

# **Finite Element in Practice**

## **Day 2**

by

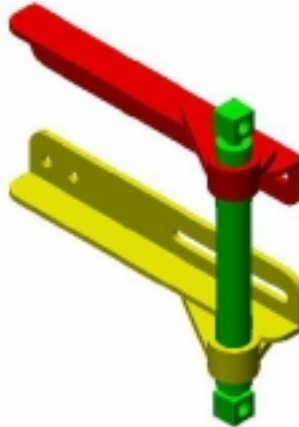
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- ◆ **Midplane Workshop**
- ◆ **Hand Mesh Workshop**
- ◆ **Heat Transfer**
- ◆ **Steady-State-Heat-Transfer Workshops**

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## IGES Import Tutorial



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Number	Description
100	Circle/Arc (curve for trimming)
102	Composite Curve (list of curves for trimming)
104	Ellipse (curve for trimming)
106	Copious Data (for some CAD Systems, interpreted as a curve)
110	Line (curve for trimming)
112	Parametric Spline Curve (curve for trimming)
114	Parametric Spline Surface
116	Point (used for 190)
118	Ruled Surface
120	Surface of Revolution (some CAD systems incorrectly specified the beginning and ending angles in early files)
122	Tabulated Cylinder Surface
123	Direction (used for 190)
126	NURB Curve (curve for trimming)
128	NURB Surface
140	Offset Surface (can be applied to any surface type)
142	Curve on Parametric Surface (basic trimming curve)
144	Trimmed Surface
190	Parametric Plane

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## ◆ Automatic Mesh

**Solid**

**Midplane**

**Plate/Shell**

## ◆ Hand Mesh

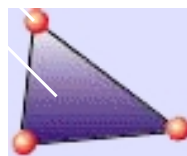
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*Node*

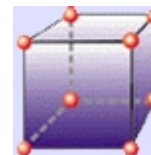
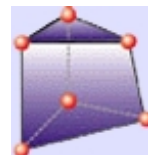
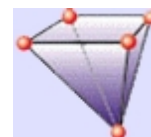
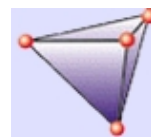
*Element*



**1-D**



**2-D**



**3-D**

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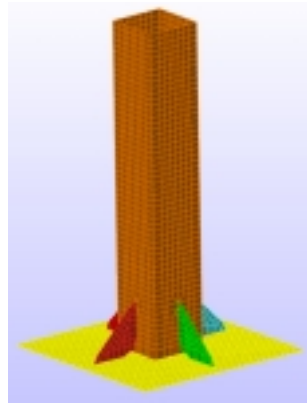
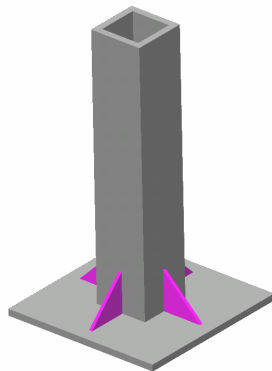
A node is a coordinate location in space where the DOF are defined..

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An element is a mathematical relation that defines how the DOF of a node relate to the next.

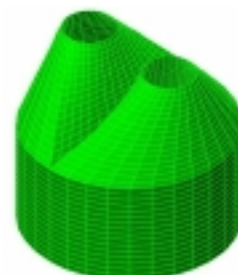
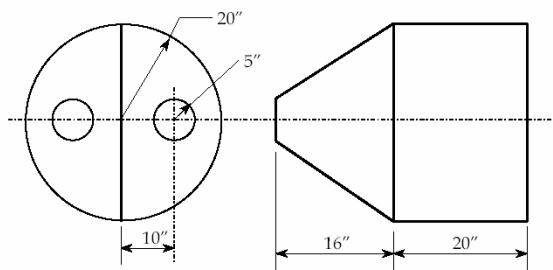
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## Midplane Mesh

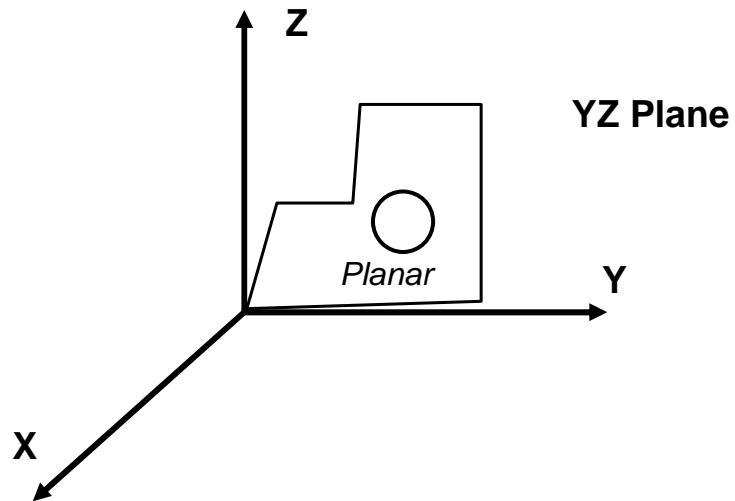


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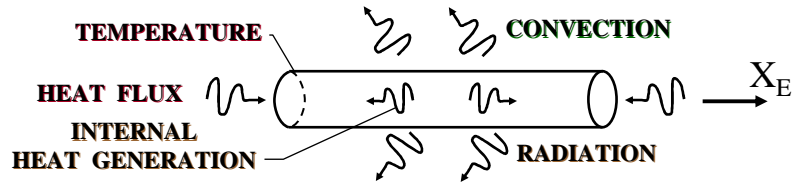
## Hand Mesh



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## ***Heat Transfer***



◆ **Load Components**

- Temperature
- Heat Flux
- Convection
- Radiation
- Internal Heat Generation

◆ **One DOF at Each Node**

- Temperature : T

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$$-\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z}\right) + Q = \rho c \frac{\partial T}{\partial t}$$

**Fourier's Law of Conduction**

$$q_x = -kA \frac{\partial T}{\partial x}$$

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- ◆ **Steady-state heat transfer**  
**Steady-state conditions**
- ◆ **Transient heat transfer**  
**Time-varying conditions**

- ◆ You will have to decide what type of loads and constraints will properly define the engineering criteria for the model.
- ◆ In FEA, there are different types of loads and constraints for each analysis type.
- ◆ Applying the proper loads and constraints is one of the most important factors in getting the correct answer.
- ◆ Always double check your model.



There are multiple ways to apply different loads and constraints to a model:

- ◆ Nodal
- ◆ Element
- ◆ Edge
- ◆ Surface

The thermal rod, 2-D, plate and brick elements are geometrically identical to the structural elements.

◆ Initial Temperature

Specify a certain temperature that an area will begin the analysis at (transient analysis).

◆ Applied Temperature

Specify a certain temperature that a node is kept at due to a heat source.

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◆ Convection

Assign a convection coefficient and the ambient temperature.

◆ Radiation

Assign the radiation function and the ambient temperature.

◆ Heat Flux

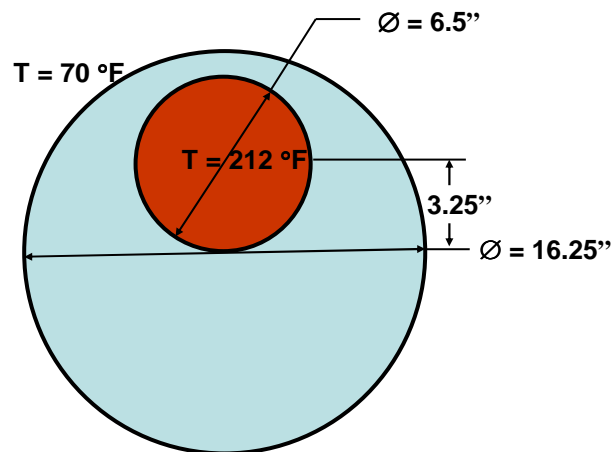
Assign the amount of heat added or removed per unit area.

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- ◆ Temperature
- ◆ Heat flux
- ◆ Total heat flow

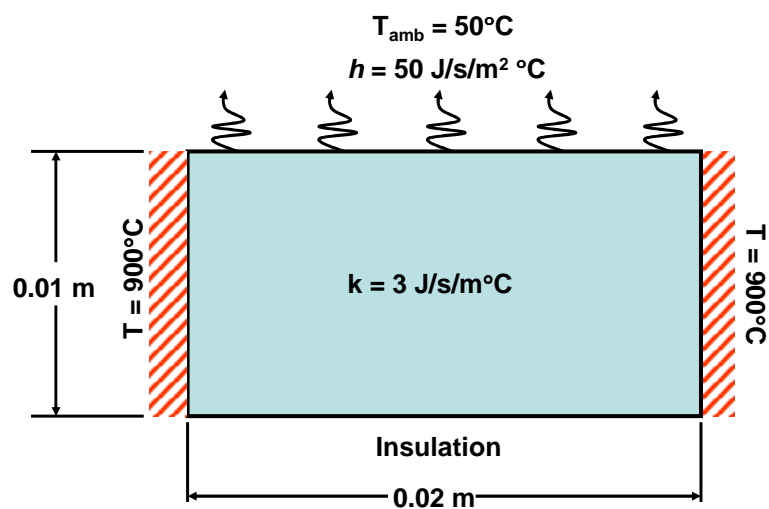
$$-\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z}\right) + Q = \rho c \frac{\partial T}{\partial t}$$

**Steady-State Heat Loss of a Stream pipe  
with Nonconcentric Insulation**



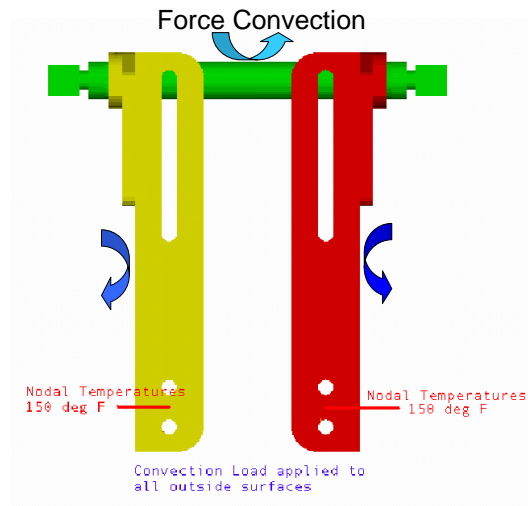
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**Ceramic Strip with Convection**



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### Steady-State Transfer Tutorial



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