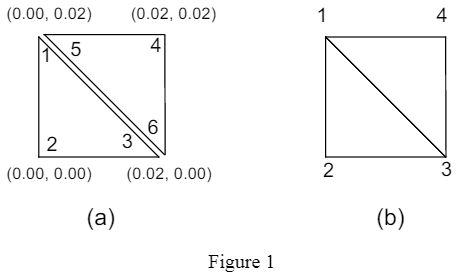
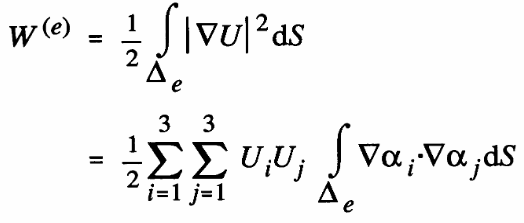
**Question 1**

**Figure 1 shows two first-order triangular finite elements used to solve the Laplace equation for electrostatic potential. Find a local S-matrix for each triangle and a global S-matrix for the mesh, which consists of just these two triangles. The local (disjoint) and global (conjoint) node-numberings are shown in Figure 1(a) and (b), respectively. Also, Figure 1(a) shows the (x, y)-coordinates of the element vertices in meters.**

**Local S-Matrices:**

Energy is each triangle is given by the following equation (taken from lecture slides):



From the above equation, we can see that

Using the example provided in the lecture FE1stOrder, a general form for S is formed:

We also need the Area of each of the triangles:

1. Triangle 1,2,3:

2

1

3

Node 1:

Node 2:

Node 3:

Calculation of alphas (values in cm):

Using the above equation (which matches the general form above), the following local S – matrix was generated:

1. Triangle (4,5,6):

4

5

6

Node 4:

Node 5:

Node 6:

Calculation of alphas (values in cm):

Using the above equation (which matches the general form above), the following local S – matrix was generated:

**Global Matrix:**

In order to find the Global Matrix, we use the following equation:

Where C is a conjoint numbering matrix and Sdis is a 6x6 matrix created by combining the two local S-matrices in the following manner:

Since each triangle has 3 nodes each separately, and when conjoint, there are 4 nodes (nodes 1 and 5 are common, and nodes 3 and 6 are common), C will be a 6x4 matrix:

And Sdis, a combination of the two local S-matrices, will be 6x6: