Thermal Analysis Tutorial



Figure 1. Geometry of Example Problem

Point	X (m)	Y (m)
А	0.0000	-0.0025
В	0.0000	0.0375
С	0.0050	0.0375
D	0.0050	0.0025
E	0.0650	0.0025
F	0.0650	-0.0025

Table 1. Points in Figure 1

Geometry

Part

- Double click on Parts the menu in Figure 2 will appear
- Choose 2D, Deformable, shell, and an approximate size of 0.13 (2 x max dimension)

Create Part	×	
Name: Part-2		
Modeling Space		
🔘 3D 💿 2D Planar	Axisymmetric	
Туре	Options	
Oeformable		
Discrete rigid	News weiledda	
Analytical rigid	None available	
Eulerian		
Base Feature		
Shell		
Wire		
Point		
Approximate size: 0.13		
Continue	Cancel	



• A sketch will come up, use the "create lines connected" button and type in the starting and ending point (in table 1) for each line in the prompt at the bottom of the window

|--|

• When complete add the fillet using the "create Fillet Between 2 curves " button . Frist type the fillet radius in the prompt then select the two line which are part of the fillet. The end sketch is shown in figure 3. Click the middle mouse button to finish the sketch.



Material

• Double click on Material and input 73 as the conductivity as shown in figure 4. Call the Material, Material-1

Edit Material	
Name: Material-1	
Description:	
Material Behaviors	
Conductivity	
<u>G</u> eneral <u>M</u> echanical <u>T</u> hermal <u>O</u> ther Conductivity	Delete
Type: Isotropic	
Use temperature-dependent data	
Number of field variables: 0	
Data	
Conductivity 1 73	



Section

- Double click on Section and select homogeneous as shown in figure 5.
- Create the section using Material-1 as in Figure 6



Figure 5

Figure 6

• Under the Part menu select Section Assignment as in figure 7



Figure 7

• Select the part in the window and then hit done as below

X Select the regions to be assigned a section Done

Assembly

• Under the assembly window select Instance and create an instance for Part-1 (Choose dependent)

Boundary Conditions and Loads Steps

Load Step

• Double click on load steps and create Step-1 and select Heat Transfer as in figure 8



Figure 8

• Double click on step one bringing up the edit step menu in Figure 8A. Select Stead-State Analysis

Edit Step
Name: Step-1
Type: Heat transfer
Basic Incrementation Other
Description:
Response: 💿 Steady-state 🔘 Transient
Time period: 1
NIgeom: Off Edit
OK

Figure 8A

• Double click on BC's and create a Temperature boundary condition as in Figure 9

Create Boundary Condition		
Name: BC-2		
Step: Step-1		
Procedure: Heat t	ransfer	
Category	Types for Selected Step	
Mechanical	Temperature	
Other	Connector material flow	
Submodel		
Continue	Cancel	

Figure 9

• Select the upper edge and apply 50K temperature as shown in Figure 10

	Edit Boundary Condition	1
	Name: BC-2 Type: Temperature Step: Step-1 (Heat transfer) Region: (Picked) Edit Region	
	Method: Specify magnitude Distribution: Uniform Create Magnitude: 50 Amplitude: (Ramp) Create	
	OK Cancel	
Y X X		



• Select the right edge and apply 300K temperature

Mesh

• Under the Part menu select Mesh as shown in figure 11



Figure 11

• Under the Mesh menu (top of screen) select Mesh Controls. Select Tri elements and a Free Mesh Technique as in figure 12

Mesh Controls			
Element Shape	l-dominated 💿 Tri		
Technique	Algorithm		
As is	Use mapped meshing whether the second sec	nere appropriate	
Free			
Structured			
Sweep			
Multiple			
ОК	Defaults	Cancel	

Figure 12

• Under the Mesh menu (top of screen) select Element Type. Select Standard Linear Heat Transfer Elements as in figure 13

Element Type	strength in such state, on or the state of the local diversion of the second d	×
Element Library Standard © Explicit	Family Gasket Generalized Plane Strain	
Geometric Order Linear Quadratic	Heat Transfer Piezoelectric	E
Quad Tri Element Controls There are no applicable DC2D3: A 3-node linear	controls for these settings.	

Figure 13

• Under the Seed menu (top of screen) select Part and enter an Approximate Global Size of 0.0015 as in Figure 14

📑 Global Seeds 📃 💌			
Sizing Controls			
Approximate global size: 0.0015			
Curvature control			
Maximum deviation factor (0.0 < h/L < 1.0): 0.1			
(Approximate number of elements per circle: 8)			
Minimum size factor (as a fraction of global size):			
OK Apply Defaults Cancel			

Figure 14

- Under Mesh select part and configure that it is ok to mesh the part. The mesh is shown in Figure 15.
- To check the number of nodes and elements go to the Tools menu and select Query. Select Mesh and then select the Done button by "display detailed report" This mesh has the following attributes

Total number of nodes: 304

Total number of elements: 468

468 linear triangular elements of type DC2D3



Figure 15

Solution

• Under the analysis menu double click on jobs to bring up the menu in Figure 16



Figure 16

- Select continue and then select ok in the Edit job menu
- Select the Job Manager button ^{LEEE} bring up the menu in Figure 17

Job Manage	er			×
Name	Model	Туре	Status	Write Input
Job-1	Model-1	Full Analysis	None	Data Check
				Submit
				Continue
				Monitor
				Results
				Kill
Create	Edit Copy	Rename	Delete	Dismiss
onstraints				



- Select Data Check to check in the input deck is correct
- If Data Check complets successfully select Submit
- Ignore any warning about History Variables (results as a function of time) this is a steady state analysis (results are after a long time)
- The output window should read
- The job "Job-1" has been created.
 The job input file "Job-1.inp" has been submitted for analysis.
 Job Job-1: Analysis Input File Processor completed successfully.

Job Job-1: Abaqus/Standard completed successfully. Job Job-1 completed successfully.

• Select results which will take you to Abaqus viewer.

Post Processing

•



• Under the Results menu (top of Screen) select field output and Nodal Temperature NT11 as in Figure 18

Field Output	a prose tight (prove (or	x		
Step/Frame				
Step: 1, Step-1				
Frame: 1 Step/Fr	rame			
Primary Variable	Deformed Variable Symbol Variable	Status Variable		
Output Variable				
List only varia	List only variables with results:			
Name	Description (* indicates complex)			
HFL	Heat flux vector at integration points	5		
NT11	Nodal temperature at nodes			
RFL11	Reaction fluxes at nodes			



• Select the contour plot button again if needed to give temperature results as shown in Figure 19



Figure 19 Temperature K

• To plot the temperature distribution at y = 0 (through the middle of the bottom leg) as shown in Figure 20



Figure 20

- Select Point List then Continue
- The plot will only show output at points in the list so add a point every 0.005m along x as in Figure 21

ame: Path-1	
ype: Point List	
Path Definition	
inter one point per row	
Press Enter to update the viewport	
Point Coordinates (Examples: 0,0,3 0 0 3 ,,3)	
1 0.005,0.0,0.0	
2 0.01,0.0,0.0	
3 0.015,0.0,0.0	
4 0.02,0.0,0.0	
5 0.025,0.0,0.0	
6 0.03,0.0,0.0	Ξ
7 0.035,0.0,0.0	
8 0.04,0.0,0.0	
9 0.045,0.0,0.0	
10 0.05,0.0,0.0	
11 0.055,0.0,0.0	
12 0.06,0.0,0.0	_
13 0.065,0.0,0.0	-

Figure 21

- Select ok
- Under Tools select XY Data then Create as in Figure 22





• In the Create XY Data menu select Path as in Figure 23





• In the XY Data from Path menu select undeformed and true distance. Also check that Field Output variable is NT11 if you intend to plot temperature. If not select the Field Output button and the field output of interest as in Figure 24.

XY Data from Path				
Data Extraction				
Path:	Path-1			
Model shape:	Deformed Uno	deformed		
Point Locations:				
Include intersections				
X Values				
True distance X distance				
Normalized distance Y distance				
Sequence ID	Z distance	Tip		
Y Values				
Step: 1, Step-1	L			
Frame: 1 Step/	Frame			
Field output vari	able: NT11 Field	Output		
Note: Result option settings will be applied to calculate result values for the current step and frame.				
Save As	Plot	ancel		

Figure 24

• Select Plot to create a plot of the temperature over the x distance as in Figure 25.



Figure 25

- Select Save As and Save the data as XYData-1
- Under the tools menu and XY Data Select Edit then XYData-1
- Since the plot in Figure 25 is difficult to format and compare with other results, it can be useful to copy the data selected in the previous step into a better plotting program (excel, matlab, etc) as in Figure 26



Figure 26