Element 135 Three-dimensional Four-node Tetrahedron (Heat Transfer Element)

This element is a linear isoparametric three-dimensional tetrahedron for heat transfer applications (see Figure 3-210). As this element uses linear interpolation functions, the thermal gradients are constant throughout the element. A fine mesh is required to obtain an accurate solution. The element is integrated numerically using one point at the centroid of the element. The specific heat capacity matrix of this element is formed using four-point Gaussian integration.

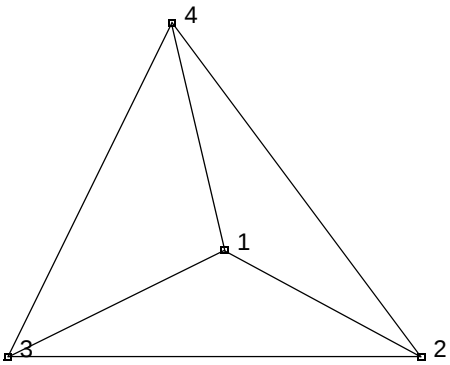

Figure 3-210 Form of Element 135

Geometry

The geometry of the element is interpolated from the Cartesian coordinates of four nodes.

Connectivity

The convention for the ordering of the connectivity array is as follows:

> Nodes 1, 2, 3 are the corners of the first face, given in counterclockwise order when viewed from inside the element. Node 4 is on the opposing vertex. Note that in most normal cases, the elements are generated automatically via a preprocessor (such as Mentat or a CAD program) so that you need not be concerned with the node numbering scheme.

Quick Reference

Type 135

Four-nodes, isoparametric arbitrary heat transfer tetrahedron.

Connectivity

Four nodes numbered as described in the connectivity write-up for this element and as shown in Figure 3-210.

Geometry

Not required.

Coordinates

Three global coordinates in the x-, y-, and z-directions.

Degrees of Freedom

1 = temperature
1 = voltage, temperature (Joule Heating)
1 = potential (electrostatic)

Distributed Fluxes

Distributed fluxes chosen by value of `IBODY` are as follows:

Load Type	Description
0	Uniform flux on 1-2-3 face.
1	Nonuniform flux on 1-2-3 face.
2	Uniform flux on 1-2-4 face.
3	Nonuniform flux on 1-2-4 face.
4	Uniform flux on 2-3-4 face.
5	Nonuniform flux on 2-3-4 face.
6	Uniform flux on 1-3-4 face.
7	Nonuniform flux on 1-3-4 face.
8	Uniform body flux per unit volume.
9	Nonuniform body flux per unit volume.

The FLUX user subroutine is called once per integration point when flagged. The magnitude of load defined by DIST FLUXES is ignored and the FLUX value is used instead.

For nonuniform body flux, flux values must be provided for the one integration point.

For nonuniform surface fluxes, flux values need to be supplied for the 3-integration points on the face of application, where the integration points have the same location as the nodal points.

Films

Same specification as **Distributed Fluxes**.

Joule Heating

Capability is available.

Electrostatic

Capability is available.

Magnetostatic

Capability is not available.

Current

Same specification as **Distributed Fluxes**.

Charges

Same specification as **Distributed Fluxes**.

Output Points

Centroid.

Notes: A large bandwidth results in a lengthy central processing time.

You should invoke the appropriate OPTIMIZE option in order to minimize the matrix solution time.