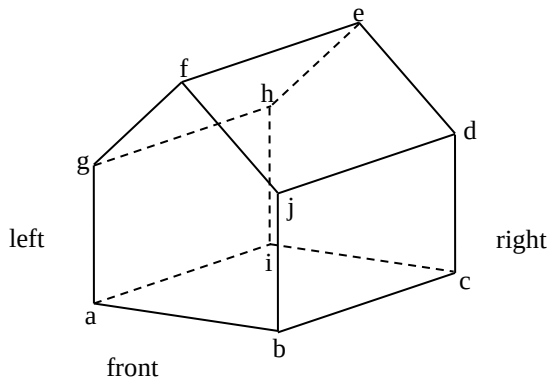
Tut 1

Qn 1

The three dimensional coordinates of the house-shaped object below are as follows:

a = (0, 0, 0) b = (10, 0, 0) c = (10, 0, -20)
d = (10, 10, -20) e = (5, 15, -20) f = (5, 15, 0)
g = (0, 10, 0) h = (0, 10, -20) i = (0, 0, -20) j = (10, 10, 0)



The front face is denoted by F_1, the right face F_2, the left face F_3, the back face F_4, the right roof F_5, the left roof F_6, and the ground face F_7.

a) Construct the vertex, edge, face, and attribute table of a polygonal model of the object.

b) Determine the outward unit surface normal of the left roof face.

c) Derive the equation of the face d e f j in the form

A x + B y + C z + D = 0

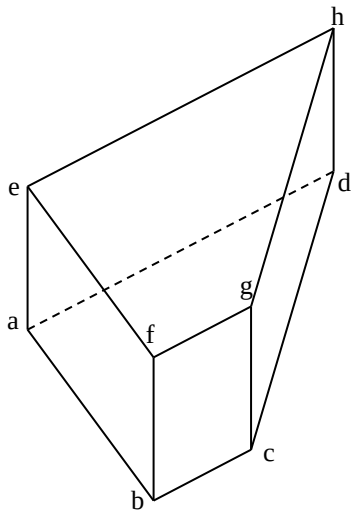
such that if the (LHS > 0) $\Leftrightarrow$ (Outside) and vice versa.

d) Suggest a method for determining whether a point is inside or outside the house.

e) Suggest a general method for determining whether a point is inside or outside any volumetric object.

f) Suggest an application for the function in e).

Qn 2



a (0, 0, 0) e (0, 0, 5)
b (10, 0, 0) f (10, 0, 5)
c (10, 4, 0) g (10, 4, 5)
d (0, 25, 0) h (0, 25, 5)

Two popular object representation methods are tables and quadrilateral mesh.

a) Using tables, write C code to represent the face □ bcgf in the form of vertex table, edge table and face table. Use vertices to form the face table.

b) Represent the object above, except the top and bottom face, as a quadrilateral mesh. To save time, you are only required to draw a 2D array and put the alphabet (e.g. a) to each of the vertex of the array to show your idea.

c) Derive the plane equation of □cdhg.

d) Give an advantage of using the mesh representation compared to using the table representation.

Qn 3

a) In CG, the *parametric form* is used instead of the *non-parametric form*. What is the reason(s)?

b) The non-parametric form of a superellipsoid is given by

$$\left[\left(\frac{x}{r_x}\right)^{2/s_2} + \left(\frac{y}{r_y}\right)^{2/s_2}\right]^{s_2/s_1} + \left(\frac{z}{r_z}\right)^{2/s_1} = 1$$

Derive its equivalent parametric form. Give the physical meaning of any additional variables you introduce.

Qn 4

Consider the following program fragment:

```
void calculate_mesh (void)
{
        for (int i=0; i<GRIDSIZE; i++)
                for (int j=0; j<GRIDSIZE; j++)
                {

                  mesh[i][j].x = …
                  mesh[i][j].y = …
                  mesh[i][j].z =  …

                }
}
```

Complete the above program to model a super-ellipsoid mesh with the following requirement:

Center : *(50, 100, 200)*
Bounding Box volume : $100 \times 200 \times 400$
s_1 and s_2 : user input parameters

Qn 5

State the i) non-parametric and ii) parametric form of

a) elliptic paraboloid
b) hyperboloid of two sheets (Hint: use $\cosh^2 x - \sinh^2 x = 1$)

They are 3D forms of the 2D quadric, parabola and hyerbola respectively.

Consult MathWorld: http://mathworld.wolfram.com/ for definitions.

OpenGL Mini-project Progress

At this point, you should be doing OpenGL Ex 1. After finishing the exercise, try replacing the quadrilateral mesh with

glutSolidCube (0.5);

What do you observe?