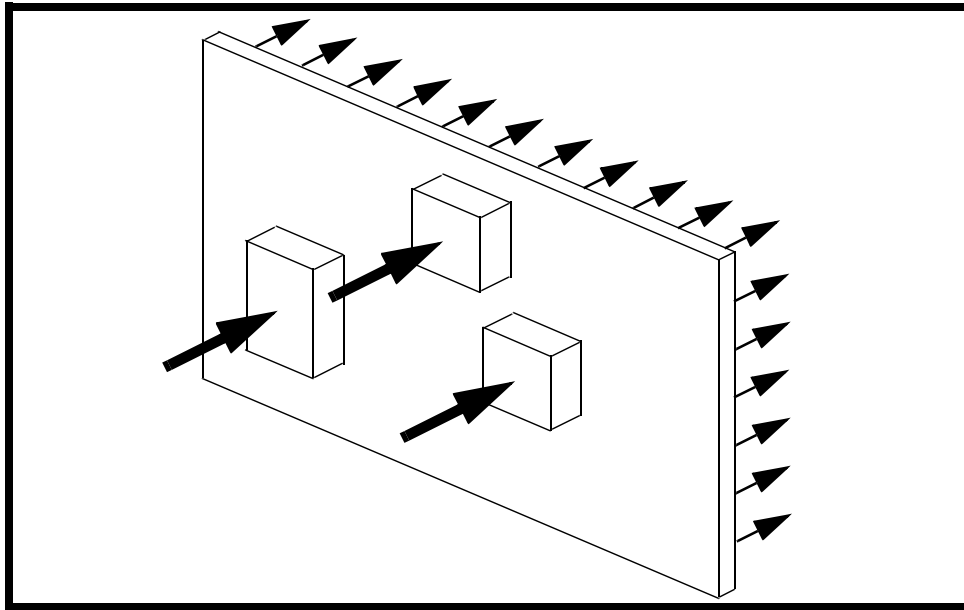

WORKSHOP 1

Free Convection on a Printed Circuit Board

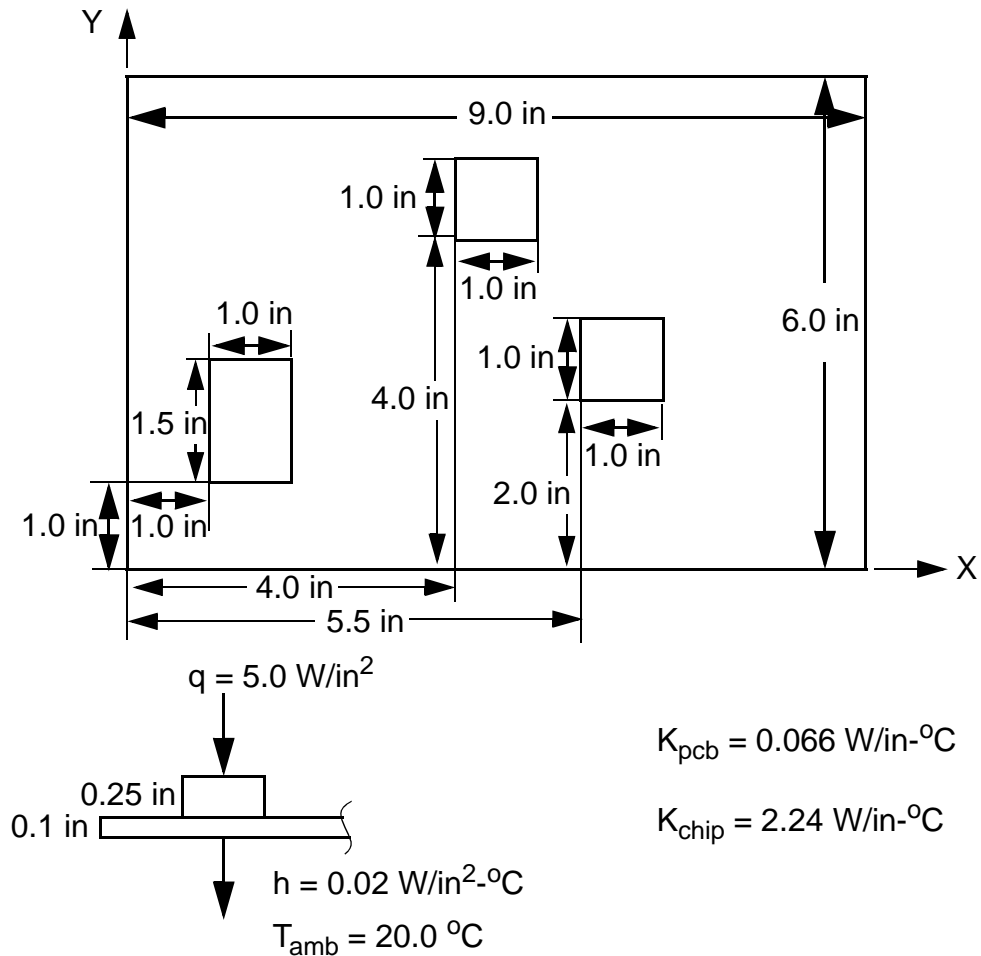


Objectives:

- Create a geometric representation of a printed circuit board.
- Apply thermal loading of free convection and heat fluxes to the model.
- Run a steady-state heat transfer analysis of the board.

Model Description:

Below is shown a model for a printed circuit board, complete with dimensions, material properties, and thermal loading conditions. You will create this model and analyze it to determine the steady-state temperature distribution.



Exercise Procedure:

1. Start up MSC.Nastran for Windows 4.0.2 and begin to create a new model.

Double click on the icon labeled MSC.Nastran for Windows V4.0.2.

On the *Open Model File* form, select **New Model**.

Open Model File:

New Model

2. Turn off the Parasolid Geometry Engine.

For simple geometry, the standard engine will suffice and be easier to use.

Tools/Advanced Geometry...

Standard

OK

3. Create the materials of the model.

First, create a material called **pcb**.

Model/Material...

Title:

pcb

Conductivity, k:

.066

OK

Next, create a material called **chip**.

Title:

chip

Conductivity, k:

2.24

OK

Cancel

4. Create the element properties for the model.

First, create a property for the printed circuit board called **pcb**.

Model/Property...

Title:

Material:

Elem/Property Type...

Volume Elements: Solid

Next, create an element property for the chips called **chip**.

Title:

Material:

5. Create the geometry for the model.

First, create surfaces to represent the board and the chips.

Geometry/Surface/Corners...

Create the board surface:

X:	Y:	Z:	<input type="button" value="OK"/>
<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="button" value="OK"/>
<input type="text" value="9"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="button" value="OK"/>
<input type="text" value="9"/>	<input type="text" value="6"/>	<input type="text" value="0"/>	<input type="button" value="OK"/>
<input type="text" value="0"/>	<input type="text" value="6"/>	<input type="text" value="0"/>	<input type="button" value="OK"/>

Create the first chip surface:

X:	Y:	Z:	
1	1	0	OK
2	1	0	OK
2	2.5	0	OK
1	2.5	0	OK

And the second chip surface:

X:	Y:	Z:	
4	4	0	OK
5	4	0	OK
5	5	0	OK
4	5	0	OK

And the third chip surface:

X:	Y:	Z:	
5.5	2	0	OK
6.5	2	0	OK
6.5	3	0	OK
5.5	3	0	OK

Cancel

To fit the display onto the screen, use the Autoscale feature.

View/Autoscale... (or use <Ctrl>+A)

Next, extrude the surfaces into solids.

Geometry/Volume/Extrude...

(Select the largest surface, representing the board.)

OK

	X:	Y:	Z:
<i>Base:</i>	0	0	0
<i>Tip:</i>	0	0	-.1

OK

(Select the three small surfaces, representing the chips.)

OK

	X:	Y:	Z:
<i>Base:</i>	0	0	0
<i>Tip:</i>	0	0	.25

OK
Cancel

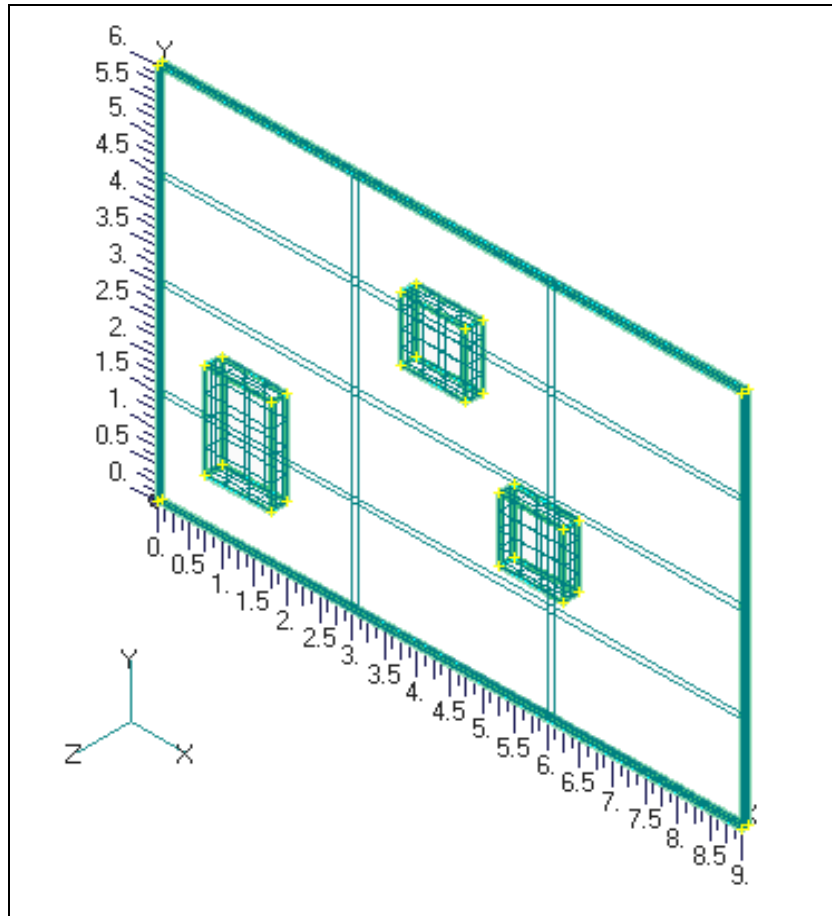
Rotate the model to a isometric view.

View/Rotate... *(or use <F8> or <Ctrl>+R)*

Isometric
OK

Your model should be like the following figure:

Figure 1.1: The isometric view of the model.



- Set the default size for the mesh.

Mesh/Mesh Control/Default Size

Size:

- Create the mesh for the pcb (the circuit board).

Mesh/Geometry/Volume...

(Select the largest volume (the board).)

Property:

Finally create the mesh for the chips.

Mesh/Geometry/Volume...

(Select the three smaller volumes (the chips).)

OK

Property:

2..chip

OK

Finally, remove coincident nodes of the model.

Tools/Check/Coincident Nodes...

Select All

OK

When asked, "OK to Specify Additional Range of Nodes to Merge?" respond with **No**.

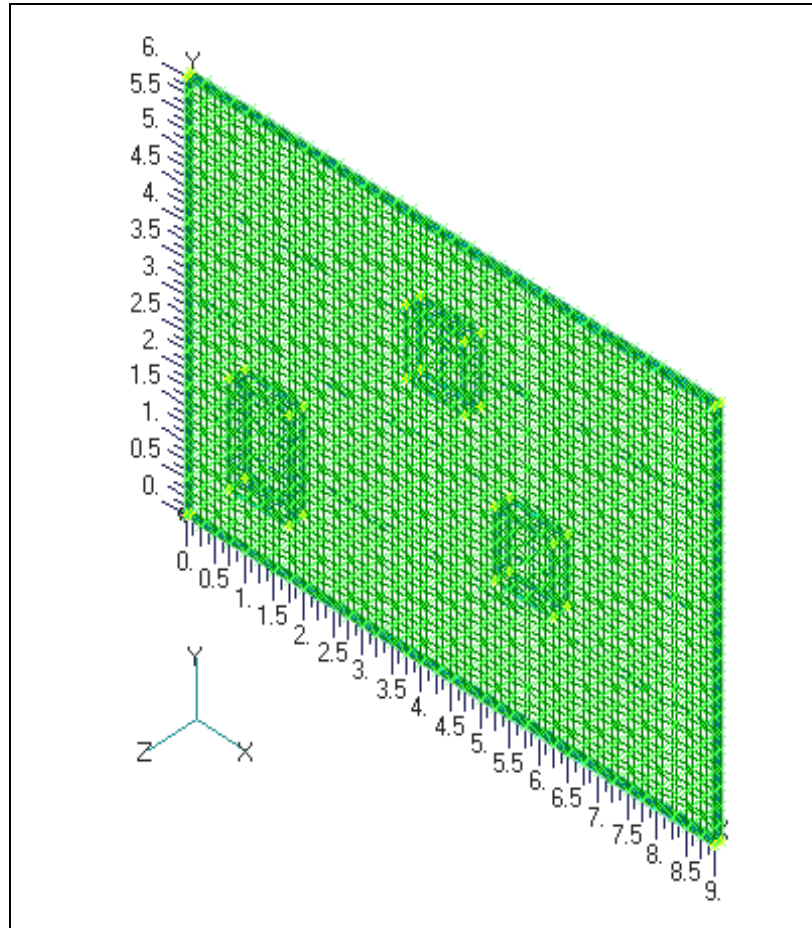
No

Merge Coincident Entities

OK

Your model should be like the following figure:

Figure 1.2: The meshed model.



8. Create the thermal loading for the model.

First, a load set must first be created before creating the appropriate model loading.

Model/Load/Set...

Title:

thermal

OK

Next, apply a uniform default temperature to the model.

Model/Load/Body...

(next to Thermal options)

Active

Default Temperature:

20

OK

Change the view to make applying the loads easier.

View/Rotate...

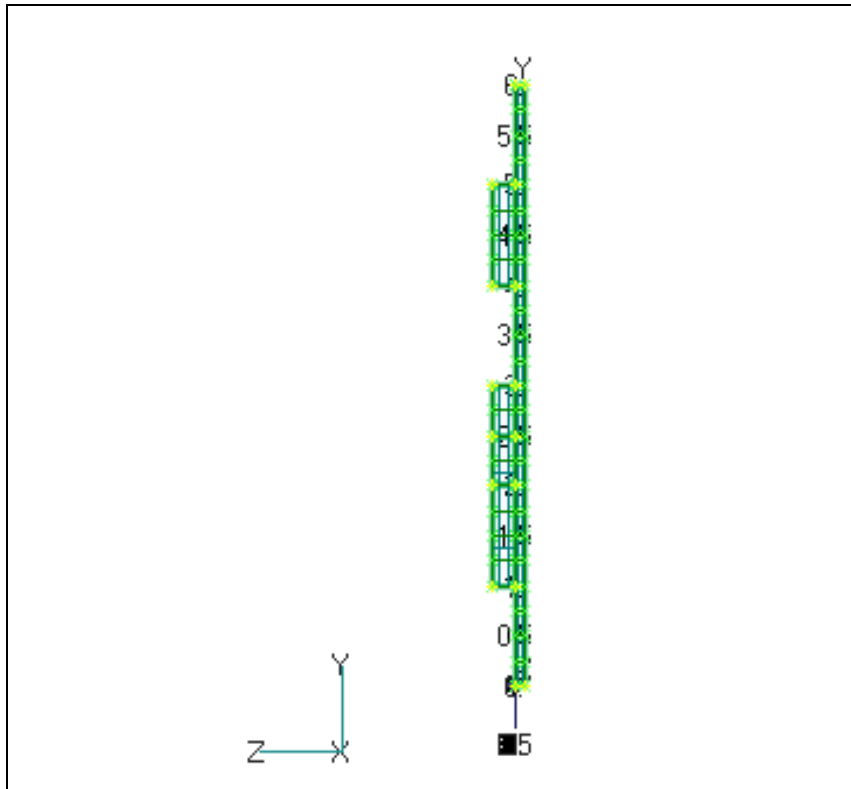
(or use <F8>)

YZ Right

OK

Your model should be like the following figure:

Figure 1.3: The model set with default temperature.



Apply a heat flux to the chips in the model.

Model/Load/Elemental...

(Hold shift and drag a box around the left edges of all chip elements.)

OK

Type:

Heat Flux

Value:

5

OK

Face:

2

OK

Apply free convection to the back of the board in the model.

(Hold shift and drag a box around the right edges of all board elements.)

OK

Type:

Convection

Coefficient:

.02

Temperature:

20

OK

Face:

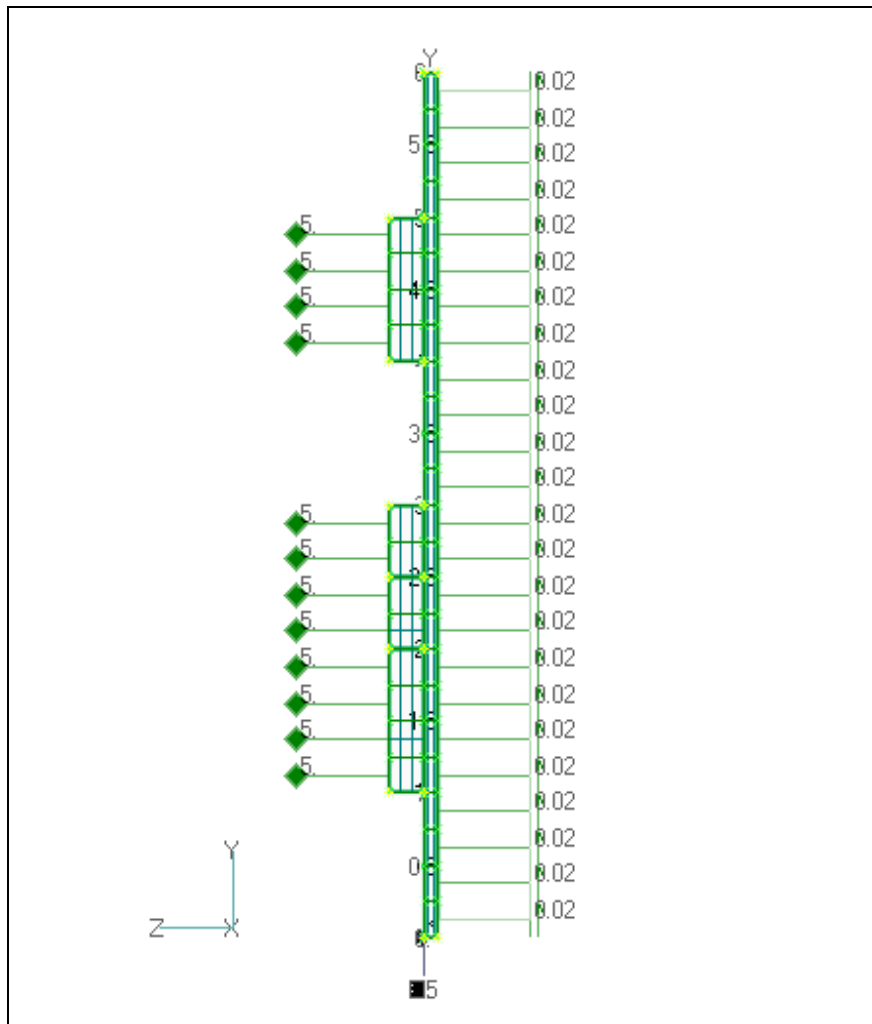
2

OK

Cancel

Your loaded model should be like the following figure:

Figure 1.4: The loaded model.



9. Create the input file and run the analysis.

File/Analyze...

Analysis Type:

20..Steady-State Heat Transfer

Run Analysis

OK

When asked if you wish to save the model, respond **Yes**.

Yes

File Name:

pcb

Save

When the MSC.Nastran manager is through running, MSC.Nastran for Windows will be restored on your screen, and the *Message Review* form will appear. To read the messages, you could select **Show Details**. Since the analysis ran smoothly, we will not bother with the details this time.

Continue

10. Change the display to better view the results.

First, change the viewing angle.

View/Rotate...

(or use <F8>)

Isometric

OK

Next, remove all geometry and thermal loading markers from the screen

View/Options...

Quick Options...

(or use <Ctrl>+Q)

Geometry Off

Load - Heat Flux

Load - Convection

Done

OK

11. Create a final temperature distribution contour plot.

View/Select...

(or use <F5>)

Model Style:

Quick Hidden Line

Render

Contour Style:

● **Contour**

Deformed and Contour Data...

Contour:

31..Temperature

OK

OK

In Figure 1.5, notice the temperature gradients around the chips, where all the heat is produced.

When done, exit MSC.Nastran for Windows.

File/Exit

This concludes this exercise.

Figure 1.5: Free convection analysis on a printed circuit board.

