**Coordinates of cube vertexes:**

| | X Y Z |
|---|---|
| 1.vertex of cube | {-0.3, 0.3, 0.3} |
| 2.vertex of cube | { 0.3, 0.3, 0.3} |
| 3.vertex of cube | { 0.3,-0.3, 0.3} |
| 4.vertex of cube | {-0.3,-0.3, 0.3} |
| 5.vertex of cube | {-0.3, 0.3,-0.3} |
| 6.vertex of cube | { 0.3, 0.3,-0.3} |
| 7.vertex of cube | { 0.3,-0.3,-0.3}, |
| 8.vertex of cube | {-0.3,-0.3,-0.3} |

**Light source at this position:** [0.0, 0.0, -5.0]

1) **I enable this function (GL_LIGHTING) because lights will be seen more clearly.**

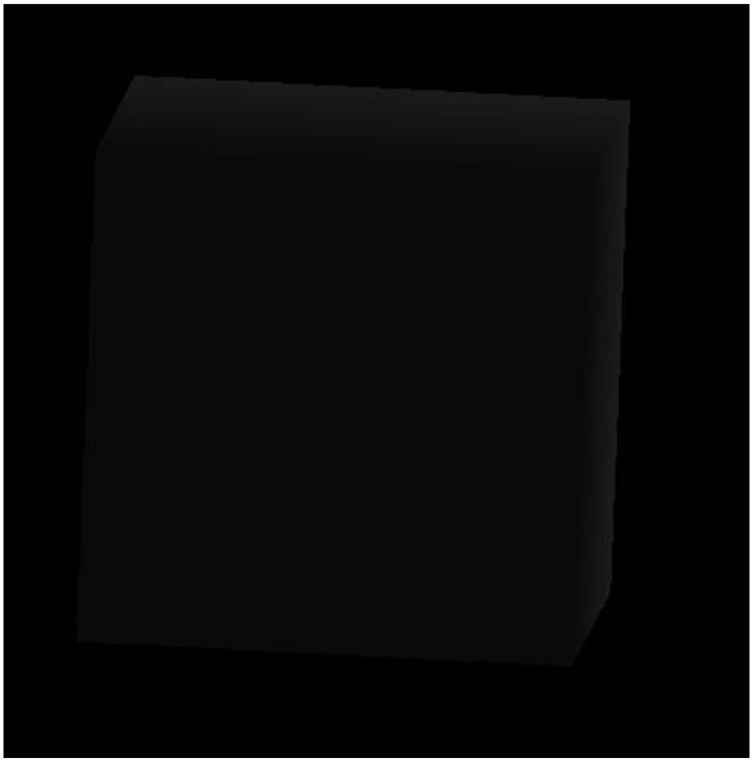


***Figure1:*** **Light source at (0.0, 0.0, -5.0) and rotate around [x=10,y=5,z=3] and 10 angle.**

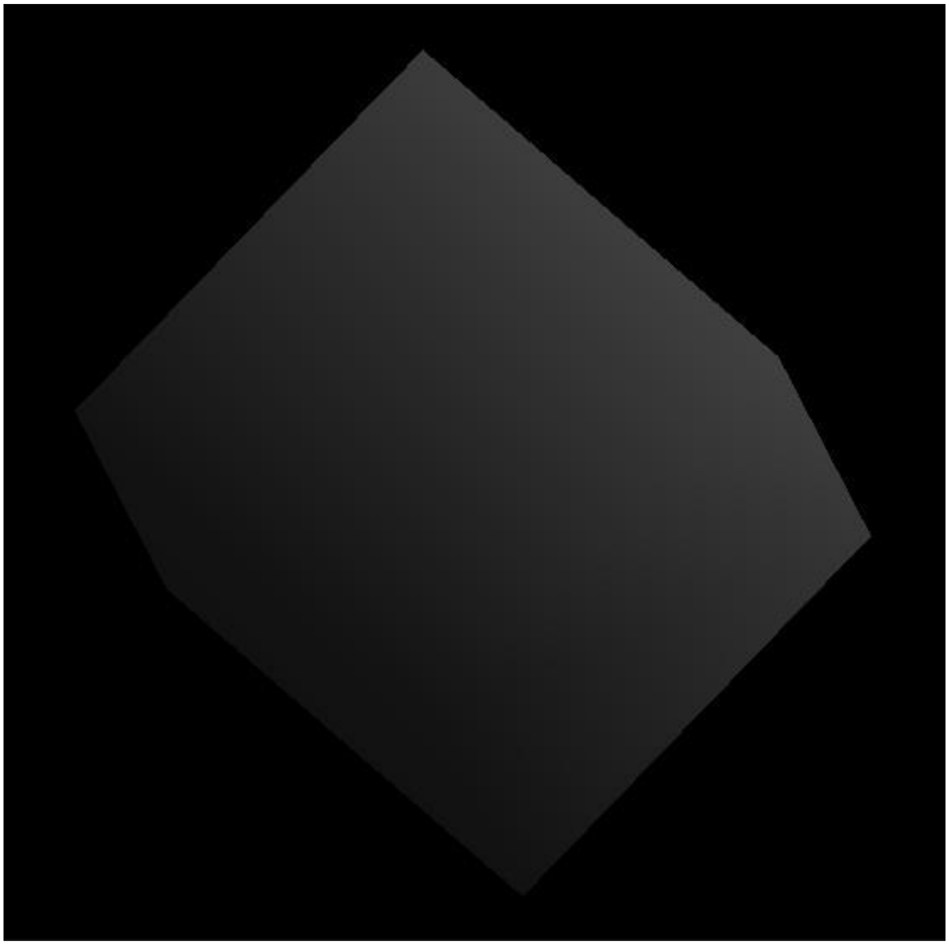
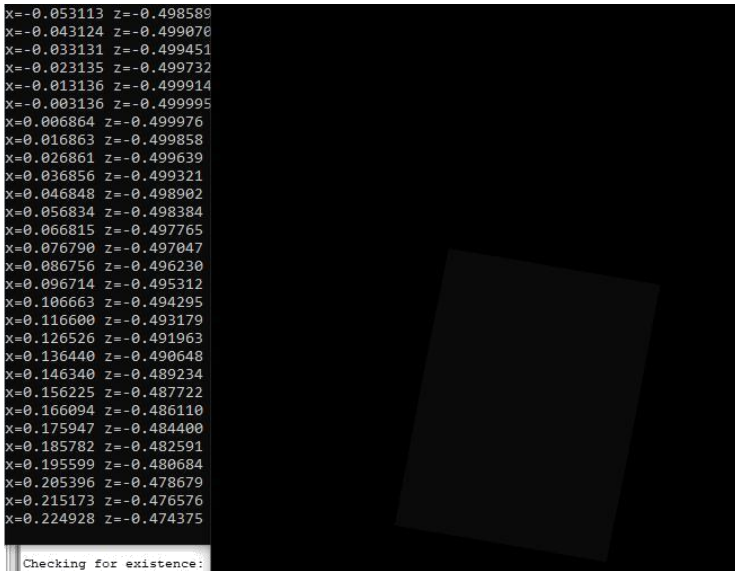


***Figure2:*** **Light source at (0.0, 0.0, -5.0) and rotate around [x=10,y=5,z=3] and 100 angle.**

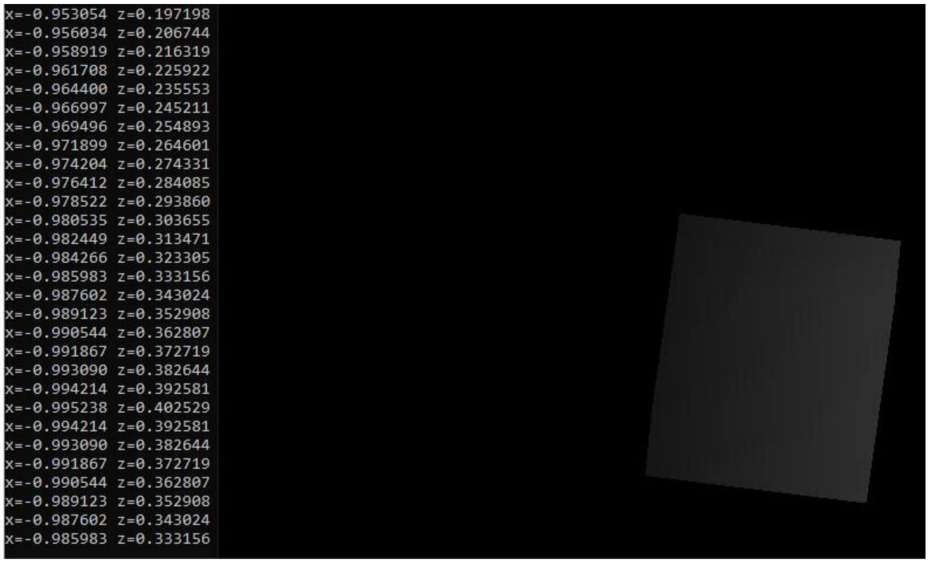
**X and Z coordinates (in below figures) state coordinates of cube controlled by keyboard(GL_LIGHTING is enabled ):**



```
x=-0.053113 z=-0.498589
x=-0.043124 z=-0.499070
x=-0.033131 z=-0.499451
x=-0.023135 z=-0.499732
x=-0.013136 z=-0.499914
x=-0.003136 z=-0.499995
x=0.006864 z=-0.499976
x=0.016863 z=-0.499858
x=0.026861 z=-0.499639
x=0.036856 z=-0.499321
x=0.046848 z=-0.498902
x=0.056834 z=-0.498384
x=0.066815 z=-0.497765
x=0.076790 z=-0.497047
x=0.086756 z=-0.496230
x=0.096714 z=-0.495312
x=0.106663 z=-0.494295
x=0.116600 z=-0.493179
x=0.126526 z=-0.491963
x=0.136440 z=-0.490648
x=0.146340 z=-0.489234
x=0.156225 z=-0.487722
x=0.166094 z=-0.486110
x=0.175947 z=-0.484400
x=0.185782 z=-0.482591
x=0.195599 z=-0.480684
x=0.205396 z=-0.478679
x=0.215173 z=-0.476576
x=0.224928 z=-0.474375
```

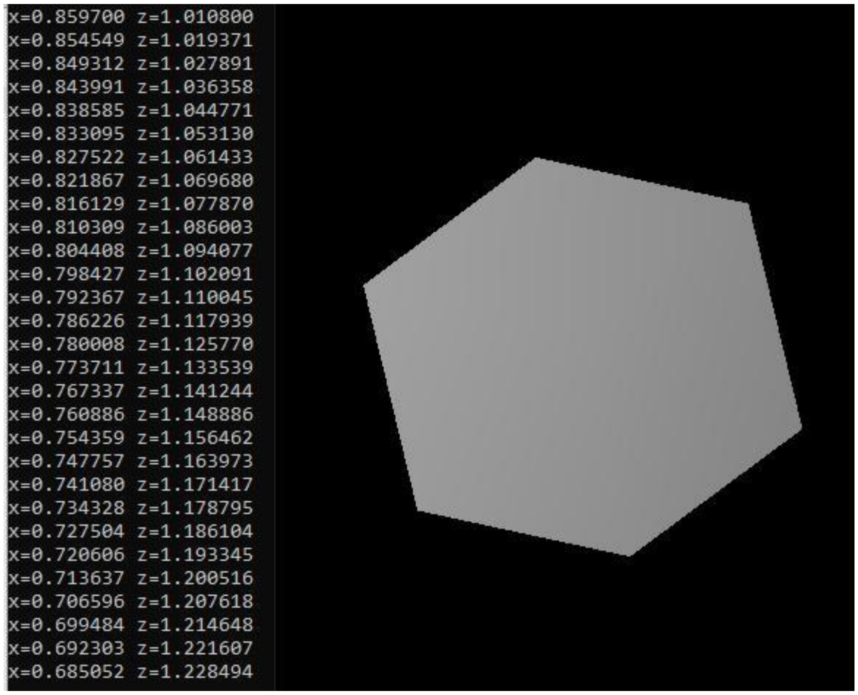
```
Checking for existence:
```

***<u>Figure3:</u>*****We can control camera by keyboard. Because of light source ,cube will be like in this image(almost black).**



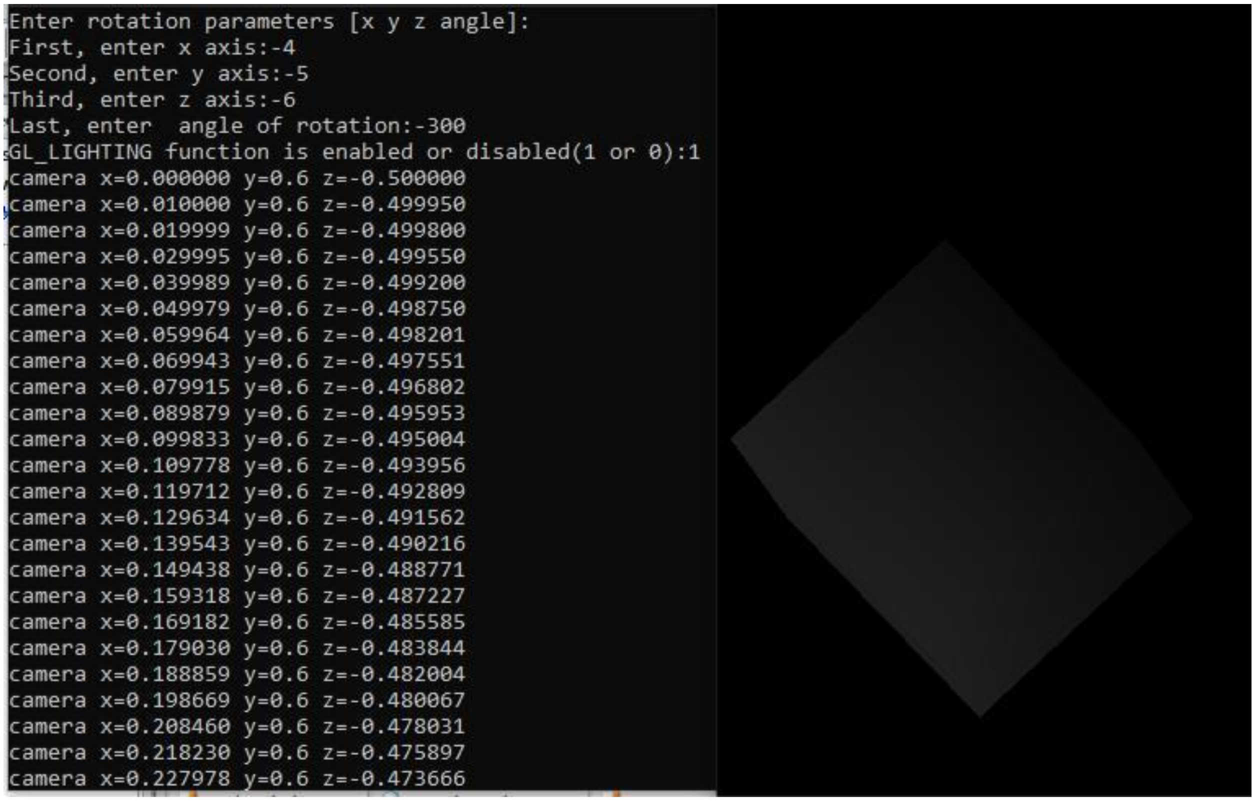
```
x=-0.953054 z=0.197198
x=-0.956034 z=0.206744
x=-0.958919 z=0.216319
x=-0.961708 z=0.225922
x=-0.964400 z=0.235553
x=-0.966997 z=0.245211
x=-0.969496 z=0.254893
x=-0.971899 z=0.264601
x=-0.974204 z=0.274331
x=-0.976412 z=0.284085
x=-0.978522 z=0.293860
x=-0.980535 z=0.303655
x=-0.982449 z=0.313471
x=-0.984266 z=0.323305
x=-0.985983 z=0.333156
x=-0.987602 z=0.343024
x=-0.989123 z=0.352908
x=-0.990544 z=0.362807
x=-0.991867 z=0.372719
x=-0.993090 z=0.382644
x=-0.994214 z=0.392581
x=-0.995238 z=0.402529
x=-0.994214 z=0.392581
x=-0.993090 z=0.382644
x=-0.991867 z=0.372719
x=-0.990544 z=0.362807
x=-0.989123 z=0.352908
x=-0.987602 z=0.343024
x=-0.985983 z=0.333156
```

***<u>Figure4:</u>*****We can control camera by keyboard. Because of light source ,cube will be like in this image(some area is illuminated some area is black)**



```
x=0.859700 z=1.010800
x=0.854549 z=1.019371
x=0.849312 z=1.027891
x=0.843991 z=1.036358
x=0.838585 z=1.044771
x=0.833095 z=1.053130
x=0.827522 z=1.061433
x=0.821867 z=1.069680
x=0.816129 z=1.077870
x=0.810309 z=1.086003
x=0.804408 z=1.094077
x=0.798427 z=1.102091
x=0.792367 z=1.110045
x=0.786226 z=1.117939
x=0.780008 z=1.125770
x=0.773711 z=1.133539
x=0.767337 z=1.141244
x=0.760886 z=1.148886
x=0.754359 z=1.156462
x=0.747757 z=1.163973
x=0.741080 z=1.171417
x=0.734328 z=1.178795
x=0.727504 z=1.186104
x=0.720606 z=1.193345
x=0.713637 z=1.200516
x=0.706596 z=1.207618
x=0.699484 z=1.214648
x=0.692303 z=1.221607
x=0.685052 z=1.228494
```

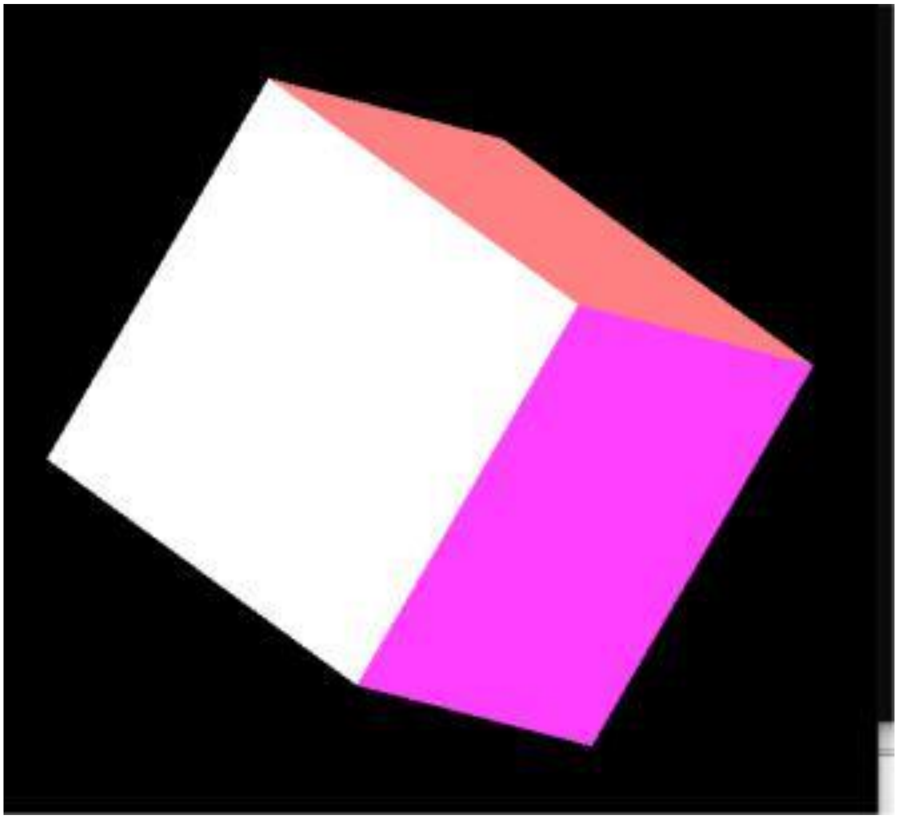
***Figure5:*** **We can control camera by keyboard. Because of light source ,cube will be like in this image(cube is illuminated fully)**



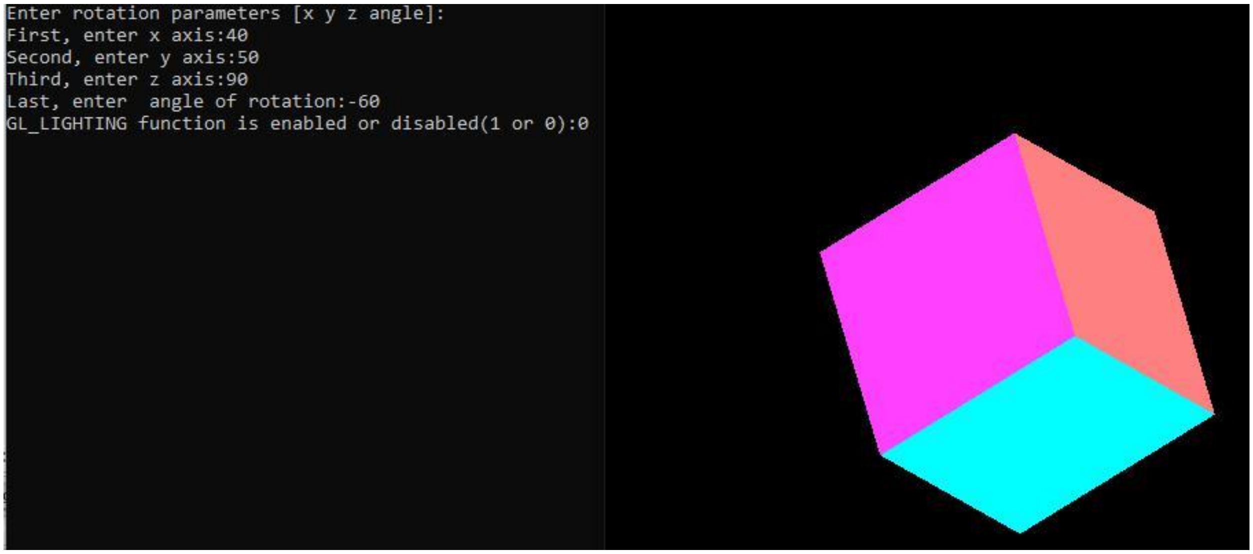
```
Enter rotation parameters [x y z angle]:
First, enter x axis:-4
Second, enter y axis:-5
Third, enter z axis:-6
Last, enter  angle of rotation:-300
GL_LIGHTING function is enabled or disabled(1 or 0):1
camera x=0.000000 y=0.6 z=-0.500000
camera x=0.010000 y=0.6 z=-0.499950
camera x=0.019999 y=0.6 z=-0.499800
camera x=0.029995 y=0.6 z=-0.499550
camera x=0.039989 y=0.6 z=-0.499200
camera x=0.049979 y=0.6 z=-0.498750
camera x=0.059964 y=0.6 z=-0.498201
camera x=0.069943 y=0.6 z=-0.497551
camera x=0.079915 y=0.6 z=-0.496802
camera x=0.089879 y=0.6 z=-0.495953
camera x=0.099833 y=0.6 z=-0.495004
camera x=0.109778 y=0.6 z=-0.493956
camera x=0.119712 y=0.6 z=-0.492809
camera x=0.129634 y=0.6 z=-0.491562
camera x=0.139543 y=0.6 z=-0.490216
camera x=0.149438 y=0.6 z=-0.488771
camera x=0.159318 y=0.6 z=-0.487227
camera x=0.169182 y=0.6 z=-0.485585
camera x=0.179030 y=0.6 z=-0.483844
camera x=0.188859 y=0.6 z=-0.482004
camera x=0.198669 y=0.6 z=-0.480067
camera x=0.208460 y=0.6 z=-0.478031
camera x=0.218230 y=0.6 z=-0.475897
camera x=0.227978 y=0.6 z=-0.473666
```

***Figure6:*** **We can control camera by keyboard. Because of light source ,cube will be like in this image(cube is illuminated partially)**

**2)I disable this function (GL_LIGHTING) because cube will be seen more clearly .I used 6 different colors on cube because shape of cube structure will be seen more clearly.**

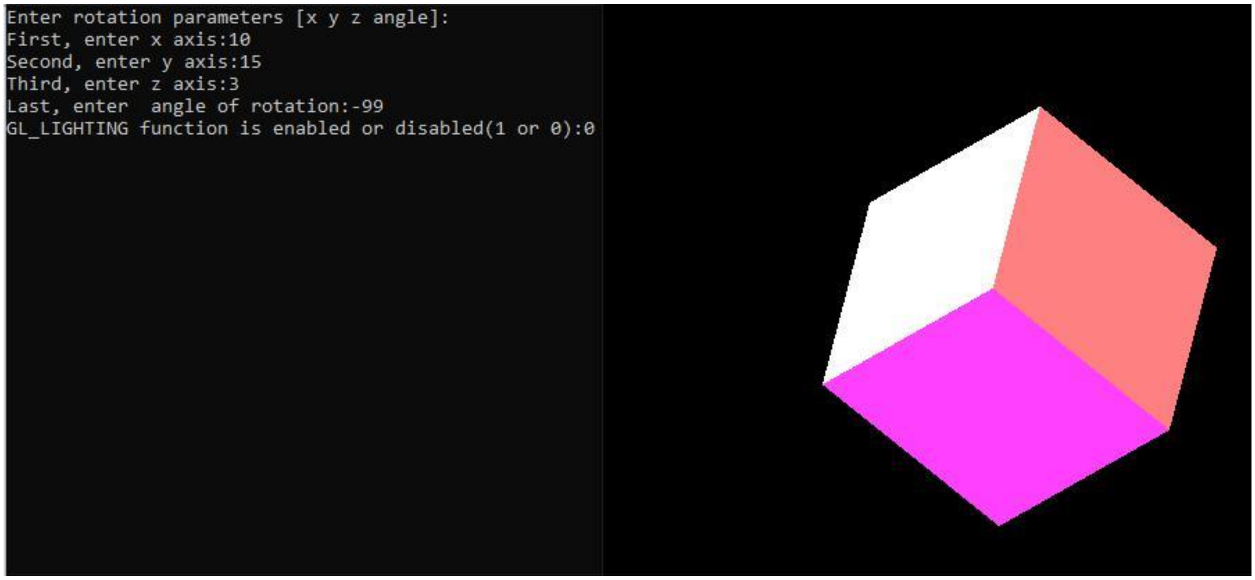


***<u>Figure7:</u>*****Rotating of cube around a vector [x=2 y=3 z=4] by angle=50**



```
Enter rotation parameters [x y z angle]:
First, enter x axis:40
Second, enter y axis:50
Third, enter z axis:90
Last, enter  angle of rotation:-60
GL_LIGHTING function is enabled or disabled(1 or 0):0
```

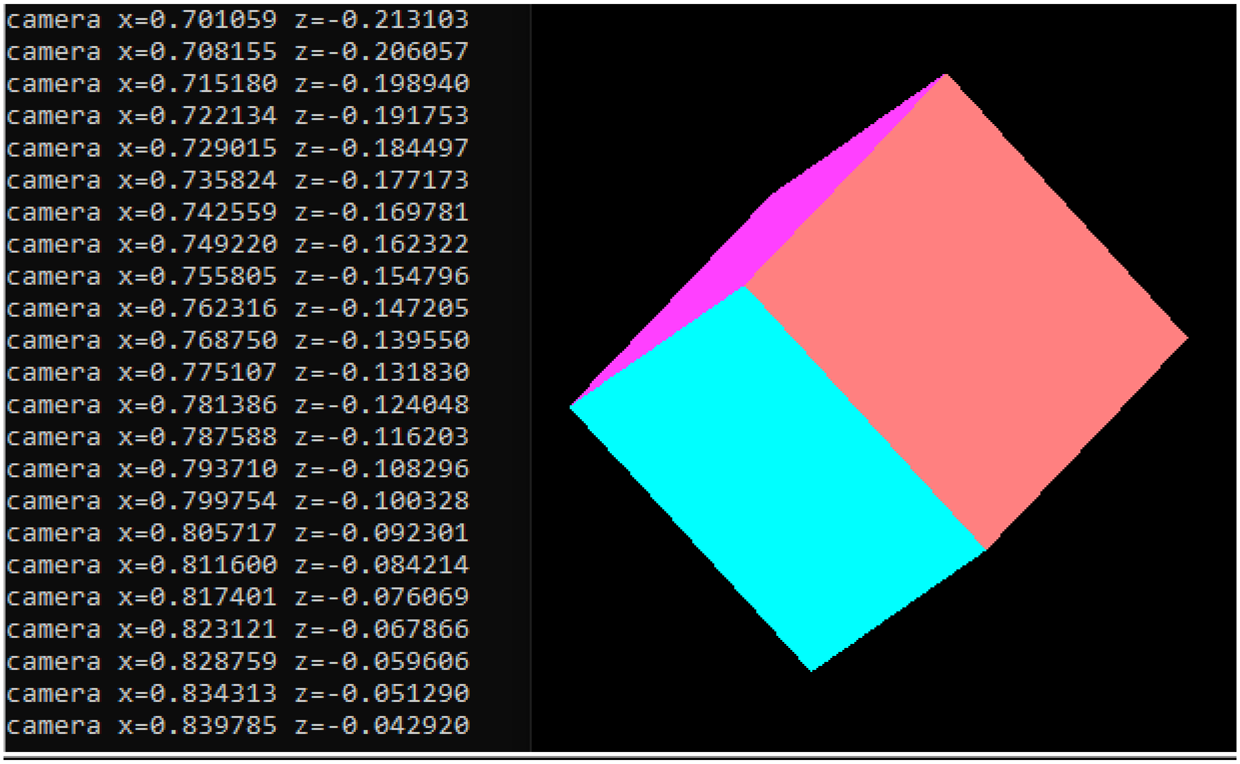
***Figure8:*** **Rotation around[ 40 50 90] vector by -60 degree.**



```
Enter rotation parameters [x y z angle]:
First, enter x axis:10
Second, enter y axis:15
Third, enter z axis:3
Last, enter  angle of rotation:-99
GL_LIGHTING function is enabled or disabled(1 or 0):0
```

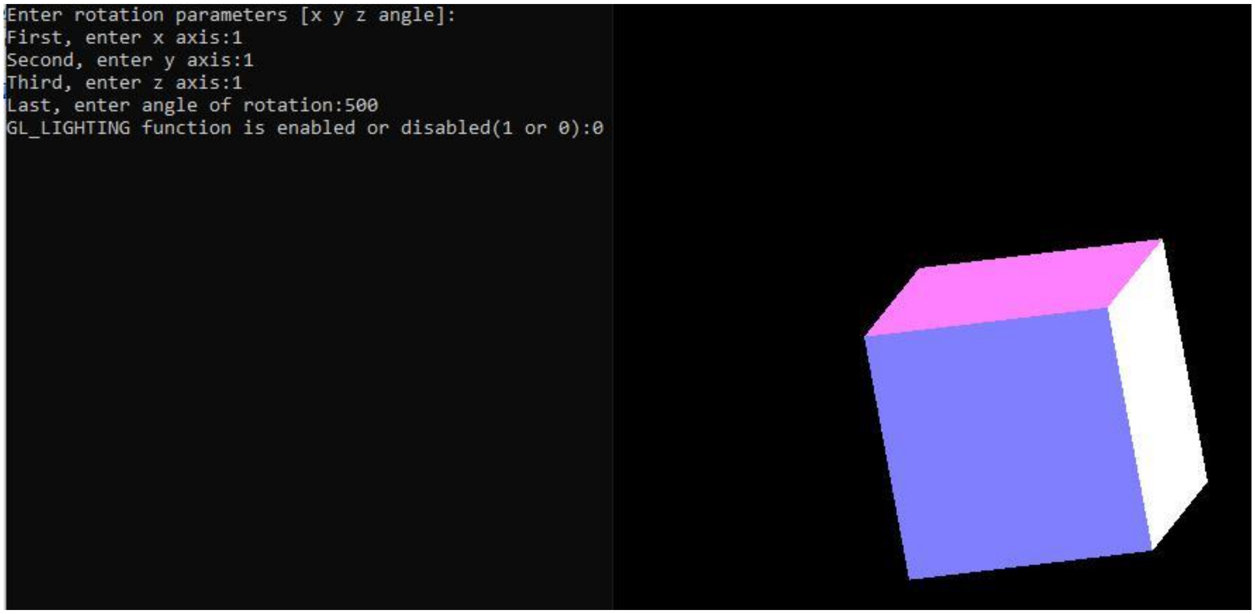
***Figure9:*** **Rotation around [10 15 3] vector by -99 degree.**

**X and Z coordinates (in below figures) state coordinates of cube controlled by keyboard(GL_LIGHTING is disabled ):**



```
camera x=0.701059 z=-0.213103
camera x=0.708155 z=-0.206057
camera x=0.715180 z=-0.198940
camera x=0.722134 z=-0.191753
camera x=0.729015 z=-0.184497
camera x=0.735824 z=-0.177173
camera x=0.742559 z=-0.169781
camera x=0.749220 z=-0.162322
camera x=0.755805 z=-0.154796
camera x=0.762316 z=-0.147205
camera x=0.768750 z=-0.139550
camera x=0.775107 z=-0.131830
camera x=0.781386 z=-0.124048
camera x=0.787588 z=-0.116203
camera x=0.793710 z=-0.108296
camera x=0.799754 z=-0.100328
camera x=0.805717 z=-0.092301
camera x=0.811600 z=-0.084214
camera x=0.817401 z=-0.076069
camera x=0.823121 z=-0.067866
camera x=0.828759 z=-0.059606
camera x=0.834313 z=-0.051290
camera x=0.839785 z=-0.042920
```

**Figure10:Cube and camera coordinates. Camera is moving with keyboard's arrow keys.**



```
Enter rotation parameters [x y z angle]:
First, enter x axis:1
Second, enter y axis:1
Third, enter z axis:1
Last, enter angle of rotation:500
GL_LIGHTING function is enabled or disabled(1 or 0):0
```

**Figure11:Cube and its rotation coordinates.**

Codes of program:

```
#include<windows.h>
#include <GL/glu.h>
#include <GL/glut.h>
#include <math.h>
#include <stdio.h>
int lolnot=1;//GL_LIGHTING is open or close
float xrv ,yrv ,zrv,degree;//rotation parameters.
// camera position angle
float angle=0.0;
// vector representing the camera's center position
float lx=0.0f,lz=-1.0f;
// camera s x and z
float x=0.0f,z=0.5f;
void init()
{
   glClearColor(0,0,0,1);
   glColor3f(1,0,0);
   glShadeModel (GL_SHININESS);
   //For light source
   GLfloat light_position[] = { 0.0, 0.0, -5.0, 1.0 };//-1-1 1 //x y z brightness
   glLightfv(GL_LIGHT0, GL_POSITION, light_position);
   if(lolnot==1){
      glEnable(GL_LIGHTING);
   }
   else {
      glDisable(GL_LIGHTING);
   }
```

```
  glEnable(GL_LIGHT0);
  glEnable(GL_DEPTH_TEST);
}
void Cube_Face(GLfloat P1[],GLfloat P2[],GLfloat P3[],GLfloat P4[])
{
  glBegin(GL_POLYGON);
    glVertex3fv(P1);
    glVertex3fv(P2);
    glVertex3fv(P3);
    glVertex3fv(P4);
  glEnd();
}
void Cube(GLfloat V0[],GLfloat V1[],GLfloat V2[],GLfloat V3[],GLfloat V4[],GLfloat
V5[],GLfloat V6[],GLfloat V7[])
{
    glColor3f(1,1,1);//Front face of cube
    Cube_Face(V0,V1,V2,V3);
    glColor3f(0,1,1);//Back face of cube
    Cube_Face(V4,V5,V6,V7);
    glColor3f(1,0.25,1);//Left face of cube
    Cube_Face(V0,V3,V7,V4);
    glColor3f(1,0.5,1);//Back face of cube
    Cube_Face(V1,V2,V6,V5);
    glColor3f(1,0.5,0.5);//Top face of cube
    Cube_Face(V0,V1,V5,V4);
    glColor3f(0.5,0.5,1);//Down face of cube
    Cube_Face(V3,V2,V6,V7);
}
void Cube_Draw(){
  GLfloat Vx[8][3]={
                     {-0.3, 0.3, 0.3 },//1.vertex of cube
                     { 0.3, 0.3, 0.3 },//2.vertex of cube {
                     0.3,-0.3, 0.3 },//3.vertex of cube {-
                     0.3,-0.3, 0.3 },//4.vertex of cube {-
                     0.3,  0.3,-0.3},//5.vertex  of  cube  {
                     0.3,  0.3,-0.3  },//6.vertex  of  cube  {
                     0.3,-0.3,-0.3 },//7.vertex of cube {-
                     0.3,-0.3,-0.3 } //8.vertex of cube
                    };
  glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT);
  glLoadIdentity();
  // Set the camera position
  gluLookAt(       x, 0.1f, z,
                        x+lx, 0.6f, z+lz,
                        0.0f, 1.0f, 0.0f);

  glRotatef(degree,xrv,yrv,zrv);//rotate around a vector axis
  glutPostRedisplay();
  Cube(Vx[0],Vx[1],Vx[2],Vx[3],Vx[4],Vx[5],Vx[6],Vx[7]);//We have eight vertex in
a cube
  glFlush ();
  glutSwapBuffers();
}//For camera moving by keyboard arrow keys.
void Move_Keys(int key, int xx, int yy) {

        float rate = 0.1f;
  printf("camera x=%f y=0.6 z=%f\n",x+lx,z+lz);
        switch (key) {
```

```
        case GLUT_KEY_LEFT :
            angle -= 0.01f;
            lx = sin(angle);
            lz = -cos(angle);
            break;
        case GLUT_KEY_RIGHT :
            angle += 0.01f;
            lx = sin(angle);
            lz = -cos(angle);
            break;
        case GLUT_KEY_UP :
            x += lx * rate;
            z += lz * rate;
            break;
        case GLUT_KEY_DOWN :
            x -= lx * rate;
            z -= lz * rate;
            break;
    }
}
int main(int argc, char **argv)
{
  printf("Enter rotation parameters [x y z
  angle]:\n"); printf("First, enter x axis:");
  scanf("%f",&xrv);
  printf("Second, enter y axis:");
  scanf("%f",&yrv);
  printf("Third, enter z axis:");
```

```
    scanf("%f",&zrv);
    printf("Last, enter angle of rotation:");
    scanf("%f",&degree);
    printf("GL_LIGHTING function is enabled or disabled(1 or 0):");
    scanf("%d",&lolnot);
    glutInit(&argc, argv);
    glutInitWindowPosition(300,150);//default 300 150
    glutInitWindowSize(600,600);//default 600 600
    glutInitDisplayMode(GLUT_RGB | GLUT_DOUBLE | GLUT_DEPTH);
    glutCreateWindow("CUBE IN ROTATE(HW6)");
    init();
    glutDisplayFunc(Cube_Draw);
    glutSpecialFunc(Move_Keys);
    glutMainLoop();
    return 0;
}
```