ME 534 COMPUTER-BASED MODELING AND SIMULATION
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FINITE ELEMENT SIMULATION of a 3D DEFORMABLE OBJECT

In this project, you are going to develop a finite element model of a 3D object made of tetrahedral elements. This model should display a surface representation of the 3D object and enable a user to perform FEM simulations in real-time. During the simulations, the user will apply static forces to a node of the FEM model by pressing a key on the keyboard and observe the visual deformation of the 3D surface model. For the implementation, consider a column of soft jelly block standing on a table. The model of the jelly block is made of three 3D cubes stacked on top of each other as shown in Figure 1a. One side of each cube is 150 mm. Each cube is made of 6 tetrahedral finite elements (3 of them are as shown in Figure 1b). The jelly is fixed to the table at nodes 1, 2, 3, and 4 (i.e. boundary conditions).

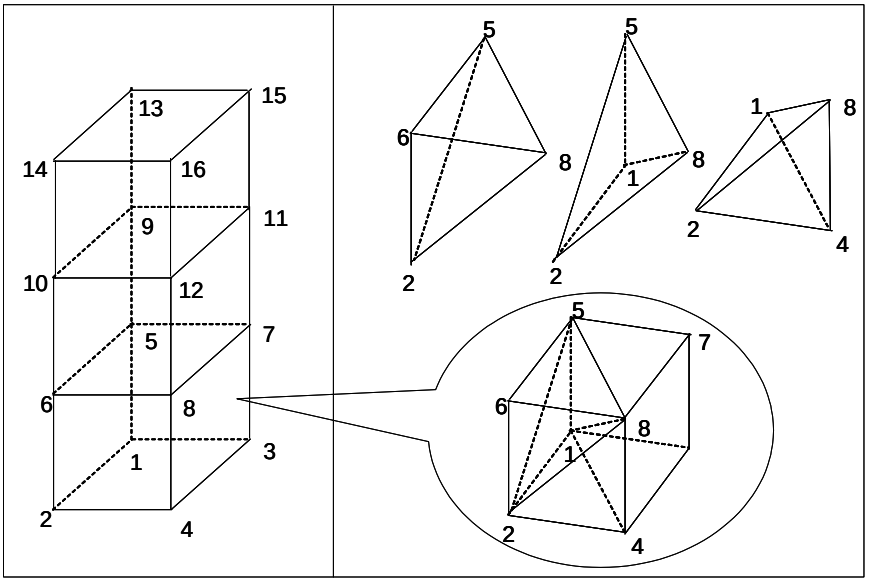

Figure 1. 3D model of the jelly for FEM simulations

Element No	Node 1	Node 2	Node 3	Node 4
1	**1**	**2**	**4**	**8**
2	**1**	**2**	**8**	**5**
3	**2**	**8**	**5**	**6**
4	**1**	**4**	**3**	**7**
5	**1**	**8**	**7**	**5**
6	**1**	**8**	**4**	**7**

Table 1. Each cube is made of 6 tetrahedron (Note that nodes 1,2, and 3 are ordered CCW when viewed from node 4).

Notes:

- Construct a 3D surface model of the jelly block from triangles (use SoCoordinate3 and SoIndexedFaceSet classes)
- Develop a C/C++ code for FEM model of a 3D object made of tetrahedral elements.
- Develop a key press event (using SoKeyBoardEvent class) to apply a force to an arbitrary node of the FEM model.
- Use the subroutines of "Numerical Recipes" for linear algebra computations.
- E (Modulus of Elasticity) = 2 kPa and Poisson's ratio = 0.3.
- Pay attention to the ordering of nodes for each tetrahedron (see the class notes).