(
for 10 ≤ x ≤ 20 (in red color ), with title to the graph.
```

In [31]:

```
from pylab import*
import numpy as np
x=np.linspace(10,20)
f=np.cos(2*x)
g=np.sin(2*x)
h=x
plot(x,f,color='red')
plot(x,g,color='red')
plot(x,h,color='red')
show()
```



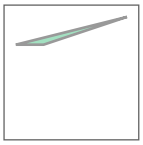
In [ ]:

```
Q.2 Attempt any TWO of the following. [10]
(a) Write a python program to rotate the ΔABC by 90◦ where A(1, 1), B(2, −2), C(1, 2).
```

In [33]:

```
A=Point(1,1)
B=Point(2,-2)
C=Point(1,2)
T=Triangle(A,B,C)
T.rotate(pi/2)
```

Out[33]:



In [ ]:

```
(b) Draw a polygon with vertices (0, 0),(2, 0),(2, 3),(1, 6). Write a python program to rotate
polygon by 180◦
```

In [37]:

```
P=Polygon(Point(0,0),Point(2,0),Point(2,3),Point(1,6))
P
```

Out[37]:

In [38]:

```
P.rotate(pi)
```

Out[38]:

In [ ]:

```
(c) Find the area and perimeter of the ΔABC, where A[0, 0], B[5, 0], C[3, 3].
```

In [40]:

```
A=Point(0,0)
B=Point(5,0)
C=Point(3,3)
T=Triangle(A,B,C)
T.area
```

Out[40]:

$$\frac{15}{2}$$

In [41]:

```
T.perimeter
```

Out[41]:

$$\sqrt{13}+3\sqrt{2}+5$$

In [ ]:

```
Q.3 Attempt the following.
(a) Attempt any ONE of the following. [7]
(i) Solve LPP by using python:
Max Z = x + y
subject to x - y ≥ 1
x + y ≥ 2
x ≥ 0, y ≥ 0.
```

In [42]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
model+=(x-y>=1)
model+=(x+y>=2)
model+=x+y
model
```

Out[42]:

```
Lp-Problem:
MAXIMIZE
1*x + 1*y + 0
SUBJECT TO
_C1: x - y >= 1

_C2: x + y >= 2

VARIABLES
x Continuous
y Continuous
```

In [43]:

```
model.solve()
```

Out[43]:

```
-2
```

In [ ]:

```
(ii) Write a python program to display the following LPP by using pulp module and simplex
method. Find its optimal solution if exist.
Max Z = 3x + 2y + 5z
subject to x + 2y + z ≤ 430
3x + 4z ≤ 460
x + 4y ≤ 120
x ≥ 0, y ≥ 0, z ≥ 0.
```

In [44]:

```
from pulp import*
model=LpProblem(name="Lp-Problem",sense=LpMaximize)
x=LpVariable(name='x',lowBound=0)
y=LpVariable(name='y',lowBound=0)
z=LpVariable(name='z',lowBound=0)
model+=(x+2*y+z<=430)
model+=(3*x+4*z<=460)
model+=(x+4*y<=120)
model+=3*x+2*y+5*z
model
```

Out[44]:

```
Lp-Problem:
MAXIMIZE
3*x + 2*y + 5*z + 0
SUBJECT TO
_C1: x + 2 y + z <= 430

_C2: 3 x + 4 z <= 460

_C3: x + 4 y <= 120

VARIABLES
x Continuous
y Continuous
z Continuous
```

In [45]:

```
model.solve()
```

Out[45]:

```
1
```

In [46]:

```
model.objective.value()
```

Out[46]:

```
635.0
```

In [47]:

```
x.value()
```

Out[47]:

```
0.0
```

In [48]:

```
y.value()
```

Out[48]:

```
30.0
```

In [49]:

```
z.value()
```

Out[49]:

```
115.0
```

In [ ]:

```
(b) Attempt any ONE of the following. [8]
(i) Write a python program to apply the following transformations on the point (-2, 4) :
(I) Refection through X-axis.
(II) Scaling in X-coordinate by factor 6.
(III) Shearing in X direction by 4 units.
(IV) Rotate about origin through an angle 30◦
```

In [50]:

```
P=Point(-2,4)
```

In [51]:

```
P.transform(Matrix([[1,0,0],[0,-1,0],[0,0,1]]))
```

Out[51]:

$\mathrm{Point2D}(-2, -4)$

In [52]:

```
P.scale(6,0)
```

Out[52]:

$\mathrm{Point2D}(-12, 0)$

In [53]:

```
P.transform(Matrix([[1,4,0],[0,1,0],[0,0,1]]))
```

Out[53]:

$\mathrm{Point2D}(-2, -4)$

In [54]:

```
P.rotate(pi/6)
```

Out[54]:

$\text{Point2D}(-2-\sqrt{3},-1+2\sqrt{3})$

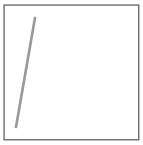
In [ ]:

```
(ii) Write a python program to find the combined transformation between the points for the
following sequence of transformations:-
(I) Rotation about origin through an angle π/2
(II) Uniform scaling by 3.5 units.
(III) Scaling in X & Y coordinate by 3 & 5 units respectively.
(IV) Shearing in X direction by 6 units.
```

In [55]:

```
A=Point(5,3)
B=Point(1,4)
S=Segment(A,B)
S.rotate(pi/2)
S.scale(3.5,3.5)
S.scale(3,5)
points=S.points
p=points[0]
q=points[1]
p1=p.transform(Matrix([[1,6,0],[0,1,0],[0,0,1]]))
q1=q.transform(Matrix([[1,6,0],[0,1,0],[0,0,1]]))
Segment(p1,q1)
```

Out[55]:



In [ ]: