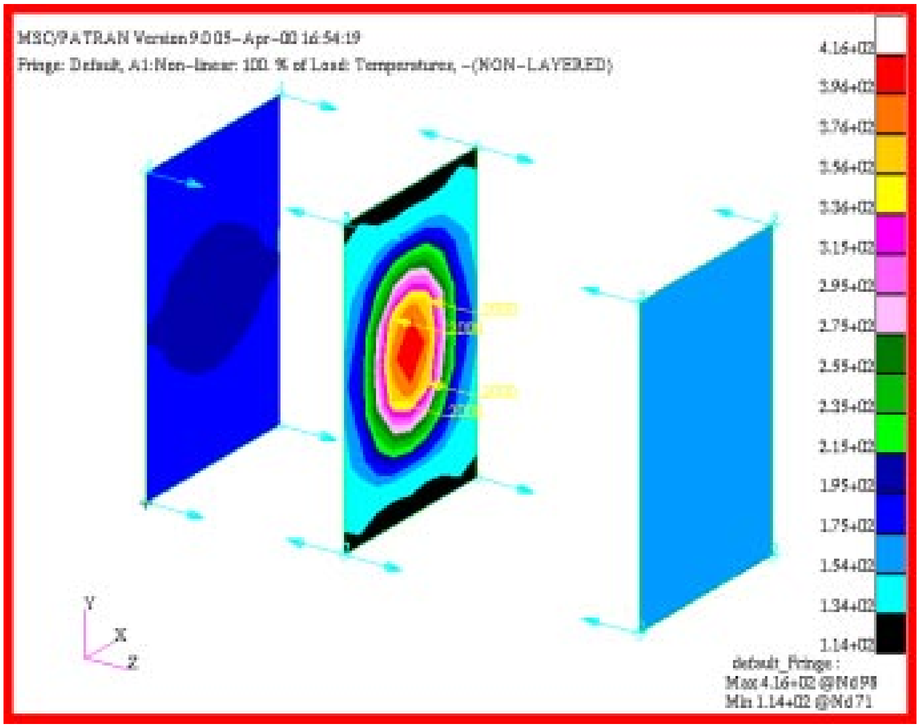
WORKSHOP 6

Radiation Enclosures



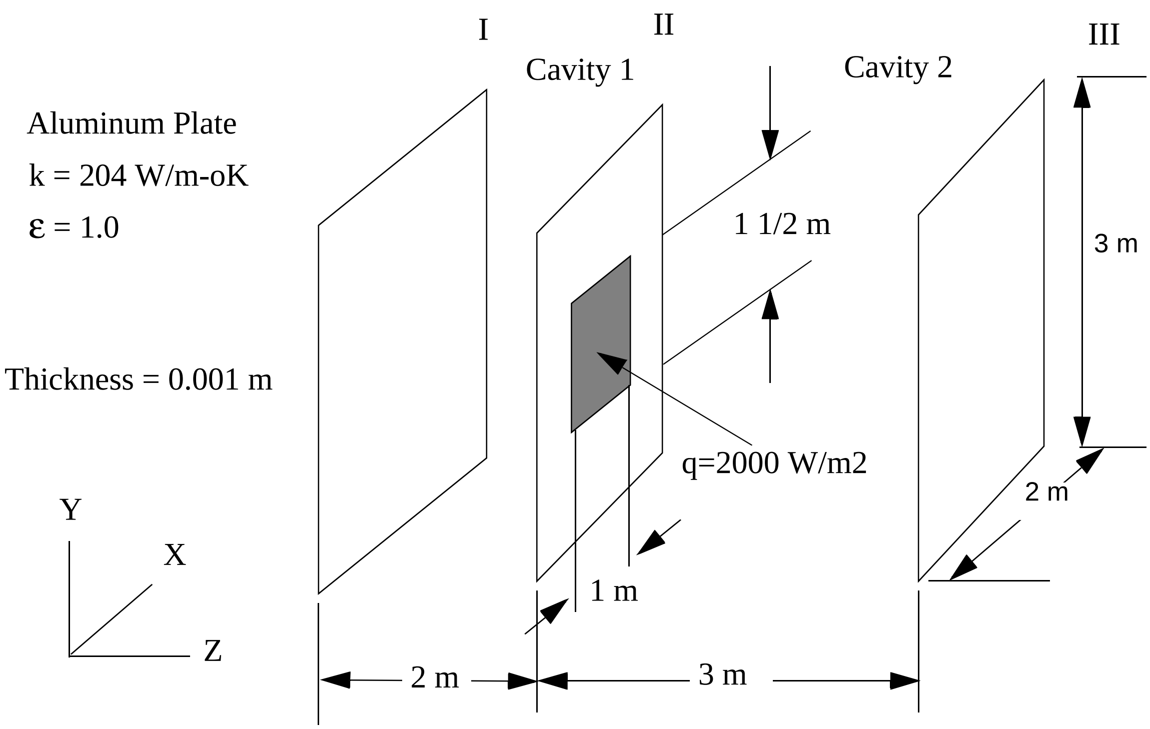
Objective:

- Create Geometry from MSC.Patran
- Attain a temperature solution withing MSC.Nastran

Model Description:

In this example we will model three plates that are in radiative equilibrium with a zero-degree ambient environment. Each plate measures 2 m by 3 m, and are arranged as shown in the figure below. The center plate (II) has a heat flux applied to it with a magnitude of 2000 W/m2 in the central region, as illustrated.

The emissivity of all surfaces is chosen as 1.0, representing perfect blackbodies. The plate thicknesses are all 0.001 m, and the material is aluminum. Temperature distribution for each plate will be determined.



Suggested Exercise Steps:

- Create a new database called **radiation_e**ncl**osures.db**
- Create surfaces that represents three plates.
- Each plate is meshed with sixteen QUAD8 elements
- Input specify Material Properties for the plates.
- Define the element properties using **alum** as the property name.
- Apply loads and boundary conditions to the model. Two radiation cavities are defined. Cavity 1 includes all the elements on Plates I and II that view each other. These elements also communicate with zero-degree space. The second cavity is comprised of the elements on Plates II and III, which see each other, and they also communicate with zero-degree space.
- The non-cavity sides of Plates I and III are treated as adiabatic surfaces (i.e., perfectly insulated
- The normal heat flux is applied to one side of the centermost four elements of Plate II, for a total heat load of 3000 W.
- Perform, read, and display the results.

Exercise Procedure:

1. Create a **New Database** called it **radiation_enclosures.db**

   File/New...

New Database Name	**radiation_enclosures**

   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 surface representing a plate.

   ◆ **Geometry**

Action:	**Create**
Object:	**Surface**
Method:	**XYZ**
Vector Coordinates List:	**<2 3 0>**
Origin Coordinates List:	**[0 0 0]**

   Apply

   You will now use Transformation to create the other 2 surfaces parallel with the previous one.

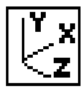
   ◆ **Geometry**

Action:	**Transform**
Object:	**Surface**
Method:	**Translate**

Translation Vector: **<0 0 2>**

Surface List: **Surface 1**

Apply



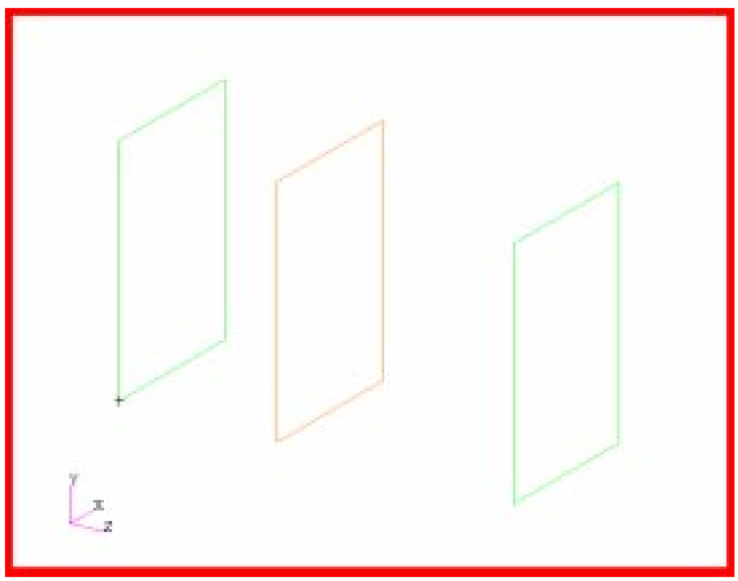
Change the view to Iso 2 View

Translation Vector: **<0 0 3>**

Surface List: **Surface 2**

Apply

When you are finished your model should look like the one shown in the figure below.



4. Mesh the plate

◆ **Finite Elements**

Action: **Create**

Object: **Mesh Seed**

Type: **Uniform**

◆**Number of Elements**

Number=: **4**

Curve List: **Surface 1.1 1.2 2.1 2.2 3.1 3.2**

Apply

5. Mesh the solids to create Quad8 element with global edge length 1.0.

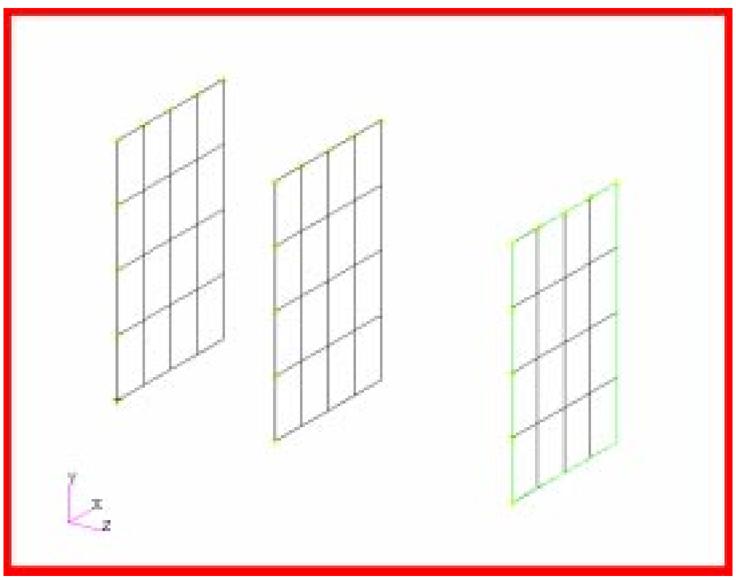
◆ **Finite Elements**

Action:	**Create**
Object:	**Mesh**
Type:	**Surface**
Global Edge Length:	**1**
Element Topology:	**Quad8**

◆ **IsoMesh**

Surface List: **Surface 1:3**

Apply



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

◆ **Materials**

Action:	**Create**
Object:	**Isotropic**
Method:	**Manual Input**
Material Name:	**alum**
Input Properties...	
Constitutive Model:	**Solid properties**
Thermal Conductivity:	**204**
OK	
Apply	

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

◆ **Properties**

Action:	**Create**
Dimension:	**2D**
Type:	**Shell**
Property Set Name:	**alum**
Input Properties...	
Material Name:	**m:alum**
Thickness:	**0.001**
OK	
Select Members:	**Surface 1:3**
Add	
Apply	

8. Define the radiation enclosures by defining two cavities for radiation exchange. This will save a lot of time attaining a temperature solution within MSC⁄NASTRAN. Basically, to identify the TOP and BOTTOM surfaces appropriately, each independent

surface within an enclosure will have a distinct SET NAME. Consistent use of the ENCLOSURE ID with each SET NAME ensures that the elements are included in the appropriate enclosure.

◆ **Load/BCs**

Action:	**Create**
Object:	**Radiation**
Type:	**Element Uniform**
Options:	**Enclosures**
New Set Name:	**enl_1**
Target Element Type:	**2D**
Input Data...	
Surface Option:	**Top**
Enclosure ID:	**1**
Top Surf Emissivity:	**1.0**
❑ **Surface Can Shade**	
❑ **Surface Can Be Shaded**	
OK	
Select Application Region	
Geometry Filter:	◆ **Geometry**
Select Surfaces or Edges:	**Surface 1**
Add	
OK	
Apply	
New Set Name:	**encl_1a**
Input Data...	
Surface Option:	**Bottom**
Enlosure ID:	**1**
Bottom Surf Emissivity:	**1.0**

OK

Select Application Region

Geometry Filter: ◆ **Geometry**

Select Surfaces or Edges: **Surface 2**

Add

OK

Apply

New Set Name: **encl_2**

Input Data...

Surface Option: **Top**

Enlosure ID: **2**

Top Surf Emissivity: **1.0**

OK

Select Application Region

Geometry Filter: ◆ **Geometry**

Select Surfaces or Edges: **Surface 2**

Add

OK

Apply

New Set Name: **encl_2a**

Input Data...

Surface Option: **Bottom**

Enlosure ID: **2**

Bottom Surf Emissivity: **1.0**

OK

Select Application Region

Geometry Filter:	◆ **Geometry**
Select Surfaces or Edges:	**Surface 3**

Add

OK

Apply

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

◆ **Load/BCs**

Action:	**Create**
Object:	**Applied Heat**
Type:	**Element Uniform**
Options:	**Normal Flux**
New Set Name:	**heat_flux**
Target Element Type:	**2D**

Input Data...

Surface Option:	**Top**
Top Surface Heat Flux	**2000**

OK

Select Application Region

Geometry Filter:	◆ **FEM**
Select 2D Elements or Edges	**Elm 22 23 26 27**

Add

OK

Apply

10. Perform the analysis.Since radiation heat transfer, by definition makes our problem highly nonlinear, we need to consider the Default Initial Temperature setting if we hope to achieve a converged solution with the MSC.Nastran thermal solver

◆ **Analysis**

Action:	**Analyze**
Object:	**Entire Model**
Method:	**Analysis Deck**
Job Name:	**ex6**
Solution Type....	
Solution Parameters....	
Default Init Temperature=:	**500**
Radiation Parameters....	
Stefan-Boltzmann Constant:	**5.6696e-8**
OK	
OK	
OK	
Apply	

An MSC.Nastran input file called **ex6.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:

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

    11a. To submit the MSC.Patran **.bdf** file, find an available UNIX shell window. At the command prompt enter **nastran ex6.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

    11b. To submit the MSC.Nastran **.dat** file, find an available UNIX shell window and at the command prompt enter **nastran ex6 scr=yes**. Monitor the run using the UNIX **ps** command.

    When the run is completed, edit the **ex6.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.

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

13. Proceed with the Reverse Translation process, that is, attaching the **ex6.xdb** results file into MSC.Patran. To do this, return to the **Analysis** form and proceed as follows:

◆ **Analysis**

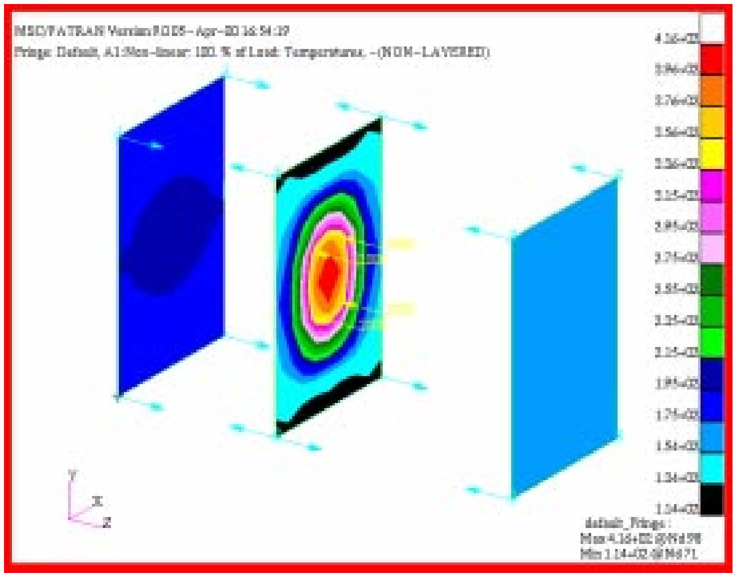
Action:	**Attach XDB**
Object:	**Result Entities**
Method:	**Local**
Select Results File...	
Select Results File	**ex6.xdb**
OK	
Apply	

14. Display the Results.

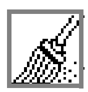
◆ **Results**

Object:	**Quick Plot**
Select Results Cases:	**Default, A1:Non-Linear: 100. % of Load**
Select Fringe Result:	**Temperatures**
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...