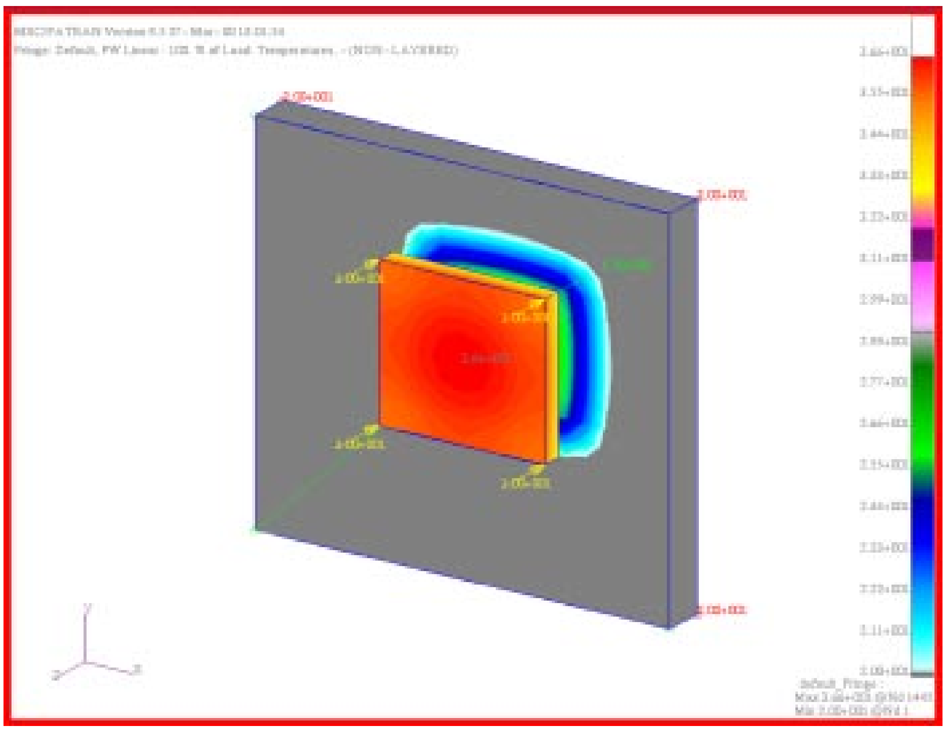
WORKSHOP 4

Thermal Contact Resistance

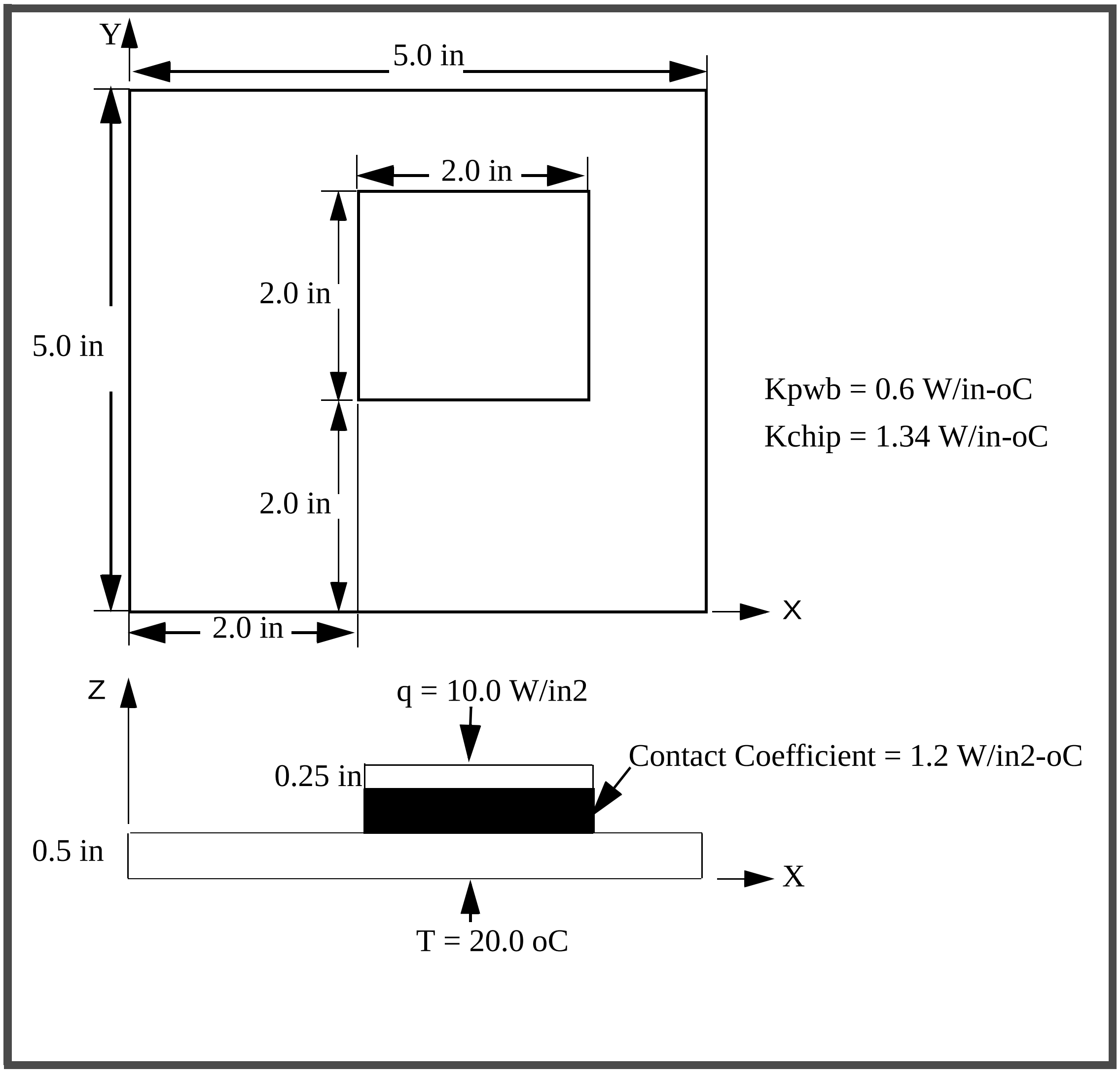


Objective:

- Create Geometry from MSC.Patran
- Determine the maximum and minimum temperature on different sides of the circuit board.

Model Description:

In this example we will model the contact resistance between two solids. In this case, the contact between an electronic component and a printed wiring board (PWB)--to determine the maximum temperature at the top of the chip and the temperature drop to the bottom of the wiring board.



Suggested Exercise Steps:

- Create a new database called **thermal_contact_resistance.db**
- Create a solid that represents the electronic component and the printed wiring board.
- Mesh surfaces and curves with global edge length of 0.25 using Hex8 as element topology
- Merge nodes by using Equivalence method under Finite Elements.
- Input specify Material Properties for both solids.
- Define the solids' properties using **pwb** and **chip** for their property names.
- Apply loads and boundary conditions to the model.Contact resistance is modeled in MSC.Patran using the Convection-Coupled menu operation (select the bottom of the chip surface and the top of the printed wiring board to specify the thermal conductance between the two surfaces).
- Apply heat flux on the top Surface of the chip with Element Uniform Type.
- Using thermal temperature, the boundary condition is applied to the backside of the PWB.
- Perform, read, and display the results.

Exercise Procedure:

1. Create a **New Database** called **thermal_contact_resistance.db**.

File/New...

New Database Name	**thermal_contact_resistance**

OK

2. Change the *Tolerance* to **Default** and the *Analysis Code* to **MSC.Nastran** in the *New Model Preferences* form. Verify that the *Analysis Type* is **Thermal.**.

New Model Preference

Tolerance	◆ **Default**
Analysis Code:	**MSC/NASTRAN**
Analysis Type	**Thermal**

OK

3. Create the solid representing the wiring board and eletronic elements.

◆ **Geometry**

Action:	**Create**
Object:	**Solid**
Method:	**XYZ**
Solid ID List:	**1**
Vector Coordinates List:	**<5 5 0.5>**
Origin Coordinates List:	**[0 0 0]**

Apply

Solid ID List:	**2**
Vector Coordinates List:	**<2 2 .25>**
Origin Coordinates List:	**[2 2 1]**

Apply

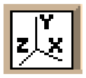
4. Mesh the solids to create Hex8 element with global edge length 0.25.

◆ Finite Elements

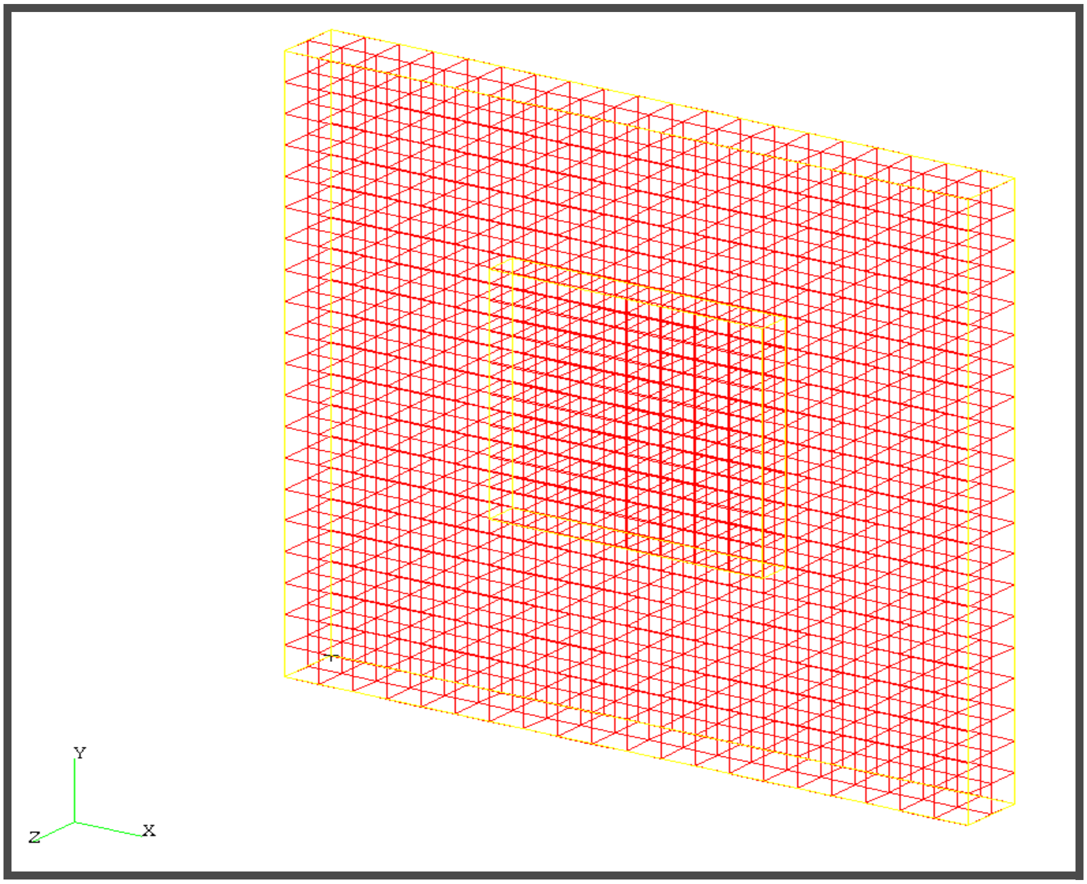
Action:	**Create**
Object:	**Mesh**
Type:	**Solid**
Global Edge Length	**0.25**
Element Topology	**Hex8**
Solid List	**Solid 1:2**

Apply

To obtain a clearer view, select Iso 1 View



Your model should appear like the one shown below.



5. Equivalence the Finite Elements to reduce the number of elements by eliminating duplicate nodes.

◆ **Finite Elements**

Action:	**Equivalence**
Object:	**All**
Type:	**Tolerance Cube**
Equivalence Tolerance:	**0.005**

Apply

6. Create the isotropic material properties using the material constants specify in figure.

◆ **Materials**

Action:	**Create**
Object:	**Isotropic**
Method:	**Manual Input**
Material Name:	**pwb**

Input Properties...

Constitutive Model:	**Solid properties**
Thermal Conductivity:	**0.6**

Apply

Material Name:	**chip**
Constitutive Model:	**Solid properties**
Thermal Conductivity:	**1.34**

Apply

7. Create the model's element properties assigning the material type to the correct region of the model.

◆ **Properties**

Action:	**Create**
Dimension:	**3D**
Type:	**Solid**
Property Set Name:	**pwb**
Input Properties...	
Material Name:	**m:pwb**
OK	
Select Members:	**Solid 1**
Add	
Apply	
Property Set Name:	**Chip**
Input Properties	
Material Names:	**m:chip**
OK	
Select Members:	**Solid 2**
Add	
OK	

8. Contact resistance is modeled in MSC.Patran using the Convection Coupled. This technique enables you to apply a connection through convection between two solid geometric faces without connecting the structures with finite elements. One advantage of this method is that mesh sizes between the two regions need not be congruent. MSC.Patran will automatically find the ambient points closest to the thermal contact area.

◆ **Load/BCs**

Action:	**Create**
Object:	**Convection**
Type:	**Element Uniform**

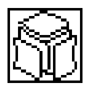
Options:	**Coupled**
New Set Name:	**coup_conv**
Target Element Type:	**3D**
Region 2:	**3D**
Input Data...	
Convection Coefficient:	**1.2**
OK	
Select Application Region	
Geometry Filter:	◆ **Geometry**
Select Solid Faces:	**Solid 2.5**
Add	
■ **Active List**	
Select Solid Faces:	**Solid 1.6**
Add	
OK	
Apply	

Note: Arrows should be pointing downward into the printed wiring board.

9. Apply a Heat Flux on the Top Surfaces of the chip.

◆ **Load/BCs**

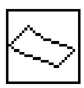
Action:	**Create**
Object:	**Applied Heat**
Type:	**Element Uniform**
Options:	**Normal Fluxes**
New Set Name:	**heat_flux**
Target Element Type:	**3D**
Input Data...	

Heat Flux:	**10**
OK	
Select Application Region	
Geometry Filter:	◆ **Geometry**
Select Solid Surfaces	**Solid 2.6**
	Select the **Free Face Solid** icon
Add	
OK	
Apply	

10. Apply a temperature Boundary Condition on the backside of the PWB.

◆ **Load/BCs**

Action:	**Create**
Object:	**Temp (Thermal)**
Type:	**Nodal**
New Set Name:	**tempbc**
Input Data...	
Boundary Temperature:	**20**
OK	
Select Application Region	
Geometry Filter:	◆ **Geometry**
Select Geometry Entities:	**Solid 1.5**



Select the **Surface or Face** icon

Add

OK

Apply

11. Perform the analysis.

◆ **Analysis**

Action:	**Analyze**
Object:	**Entire Model**
Method:	**Full Run**
Job Name:	**ex4**
Apply	

An MSC.Nastran input file called **ex4.bdf** will be generated. This process of translating your model into an input file is called the Forward Translation. The Forward Translation is complete when the Heartbeat turns green.

Submitting the Input File for Analysis:

12. Submit the input file to MSC.Nastran for analysis.

    12a. To submit the MSC.Patran **.bdf** file, find an available UNIX shell window. At the command prompt enter **nastran ex4.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

    12b. To submit the MSC.Nastran **.dat** file, find an available UNIX shell window and at the command prompt enter **nastran ex4 scr=yes**. Monitor the run using the UNIX **ps** command.

13. When the run is completed, edit the **ex4.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

14. MSC.Nastran Users have finished this exercise. MSC.Patran Users should proceed to the next step.

15. Proceed with the Reverse Translation process, that is, attaching the **ex4.xdb** results file into MSC.Patran. To do this, return to the **Analysis** form and proceed as follows:.

◆ **Analysis**

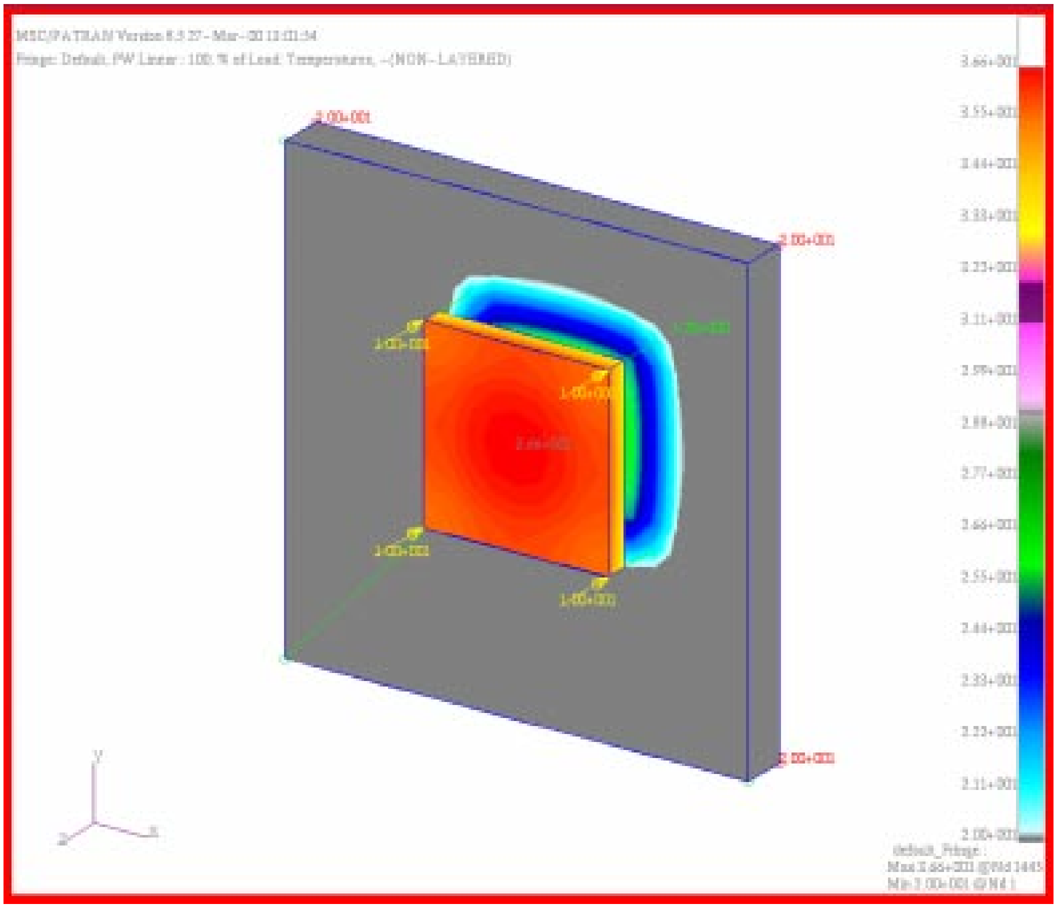
Action:	**Attach XDB**
Object:	**Result Entities**
Method:	**Local**
Select Results File...	
Select Results File	**ex4.xdb**
OK	
Apply	

16. Display the Results.

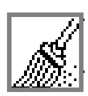
◆ **Results**

Object:	**Quick Plot**
Select Results Cases:	**Default, PW Linear: 100. % of Load**
Select Fringe Result:	**Temperature**
Apply	

Your Viewport will appear as follows.



The viewport may now be reset by clicking on the broom icon in the main window.



File/Quit...