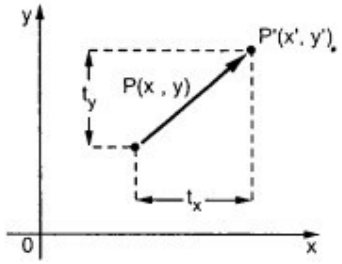
Experiment No. 6

Aim: To implement 2D Transformations: Translation, Scaling, Rotation.

Objective:
To understand the concept of transformation, identify the process of transformation and application of these methods to different object and noting the difference between these transformations.

Theory:
1) Translation –
Translation is defined as moving the object from one position to another position along straight line path. We can move the objects based on translation distances along x and y axis. tx denotes translation distance along x-axis and ty denotes translation distance along y axis.



Consider (x,y) are old coordinates of a point. Then the new coordinates of that same point (x',y') can be obtained as follows:
x' = x + tx y'
= y + ty
We denote translation transformation as P. we express above equations in matrix form as:
P' = P + T , where

$$P = \begin{bmatrix} x \\ y \end{bmatrix} \quad P' = \begin{bmatrix} x' \\ y' \end{bmatrix} \quad T = \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

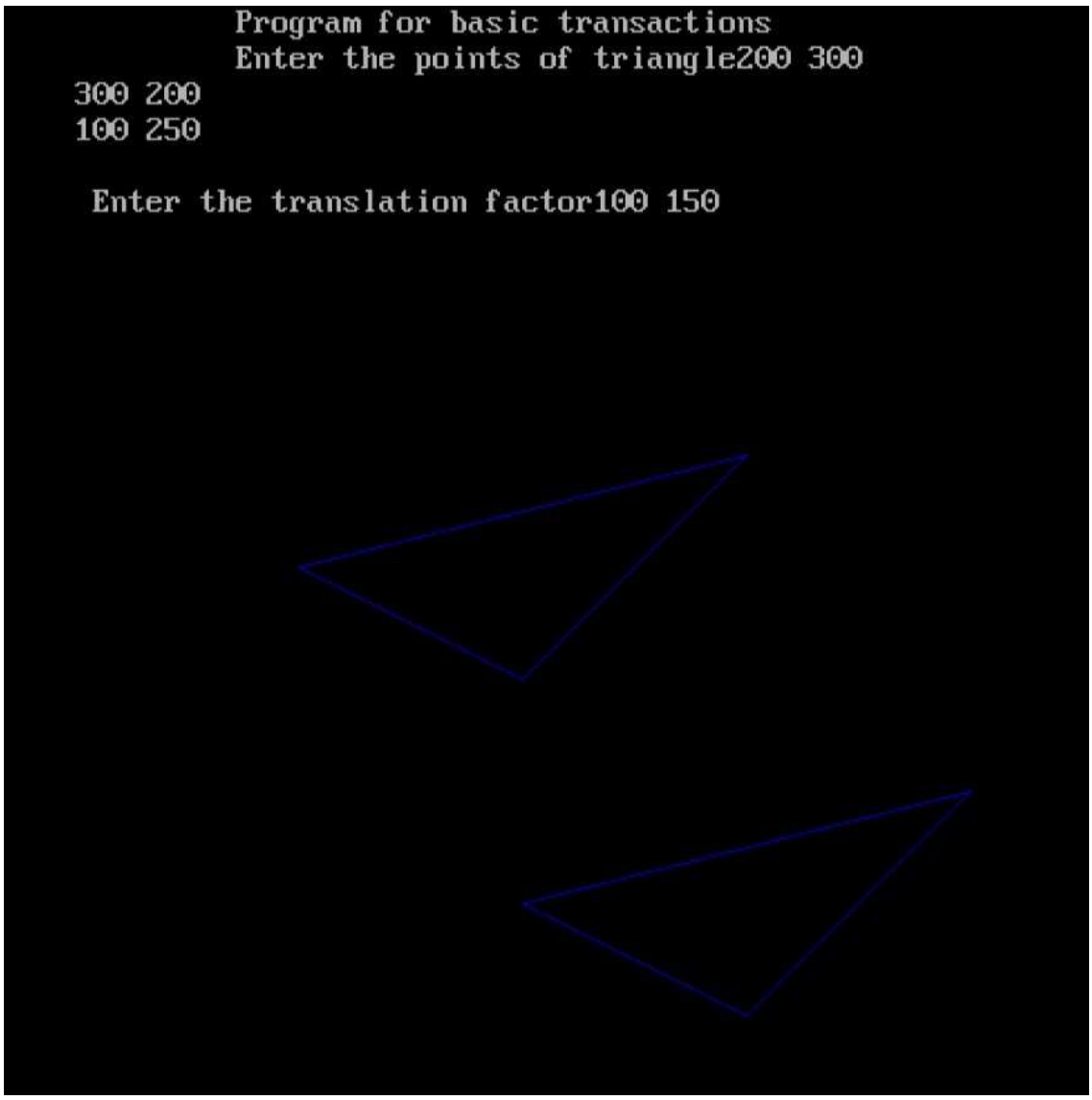
Program:

```
#include <graphics.h>

#include <stdlib.h>

#include <stdio.h>
```

```
#include <conio.h>
#include<math.h>
int main()
{
     int gm;
       int gd=DETECT;
          int
x1,x2,x3,y1,y2,y3,nx1,nx2,nx3,ny1,ny2,ny3,c;
          int sx,sy,xt,yt,r;
float t;
          initgraph(&gd,&gm," ");
printf("\t Program for basic transactions");
printf("\n\t Enter the points of triangle");
setcolor(1);
          scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
          line(x1,y1,x2,y2);
line(x2,y2,x3,y3);
       line(x3,y3,x1,y1);
  printf("\n Enter the translation factor");
scanf("%d%d",&xt,&yt);
  nx1=x1+xt;             ny1=y1+yt;
nx2=x2+xt;             ny2=y2+yt;
nx3=x3+xt;             ny3=y3+yt;
line(nx1,ny1,nx2,ny2);
line(nx2,ny2,nx3,ny3);
line(nx3,ny3,nx1,ny1);
 getch();
```

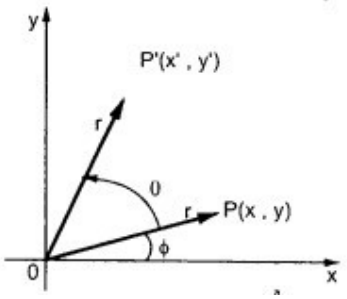
```
 closegraph();
}
```

Output –



2) Rotation –

A rotation repositions all points in an object along a circular path in the plane centered at the pivot point. We rotate an object by an angle theta. New coordinates after rotation depend on both x and y.



$$x' = x\cos\theta - y\sin\theta$$
$$y' = x\sin\theta + y\cos\theta$$

The above equations can be represented in the matrix form as given below

$$[x'\ y'] = [x\ \ y]\begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

$$P' = P \cdot R$$

where R is the rotation matrix and it is given as

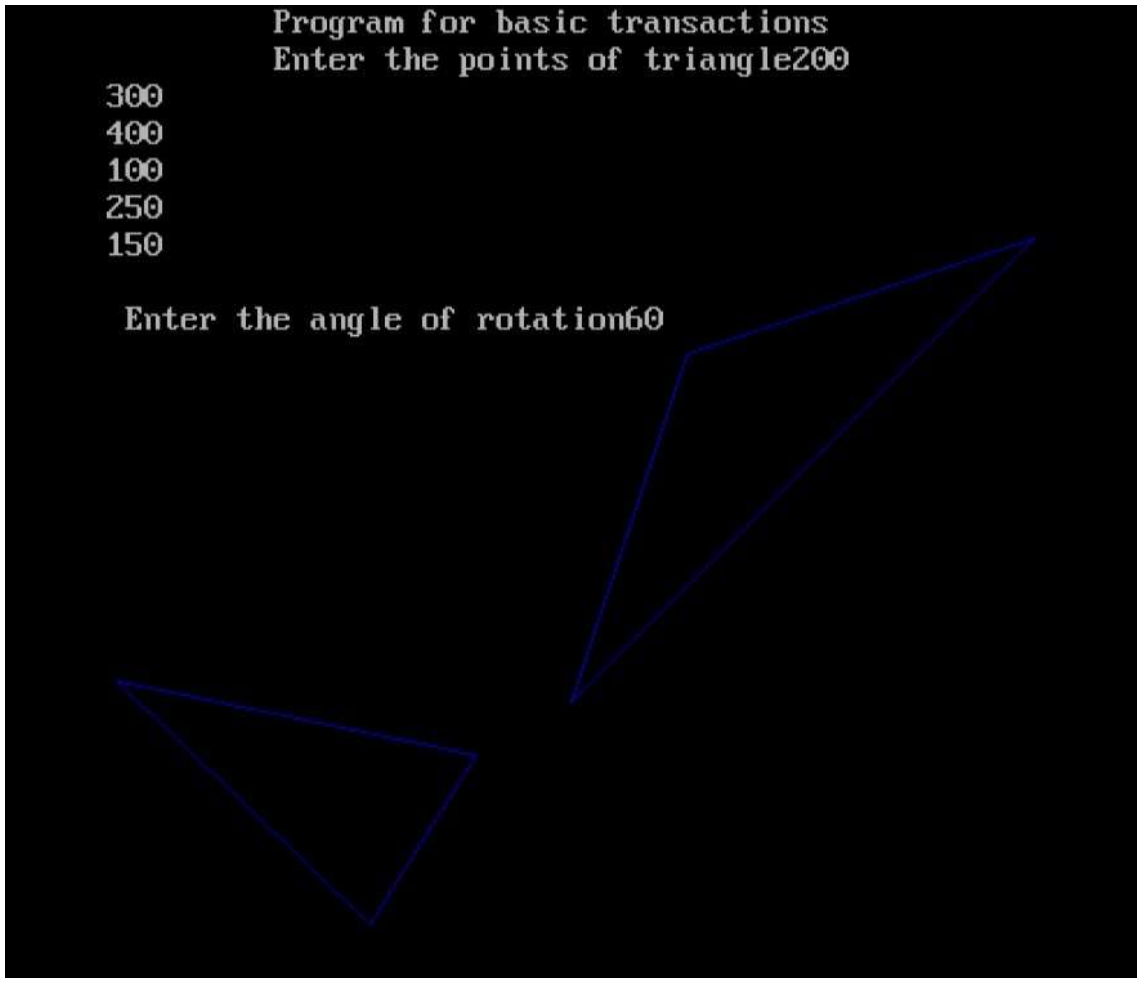
$$R = \begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

Program:

```
#include <graphics.h>

#include <stdlib.h>

#include <stdio.h>

#include <conio.h> #include<math.h> int main()

{       int gm;       int gd=DETECT;       int

x1,x2,x3,y1,y2,y3,nx1,nx2,nx3,ny1,ny2,ny3,c;

        int sx,sy,xt,yt,r;

float t;

        initgraph(&gd,&gm," ");

printf("\t Program for basic transactions");
```

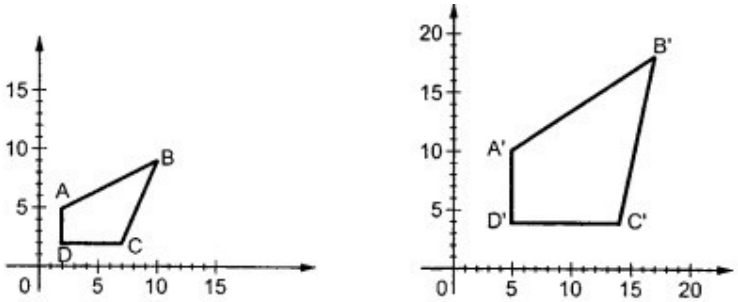
```
printf("\n\t Enter the points of triangle");
setcolor(1);
        scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
        line(x1,y1,x2,y2);
line(x2,y2,x3,y3);
line(x3,y3,x1,y1);  printf("\n Enter the
angle of rotation");
                        scanf("%d",&r);
t=3.14*r/180;
nx1=abs(x1*cos(t)-y1*sin(t));
ny1=abs(x1*sin(t)+y1*cos(t));
nx2=abs(x2*cos(t)-y2*sin(t));
ny2=abs(x2*sin(t)+y2*cos(t));
nx3=abs(x3*cos(t)-y3*sin(t));
ny3=abs(x3*sin(t)+y3*cos(t));
line(nx1,ny1,nx2,ny2);
line(nx2,ny2,nx3,ny3);
line(nx3,ny3,nx1,ny1);
getch();
  closegraph();
return 0;
}
```

Output:


Program for basic transactions
Enter the points of triangle200
300
400
100
250
150
Enter the angle of rotation60

3) Scaling -

scaling refers to changing the size of the object either by increasing or decreasing. We will increase or decrease the size of the object based on scaling factors along x and y-axis.



If (x, y) are old coordinates of object, then new coordinates of object after applying scaling transformation are obtained as:

x' = x * Sx y'

= y * Sy

Sx and Sy are scaling factors along x-axis and y-axis. we express the above equations in matrix form as:

$$[x' \; y'] = [x \; y] \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix}$$

$$= [x \cdot S_x \quad y \cdot Sy]$$

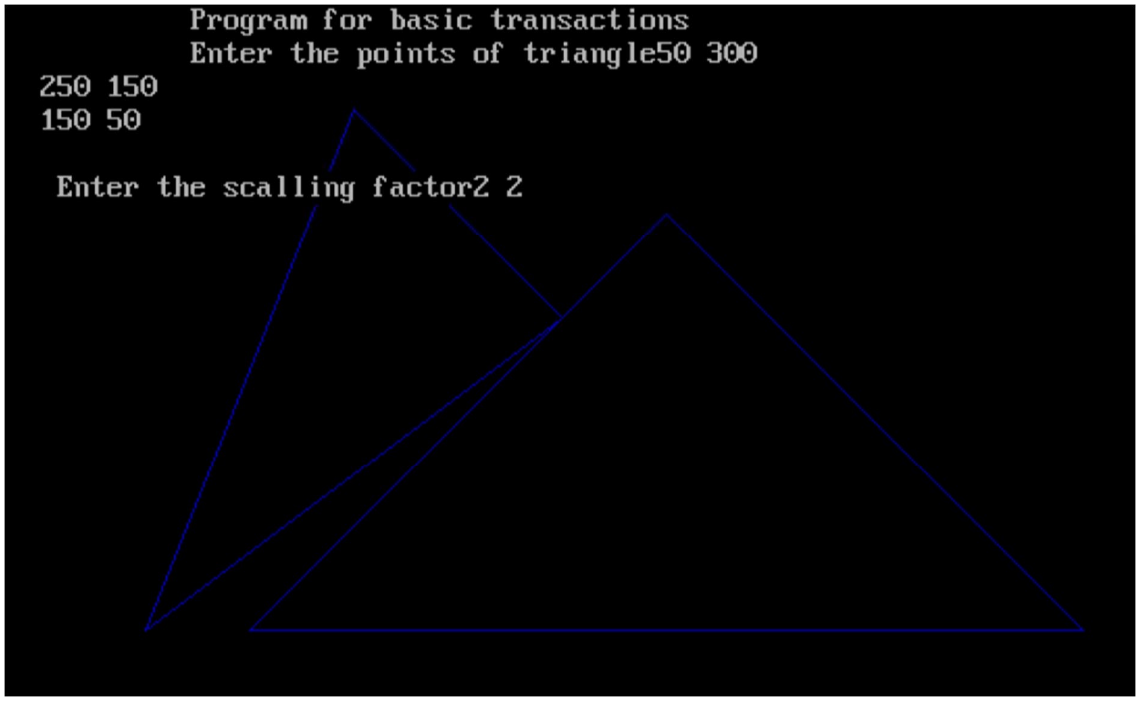
$$= P \cdot S$$

Program:

```
#include <graphics.h>

#include <stdlib.h>

#include <stdio.h>

#include <conio.h>

#include<math.h> int main()

 {

        int gm;

      int gd=DETECT;

      int x1,x2,x3,y1,y2,y3,nx1,nx2,nx3,ny1,ny2,ny3,c;

        int sx,sy,xt,yt,r;

float t;
```

```
        initgraph(&gd,&gm," ");
printf("\t Program for basic transactions");
printf("\n\t Enter the points of triangle");
setcolor(1);
        scanf("%d%d%d%d%d%d",&x1,&y1,&x2,&y2,&x3,&y3);
        line(x1,y1,x2,y2);
line(x2,y2,x3,y3);
      line(x3,y3,x1,y1);
 printf("\n Enter the scalling factor");
scanf("%d%d",&sx,&sy);
nx1=x1*sx;                          ny1=y2*sy;
nx2=x2*sx;                          ny2=y2*sy;
nx3=x3*sx;                          ny3=y3*sy;
line(nx1,ny1,nx2,ny2);
line(nx2,ny2,nx3,ny3);
line(nx3,ny3,nx1,ny1);
getch();
closegraph();
}
```

Output –



Conclusion: Comment on :

1. **Application of transformation**

Transformations are pivotal in computer graphics, involving operations like translation, scali ng, rotation, and shearing. They are used to:

- Move Objects: Translate shapes or images from one position to another.
- Resize Objects: Scale objects larger or smaller.
- Rotate Objects: Rotate objects around a specified axis.
- Distort Shapes: Apply shear transformations to distort shapes in specific directions.

These operations are fundamental in animations, modeling, simulations, and rendering proce sses in graphics applications.

2. **Difference noted between methods**

Different transformation methods vary in complexity and application:

- Translation: Simple addition of coordinates; straightforward and efficient.
- Scaling: Involves multiplication by scaling factors; changes object size.
- Rotation: Utilizes trigonometric functions; more computationally intensive.
- Shearing: Alters shape by shifting coordinates; can be complex depending on the axi s.

While translation and scaling are simpler and faster, rotation and shearing provide more flex ibility but at a higher computational cost.

3. Application t different object

Transformations are applied across various objects in computer graphics:

- 2D Graphics: Used for manipulating images, sprites, and shapes in games and UI de sign.
- 3D Models: Essential in rotating and scaling 3D objects in modeling software.
- Text: Applied in text rendering to rotate, scale, or translate characters for creative vis ual effects.
- Animations: Key in creating smooth transitions, movements, and effects in animatio ns.