

1 ASCII Mesh Format

The ASCII mesh format is intended to provide a simplified, machine independent mesh specification that permits finite element codes to interface with a number of public-domain and commercial mesh generation tools. For this reason, the ASCII mesh format has been intentionally simplified to permit easy adaptation of existing neutral file formats produced by commercial mesh generators.

The ASCII mesh file contains an 80-character title line, the spatial coordinates of the nodes, element connectivity, and all node and side sets. The mesh title line is limited to 80 characters, must be the first line in the mesh file. Lines in the mesh file may be commented out by using a #, *, \$ followed by a blank. Because the data in the mesh file is usually generated by an automatic mesh generator, the data in this file is only partially format-free in style. However, all input in the mesh file is case insensitive.

The mesh file consists of separate sections that proceed in the following order.

1. Mesh title line (80 characters maximum).
2. Header block containing control information.
3. Nodal coordinates.
4. Element connectivity.
5. Node set data.
6. Side set data.

Typically, each section of the mesh file contains a short series of comments describing the contents of the subsequent section.

2 Mesh Title Line

The first line of the ASCII mesh file is expected to contain the mesh title. A blank line is acceptable, and there are no restrictions on special characters. However, the mesh title line is limited to 80 characters in length. Comment characters, #, *, \$, in the title line are treated as a part of the 80 character title. There can be no comment lines before the title line in the mesh file.

3 Header Block

The header block follows the mesh title line and consists of a sequence of comment lines that contain control information describing the mesh. The information required in the header block consists of the number of nodes, elements, materials, node sets and side sets in the mesh as shown in the table below. All keywords are case insensitive and order-independent with the exception of the *end* keyword that terminates the header block. An example of the header block is shown in Figure 1.

ASCII Mesh File Header Block

Keyword	Variable	Meaning
Nnp	<i>Nnp</i>	Specify the number of nodes, <i>Nnp</i> .
Nel	<i>Nel</i>	Specify the number of elements, <i>Nel</i> .
Nnpe	<i>Nnpe</i>	Specify the number of nodes-per-element, <i>Nnpe</i> .
Ndim	<i>Ndim</i>	Specify the number of dimensions, <i>Ndim</i> .
Nmat	<i>Nmat</i>	Specify the number of materials, <i>Nmat</i> .
Nnd_sets	<i>Nnd_sets</i>	Specify the number of node sets, <i>Nnd_sets</i> .
Nsd_sets	<i>Nsd_sets</i>	Specify the number of side sets, <i>Nsd_sets</i> .
end		Terminate the header block

4 Nodal Coordinates

Nnp nodal coordinates are required in this section of the mesh file. For 1-D analyses ($Ndim = 1$), the y and z-coordinates are ignored. For 2-D analyses ($Ndim = 2$), the z-coordinate is ignored in the mesh file. The format specifications for the nodal coordinates are shown in the table below.

Nodal Coordinates

Columns	Format	Description
1-8	I8	node number
14-33	E20.0	x-coordinate.
34-53	E20.0	y-coordinate. (Ignored for 1-D, $Ndim = 1$)
54-73	E20.0	z-coordinate. (Ignored for 2-D, $Ndim = 2$)

The 80-character title line comes first in the mesh file.

```
#
# This is the header block
#
# Nnp      1852
# Nel      1760
# Nnpe     4
# Ndim     2
# Nmat     1
# Nnd_sets 3
# Nsd_sets 3
#
# end
#
```

Figure 1: Example title line and header block for ASCII mesh file.

5 Element Connectivity

The node numbers and material numbers associated with Nel elements are required in this section of the mesh file. For 1-D calculations ($Ndim = 1$), the last 6 node number are ignored if they are present in the connectivity. For 2-D calculations ($Ndim = 2$), the last 4 node numbers are ignored if they are present in the connectivity. The table below shows the format specifications for the element connectivity.

Element Connectivity

Columns	Format	Description
9-13	I5	material number.
14-21	I8	local node #1.
22-29	I8	local node #2.
30-37	I8	local node #3.
38-45	I8	local node #4.
...		...
70-77	I8	local node #8. (Nodes 3-8 are ignored for $Ndim = 1$) (Nodes 5-8 are ignored for $Ndim = 2$)

6 Node Sets

The node set section of the mesh file consists of three parts that describe the number of node sets in the mesh, the number of nodes in each node set, and the node lists for each node set. The following tables outline the formats required for each part of the node set section of the mesh file. In Part 1, the number of node sets, *Nnd_sets* is specified. Immediately following, in Part 2, is a list containing *Nnd_sets* lines of input that contain the node set id or node set number, and the number of nodes associated with each node set id. In Part 3, *Nnd_sets* lists of input follows. Each list contains the local node counter and the node numbers associated with the node set id's listed in Part 2. A short sample of this section of the input file is shown in Figure 2. In this example, comments are used to delineate the three sections of the input data.

Node Sets - Part 1

Columns	Format	Description
1-10	I10	Number of node sets in the mesh file.

Node Sets - Part 2

Columns	Format	Description
1-10	I10	Integer node set identifier for the node set.
11-20	I10	Number of nodes in the node set.

Node Sets - Part 3

Columns	Format	Description
1-10	I10	Node counter of the current node.
11-20	I10	Node number for the current node.

```
#
# 3 Node-sets
      3
#
# Node set   Number of Nodes
      1       118
      2        56
      3       175
#
# Node Set Number : 1
# No. of Nodes   : 118
#
      1       211
      2       190
      ...
      118     861
#
# Node Set Number : 2
# No. of Nodes   : 56
#
      1        21
      2        42
      ...
      56       841
#
# Node Set Number : 3
# No. of Nodes   : 175
#
      1       211
      2       190
      ...
      175     861
```

Figure 2: Example node set section of the ASCII mesh file.

7 Side Sets

The input section for side sets also consists of three parts that describe the number of side sets, the number of segments in each side set, and the side lists for each side set. In this section, the canonical, finite element side-ordering is used to identify element sides. The following tables outline the formats required for each part of the side set section of the mesh file. In Part 1, the number of side sets, Nsd_sets is specified. Immediately following, in Part 2, is a list containing Nsd_sets lines of input that contain the side set id or number, and the number of side segments associated with each side set id. In Part 3, Nsd_sets lists of input follows. Each side set list contains the element number and element side number associated with the side set id's listed in Part 2 of the side set data.

Side Sets - Part 1

Columns	Format	Description
1-10	I10	Number of side sets in the mesh file.

Side Sets - Part 2

Columns	Format	Description
1-10	I10	Integer side set identifier for the side set.
11-20	I10	Number of elements in the side set.

Side Sets - Part 3

Columns	Format	Description
1-10	I10	Element number for the current side set segment.
11-20	I10	Side number for the current segment.

The canonical local node numbering scheme is shown with the side numbering in Figure 3. The following tables show the local node ordering corresponding to each side number for the 2-D quadrilateral and 3-D hexahedral element. A sample side set section of the mesh file is shown in Figure 4. Note that for each side set segment, the segment lists consist of the element number and the associated side number based upon the canonical local node ordering.

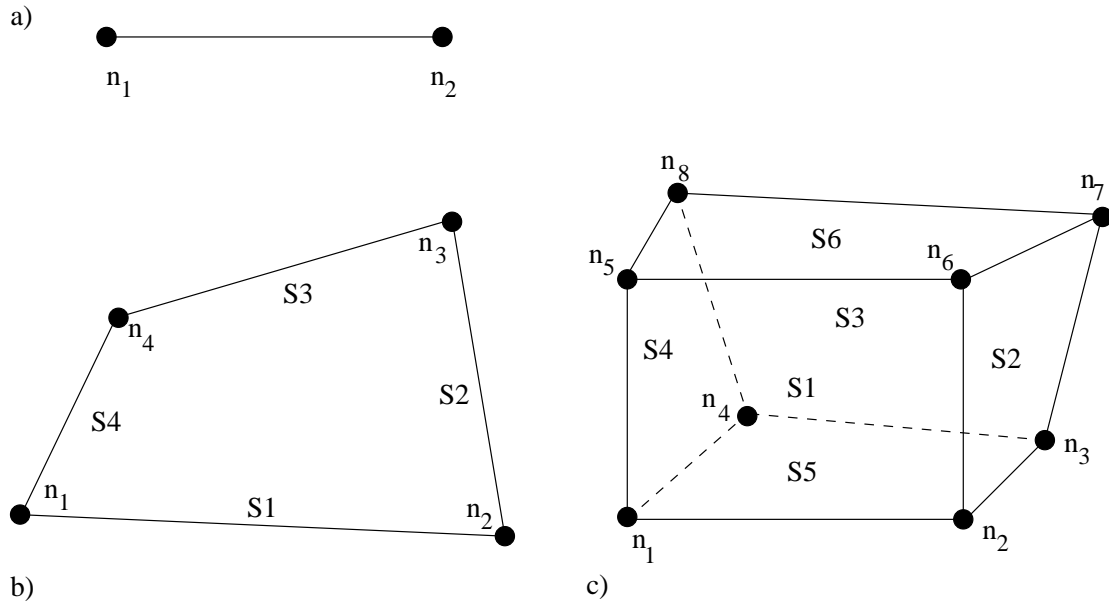


Figure 3: Canonical node and side numbering for the a) 1-D linear element, b) 2-D quadrilateral element, and c) the 3-D hexahedral element.

Side Numbers - 2-D Quadrilateral

Side	Node-1	Node-2
Side-1 (S1)	1	2
Side-2 (S2)	2	3
Side-3 (S3)	3	4
Side-4 (S4)	4	1

Side Numbers - 3-D Hexahedral Element

Side	Node-1	Node-2	Node-3	Node-4
Side-1 (S1)	1	2	6	5
Side-2 (S2)	2	3	7	6
Side-3 (S3)	3	4	8	7
Side-4 (S4)	4	1	5	8
Side-5 (S5)	1	4	3	2
Side-6 (S6)	5	6	7	8

```
#
# 2 Side-sets
      2
# Side Set  Number of Sides
      15         8
      65        50
#
# Side Set Number : 15
# No. of Segments : 8
#
      1         1
      2         1
      ...
      32        1
#
# Side Set Number : 65
# No. of Segments : 50
#
      1         4
      9         4
      ...
      393        4
```

Figure 4: Example side set section of the ASCII mesh file.

8 Sample ASCII Mesh File

The following sample ASCII mesh file is provided to show the overall structure of the mesh file, the use of comments to delineate the sections of the mesh file, and the structure of the individual sections of the mesh file.

Sample GILA ASCII mesh file

```
#
# Nnp      1681
# Nel      1600
# Nnpe     4
# Ndim     2
# Nel_blk  1
# Nnd_sets 1
# Nsd_sets 6
# end
#
# ===== Nodal Coordinates =====
#
#           1      5.0000000000000e-01-5.0000000000000e-01
#           2      5.0000000000000e-01 5.0000000000000e-01
#           ...
#          1681    -4.7499999403954e-01 4.7499999403954e-01
#
# ===== Element Connectivity =====
#
#           1      1      3      161      160
#           1      3      4      162      161
#           ...
#           1      1681      81      42      83
#
# 1 Node-sets
#           1
# Node Set  Number of Nodes
#           10      41
#
# Node Set Number : 10
# No. of Nodes    : 41
```

```

#
      1      122
      2      123
      ...
      41      1
#
# 6 Side-sets
      6
# Side Set  Number of Sides
      15      8
      65     50
      55      8
      25     22
      35     50
      45     22
#
# Side Set Number : 15
# No. of Segments : 8
#
      1      1
      2      1
      ...
      32      1
#
# Side Set Number : 65
# No. of Segments : 50
#
      1      4
      9      4
      ...
      393     4
#
# Side Set Number : 55
# No. of Segments : 8
#
      393     3
      394     3
      ...

```

```
          400          3
#
# Side Set Number : 25
# No. of Segments : 22
#
          401          1
          402          1
          ...
          422          1
#
# Side Set Number : 35
# No. of Segments : 50
#
          422          2
          444          2
          ...
          1500         2
#
# Side Set Number : 45
# No. of Segments : 22
#
          1479         3
          1480         3
          ...
          1500         3
```