Comment and self-evaluation:
I’ve done all the lab successfully. Therefore, I would evaluate myself 20/20 for the completed lab work.

Compile and try +, -, x, / operations:

Running Program:
Use your program to find the locations of the vertices (1, 2, 3), (5, 7, 8), (6, 2, 4) after a rotation of 30° about the axis that passes through the origin and the point (4, 5, 6).

Code:

```cpp
//quat.cpp
...
int main ()
{
    quat p(0, 4, 5, 6);
    quat u = p/p.abs();

    quat q = cos(3.14/12) + (sin(3.14/12)*(u));
    cout << "q is : " << q << endl;
    quat q1 = q;
    q1.invert();
    quat v1(0, 1.0, 2.0, 3.0);
    quat v2(0, 5.0, 7.0, 8.0);
    quat v3(0, 6.0, 2.0, 4.0);

    cout << "Vector (1,2,3) rotate 30 degree about that axis is : " << q*v1*q1 << endl;
    cout << "Vector (5,7,8) rotate 30 degree about that axis is : " << q*v2*q1 << endl;
    cout << "Vector (6,2,4) rotate 30 degree about that axis is : " << q*v3*q1 << endl;
}
```

Running Program:

```
emacs@b359-22:~/CSE621/lab13
$ make
make: `quat' is up to date.
$ make clean
rm quat.o
[004561244]@b359-22 lab13]$ make clean
rm quat.o
[004561244]@b359-22 lab13]$ make
 gcc -c quat.cpp -I/usr/X11R/include -I/share/mesa/include
  -lX -lXmu -lXau -lXext -lX11 -lXdmcp -lXdm -lxdm -lICE
[004561244]@b359-22 lab13]$ ./quat
q is : ( 0.96596, 0.117922, 0.147483, 0.176883 )
Vector (1,2,3) rotate 30 degree about that axis is : ( 1.19209e-07, 1.25951, 1.6687, 3.10387 )
Vector (5,7,8) rotate 30 degree about that axis is : ( 4.76837e-07, 4.93302, 6.84437, 0.17434 )
Vector (6,2,4) rotate 30 degree about that axis is : ( 0, 6.05584, 3.37548, 2.81054 )
[004561244]@b359-22 lab13]$ ./quat
q is : ( 0.96596, 0.117922, 0.147483, 0.176883 )
Vector (1,2,3) rotate 30 degree about that axis is : ( 1.19209e-07, 1.25951, 1.6687, 3.10387 )
Vector (5,7,8) rotate 30 degree about that axis is : ( 4.76837e-07, 4.93302, 6.84437, 0.17434 )
Vector (6,2,4) rotate 30 degree about that axis is : ( 0, 6.05584, 3.37548, 2.81054 )
```
Write another simple OpenGL program to cross-check your results.

Code:

```c
//point.cpp
...
void display(void)
{
    glClear (GL_COLOR_BUFFER_BIT);
    glLoadIdentity ();             /* clear the matrix */
    GLfloat matrix[16];

    glLoadIdentity (); //First vertices.
    GLfloat v1[4] = {1,2,3,1};
    glRotatef (30.0, 4, 5, 6);
    glMultMatrixf(v1);
    printf("after Rotate:\n");
    glGetFloatv(GL_MODELVIEW_MATRIX, matrix);
    printf("_MODELVIEW_MATRIX:\n");
    printpoint(matrix);

    glLoadIdentity (); // Second vertices
    GLfloat v2[4] = {5,7,8,1};
    glRotatef (30.0, 4, 5, 6);
    glMultMatrixf(v2);
    printf("after Rotate:\n");
    glGetFloatv(GL_MODELVIEW_MATRIX, matrix);
    printf("_MODELVIEW_MATRIX:\n");
    printpoint(matrix);

    glLoadIdentity (); //Third Vertices.
    GLfloat v3[4] = {6,2,4,1};
    glRotatef (30.0, 4, 5, 6);
    glMultMatrixf(v3);
    printf("after Rotate:\n");
    glGetFloatv(GL_MODELVIEW_MATRIX, matrix);
    printf("_MODELVIEW_MATRIX:\n");
    printpoint(matrix);

    printf("\n");printf("\n");printf("\n");printf("\n");printf("\n");printf("\n");

    glFlush ();
}
...
```
Running Program:

The test returns exactly same value with the quat.cpp running program, as compare below:

```c
[004561244@jb359-22 lab13]$ make
make: `quat' is up to date.
[004561244@jb359-22 lab13]$ make clean
rm quat.o
[004561244@jb359-22 lab13]$ make
g++ -c quat.cpp -I/usr/X11R/include -I/share/mesa/include
```