



AKADEMIA GÓRNICZO-HUTNICZA
IM. STANISŁAWA STASZICA W KRAKOWIE

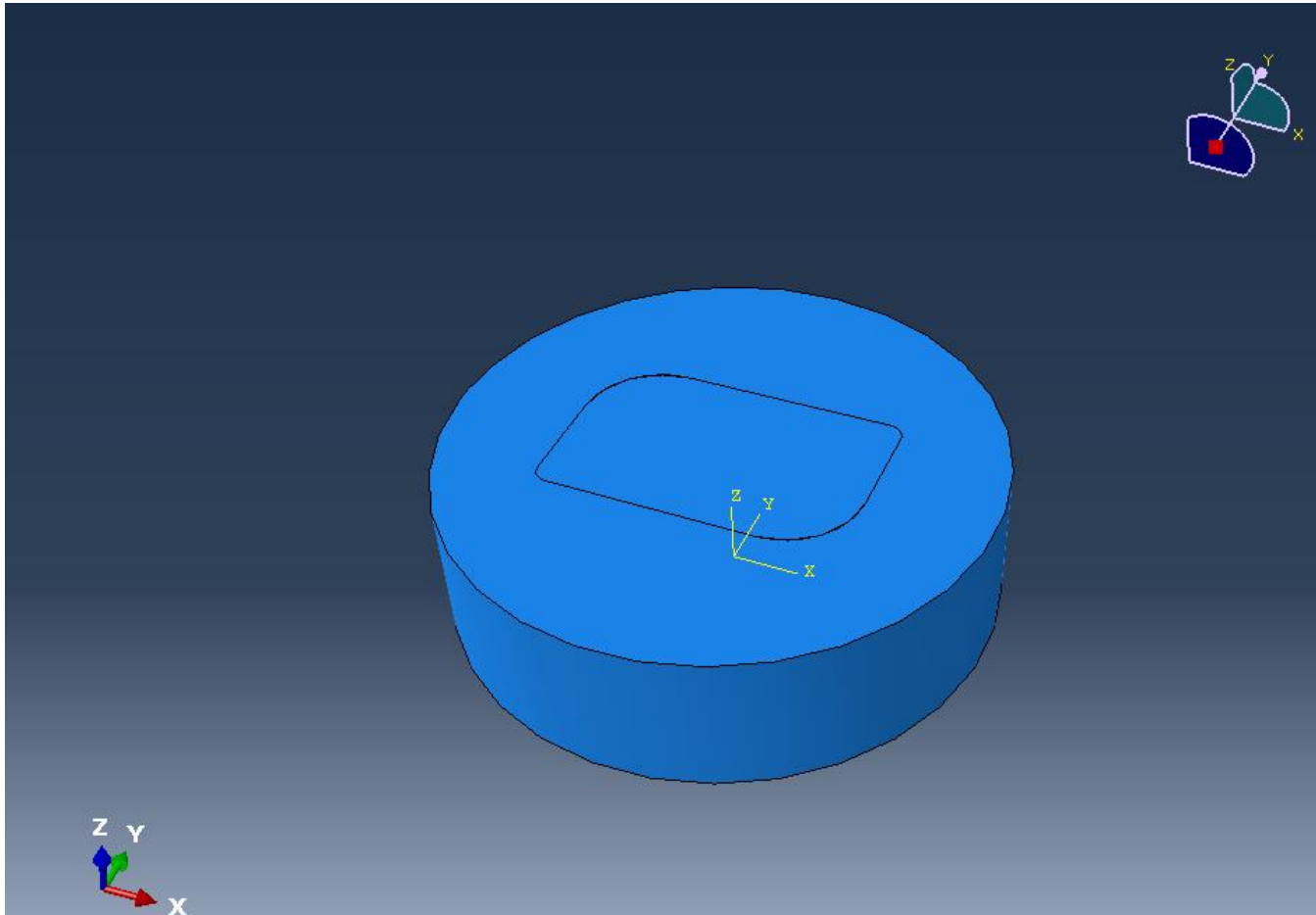
ABAQUS

Thermal analysis

dr inż. Piotr Kustra

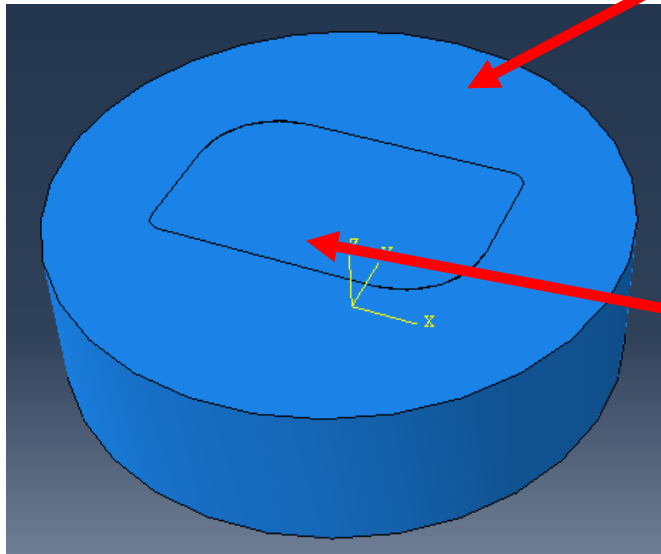
Wydział Inżynierii Metali i Informatyki Przemysłowej

Model definition



Materials definition

Materials data



Resin

$E=13\text{GPa}$

$\nu=0.35$

Aluminum

$E=70\text{GPa}$

$\nu=0.38$



Units m/mm

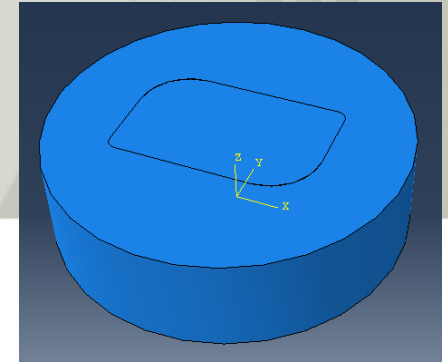
Units [m]

Resin

Specific heat	1000 J/(Kg K)
Thermal conductivity	1 W·/(m·K)
Expansion	4.2 10 ⁻⁵ 1/C
Density	1719 kg·m ³

Aluminum

Ciepło właściwe	871 J/(Kg K)
Przewodność cieplna	202 W·/(m·K)
Rozszerzalność cieplna	2.3 10 ⁻⁵ 1/C
Gęstość	2700 kg·m ³



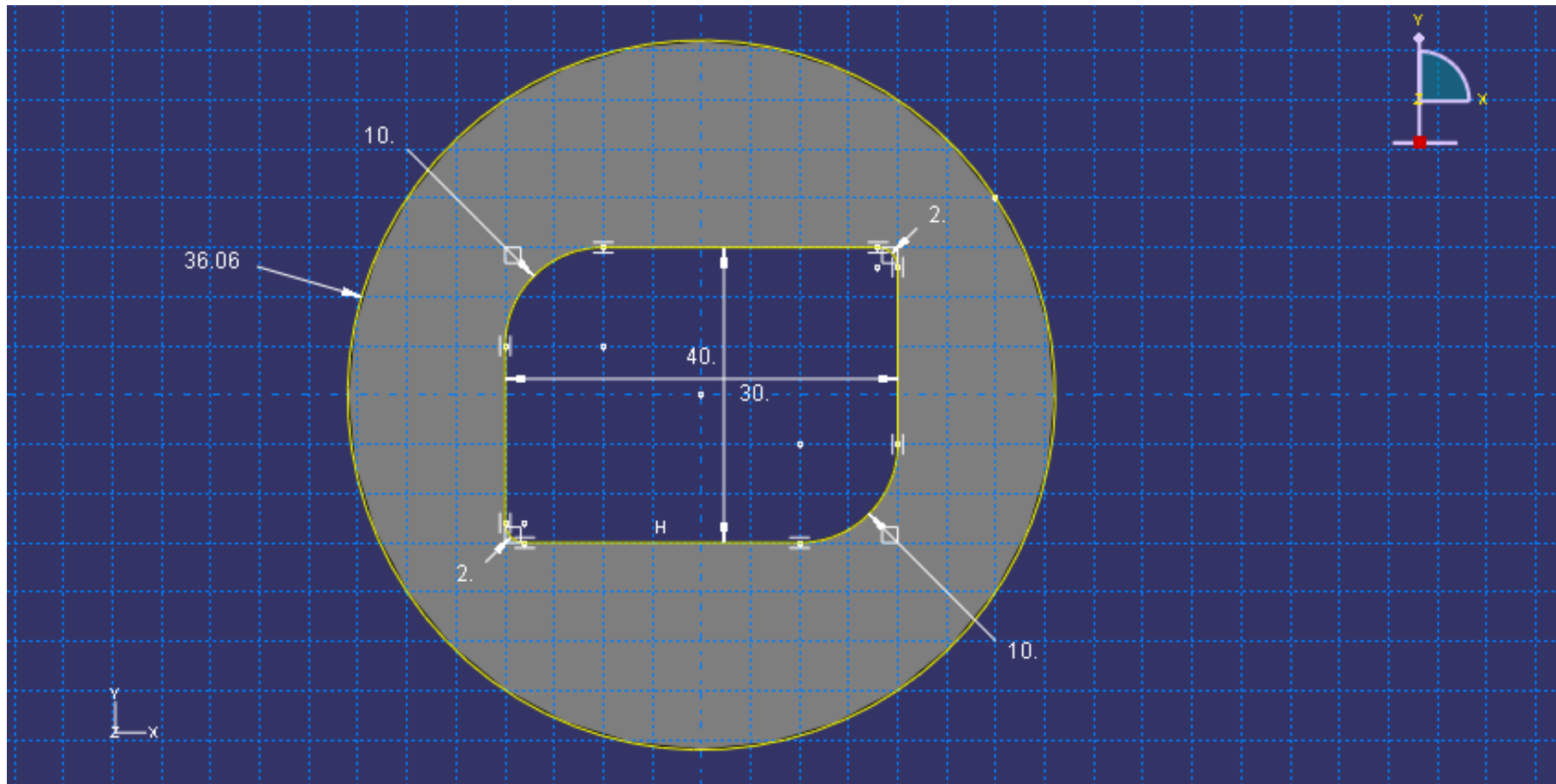
Units [mm]

Specific heat	1000000000 mJ/(tone K)
Thermal conductivity	1 mW·/(mm·K)
Expansion	4.2E-005 1/C
Density	1.719E-009 (tone/mm ³)

Specific heat	871000000 mJ/(tone K)
Thermal conductivity	202 mW·/(mm·K)
Expansion	2.3E-005 1/C
Density	2.7E-009 (tone/mm ³)

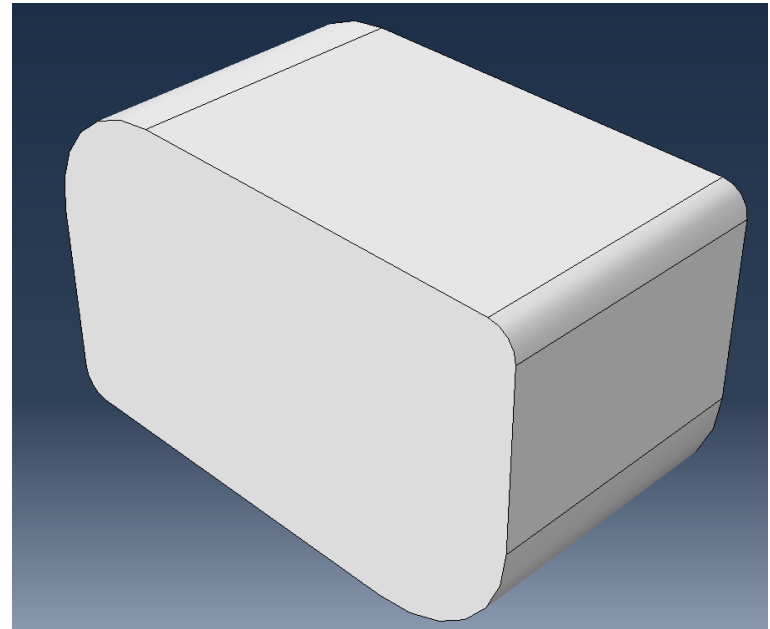
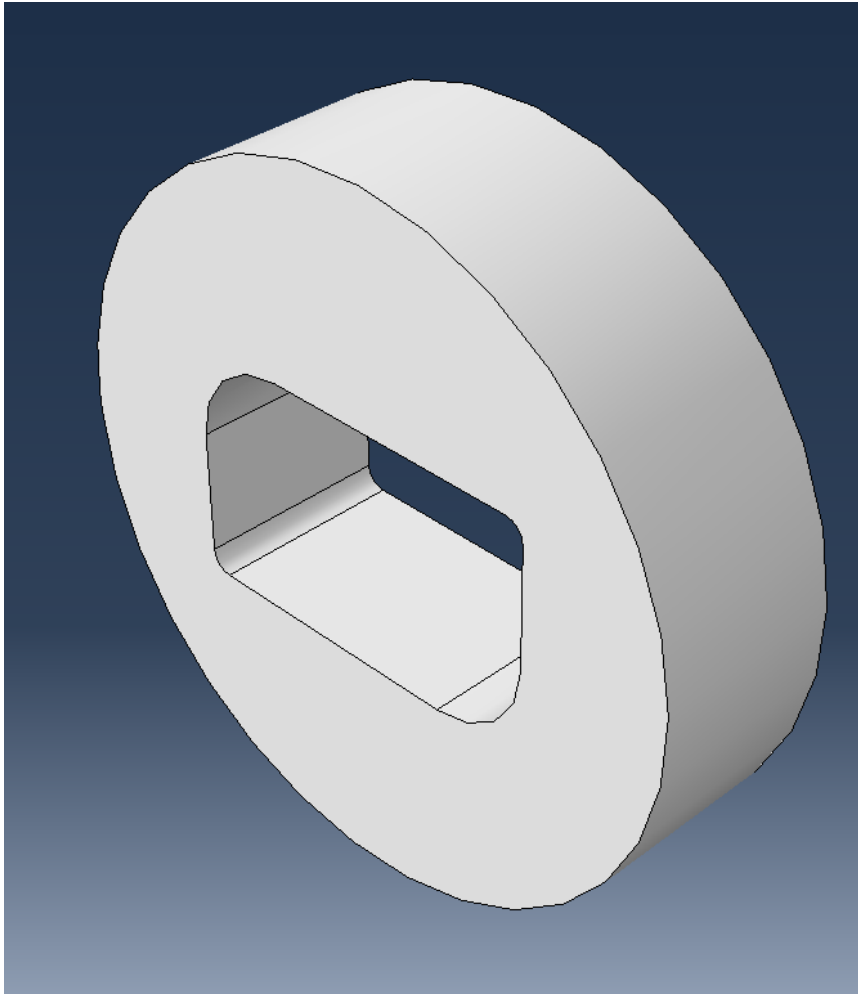
Geometry definition

Extrusion depth = 20

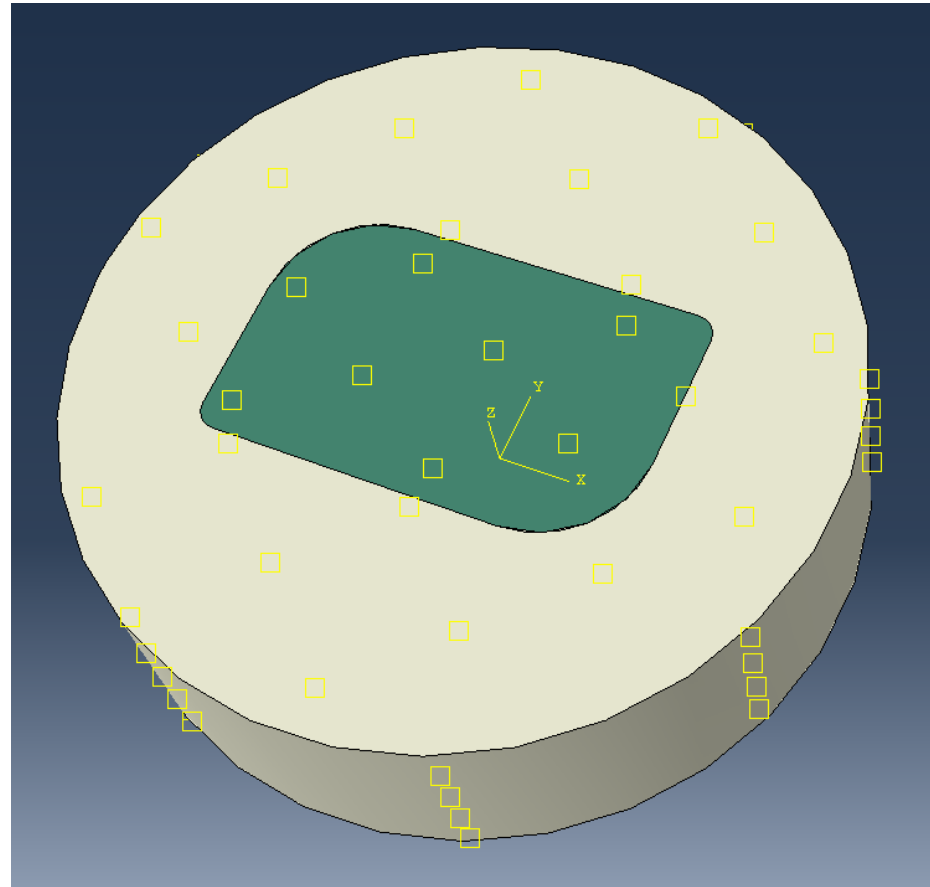




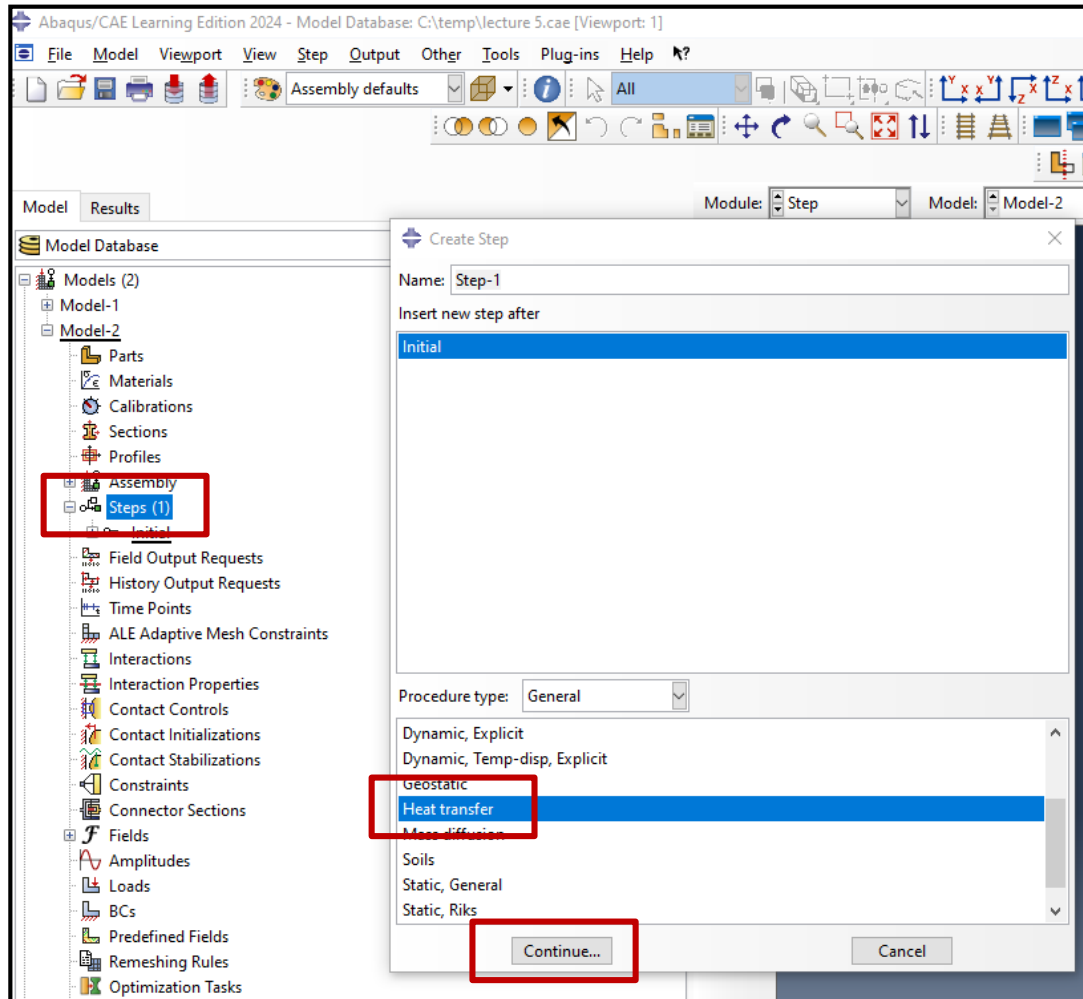
Parts



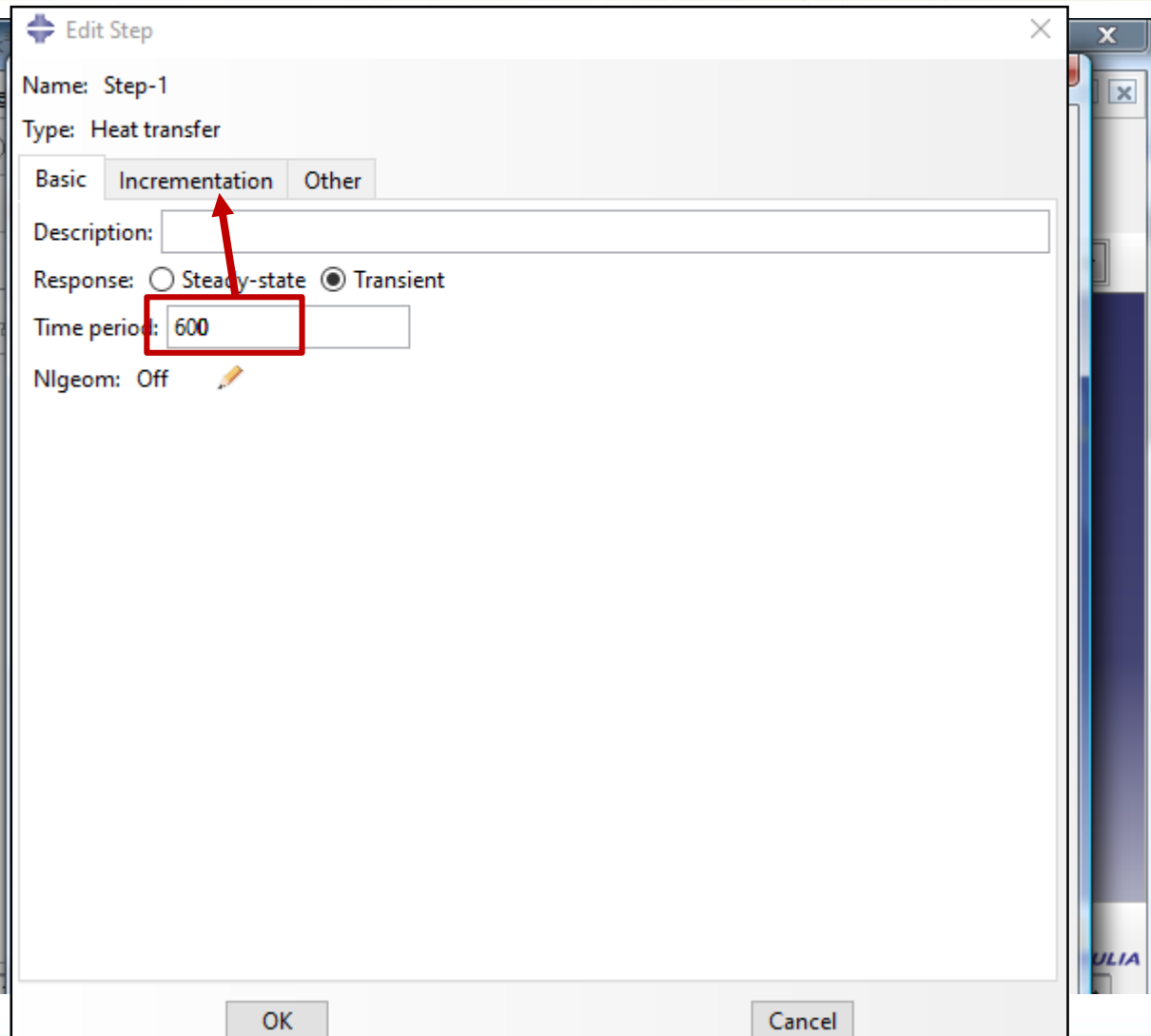
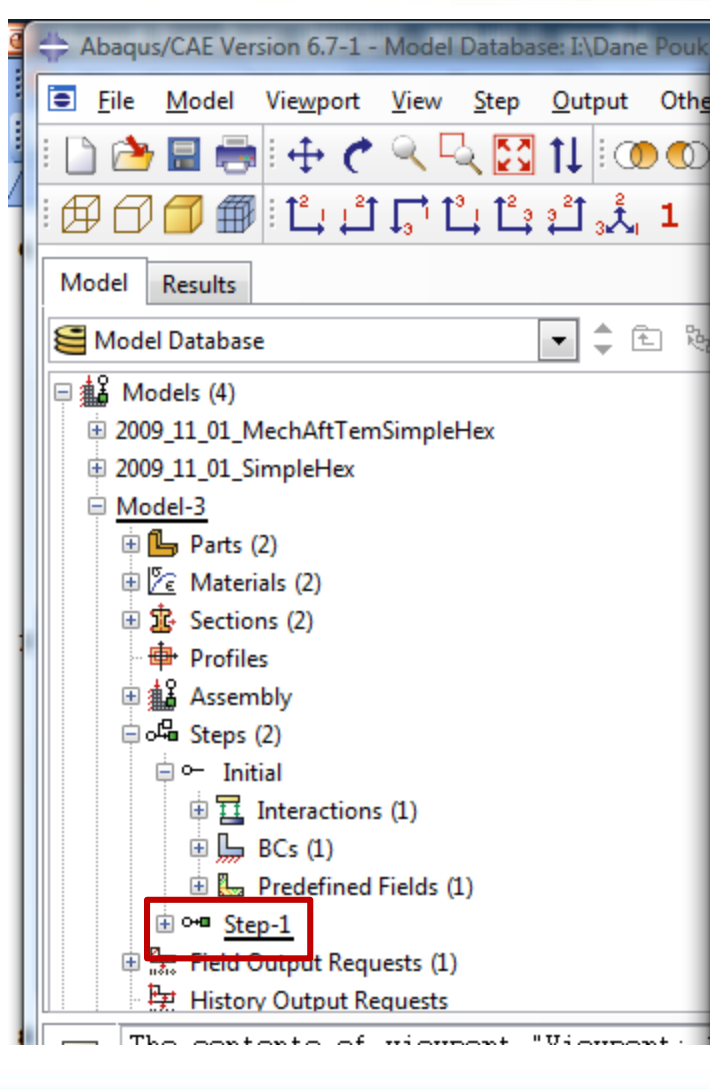
Assembly



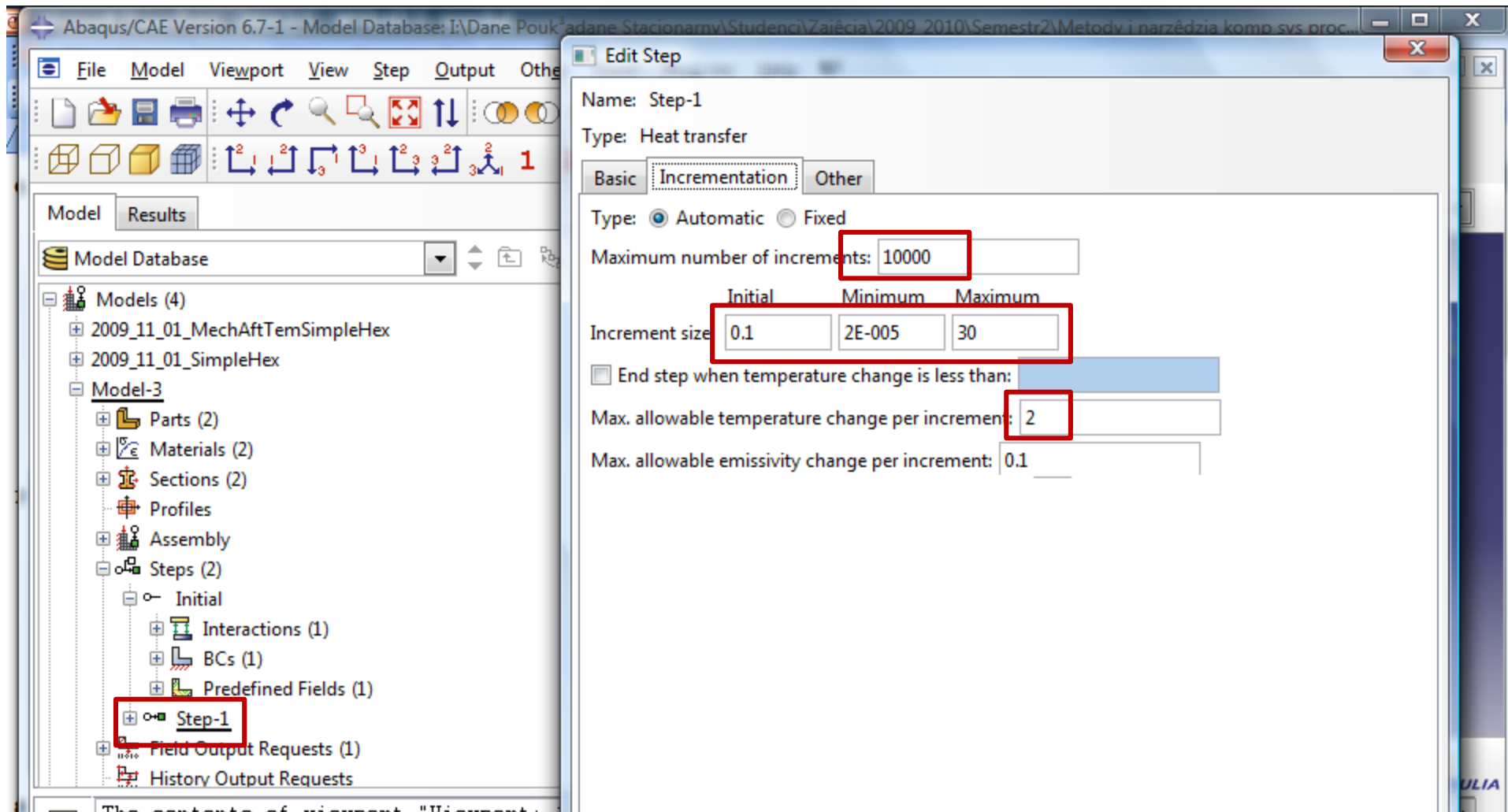
Step type definition



Step type definition



Analysis type definition



Abaqus/CAE Version 6.7-1 - Model Database: I:\Dane Pouk\adane Stacjonary\Studenci\Zaięcia\2009_2010\Semestr2\Metody i narzędzia komp sys proc...

File Model Viewport View Step Output Other

Model Database

Models (4)

- 2009_11_01_MechAftTemSimpleHex
- 2009_11_01_SimpleHex
- Model-3**
 - Parts (2)
 - Materials (2)
 - Sections (2)
 - Profiles
 - Assembly
 - Steps (2)
 - Initial
 - Interactions (1)
 - BCs (1)
 - Predefined Fields (1)
 - Step-1**
 - Field Output Requests (1)
 - History Output Requests

Edit Step

Name: Step-1

Type: Heat transfer

Basic **Incrementation** Other

Type: Automatic Fixed

Maximum number of increments: 10000

Increment size	Initial	Minimum	Maximum
0.1	2E-005	30	

End step when temperature change is less than:

Max. allowable temperature change per increment: 2

Max. allowable emissivity change per increment: 0.1

Contact definition

Edit Interaction

Name: Int-1

Type: Surface-to-surface contact (Standard)

Step: Step-1 (Heat transfer)

Main surface: Part-1-1.out

Secondary surface: Part-2-1.IN

Sliding formulation: Finite sliding Small sliding

Discretization method: Surface to surface

Exclude shell/membrane element thickness

Degree of smoothing for main surface: 0.2

Use supplementary contact points: Selectively Never Always

Contact tracking: Two configurations (path) Single configuration (state)

Secondary Adjustment: Surface Smoothing Clearance Bonding

No adjustment

Adjust only to remove overclosure

Specify tolerance for adjustment zone: 0

Adjust secondary nodes in set:

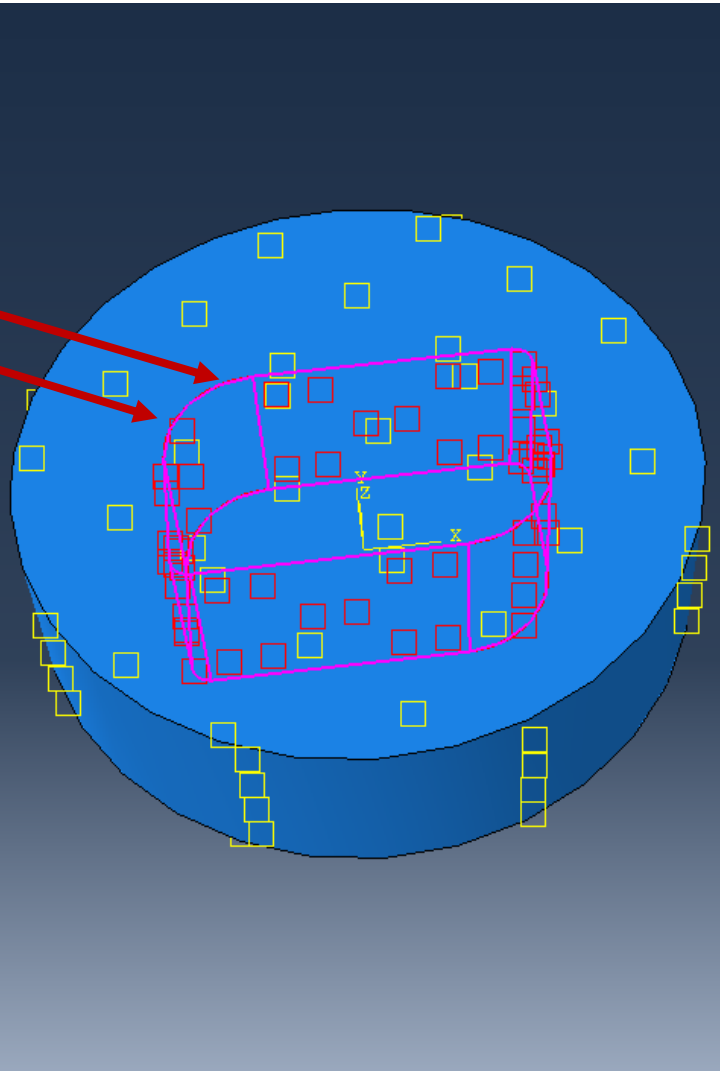
Contact interaction property: IntProp-1

Options: Interference Fit...

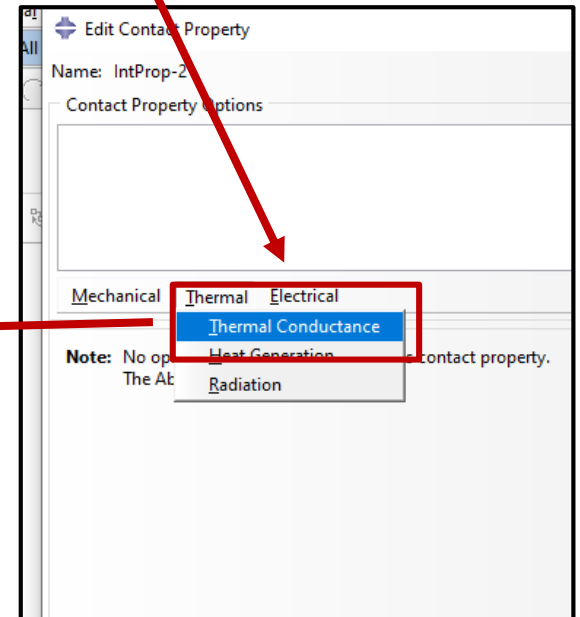
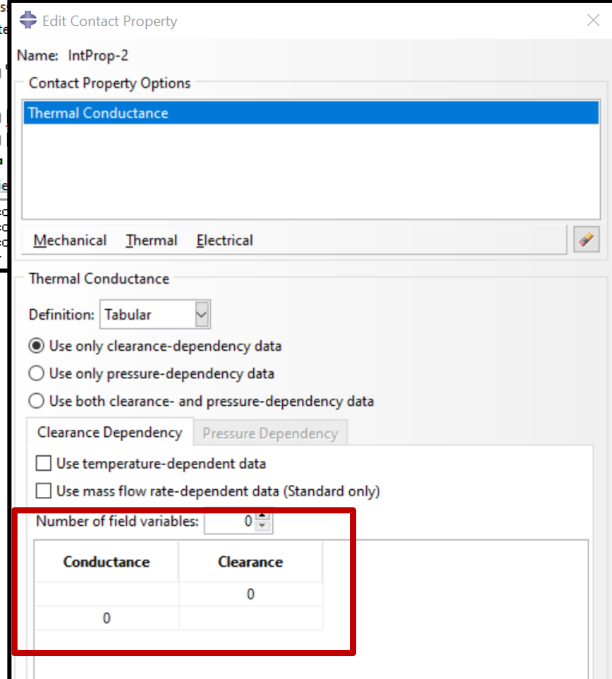
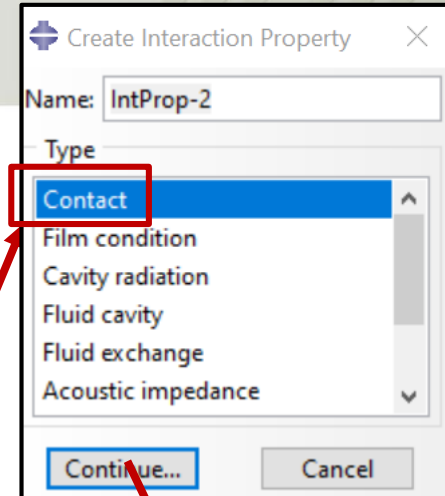
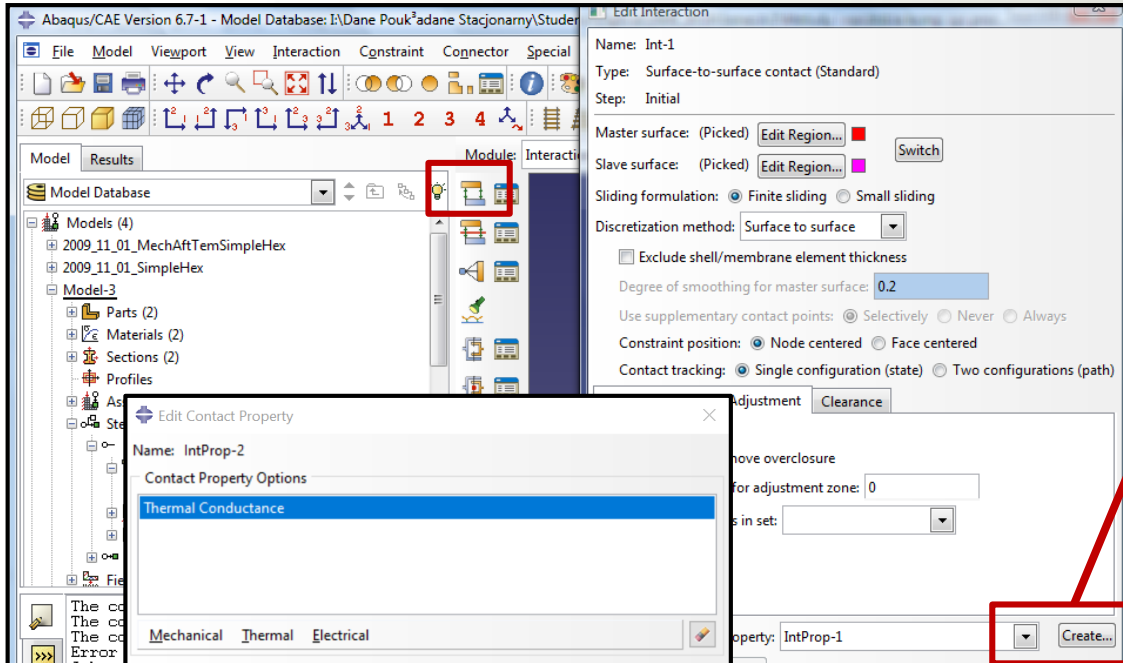
Contact controls: (Default)

Active in this step

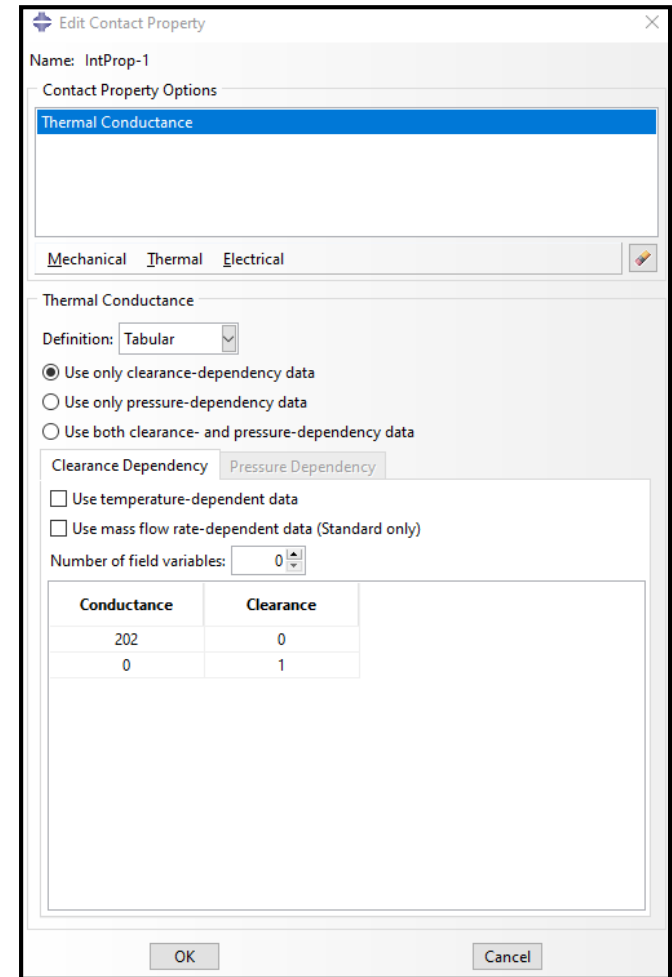
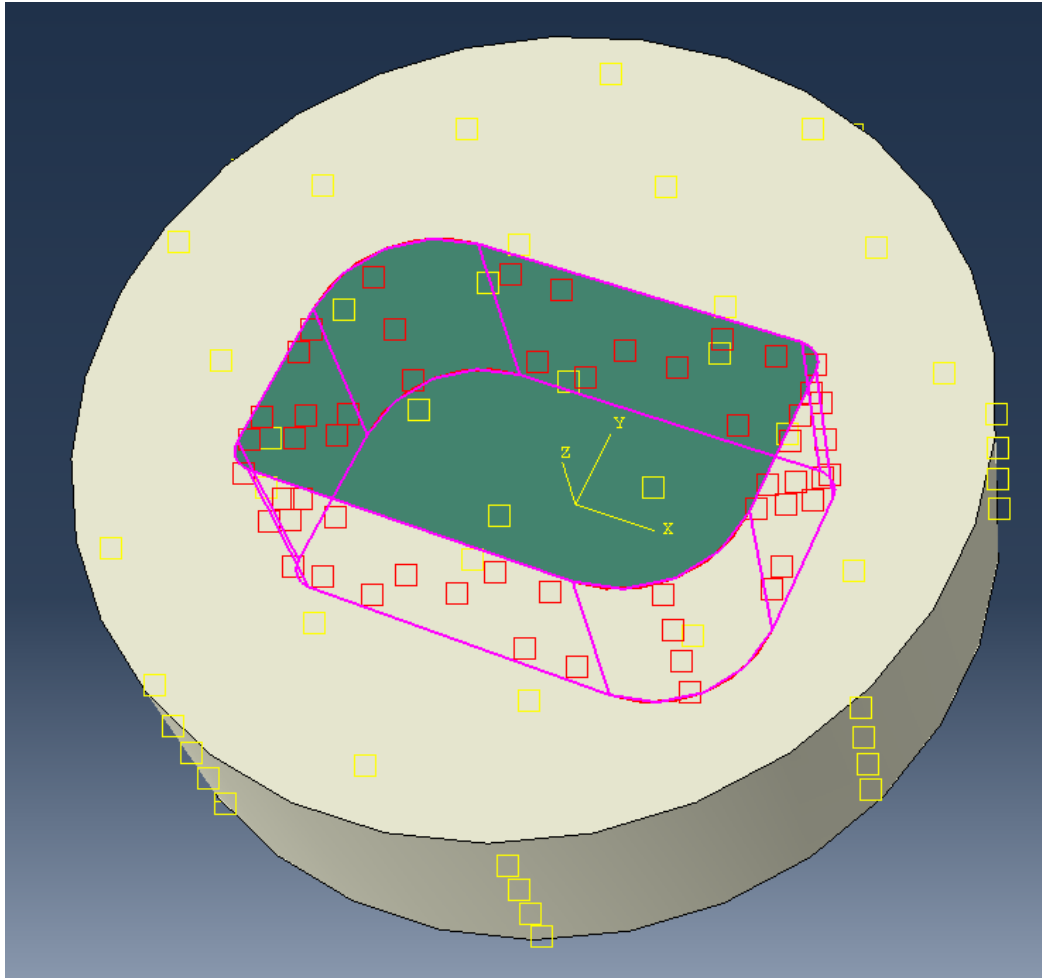
OK Cancel



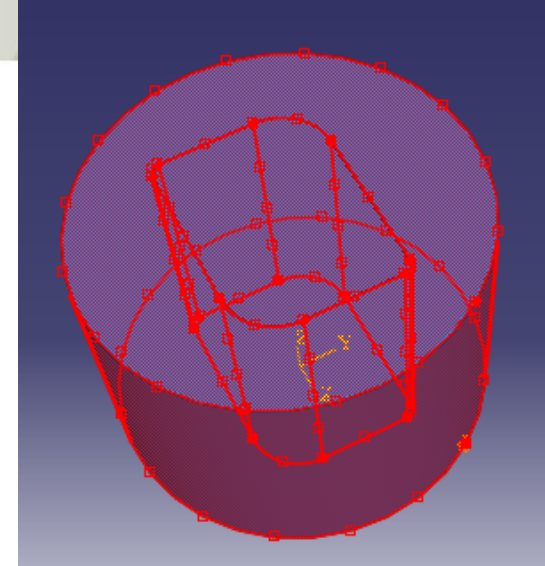
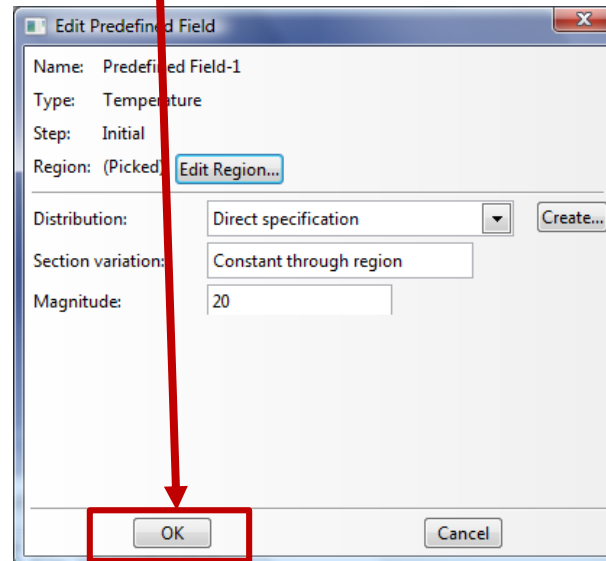
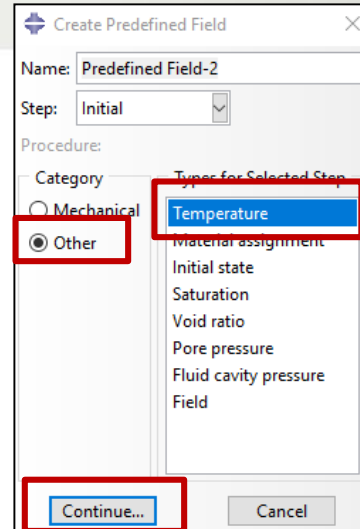
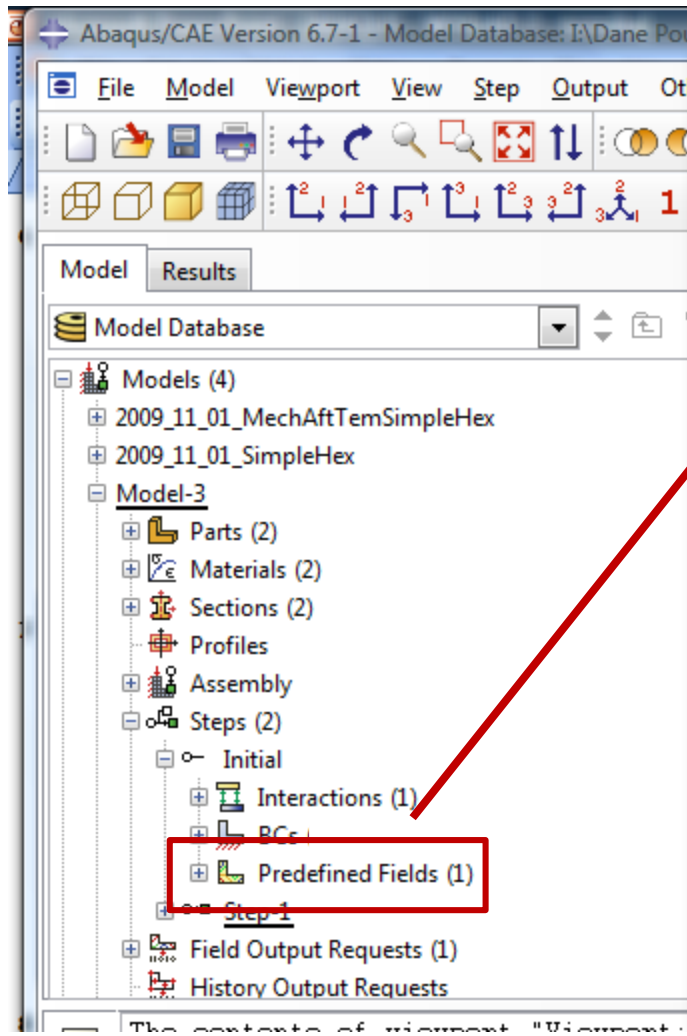
Contact definition



Interaction properties

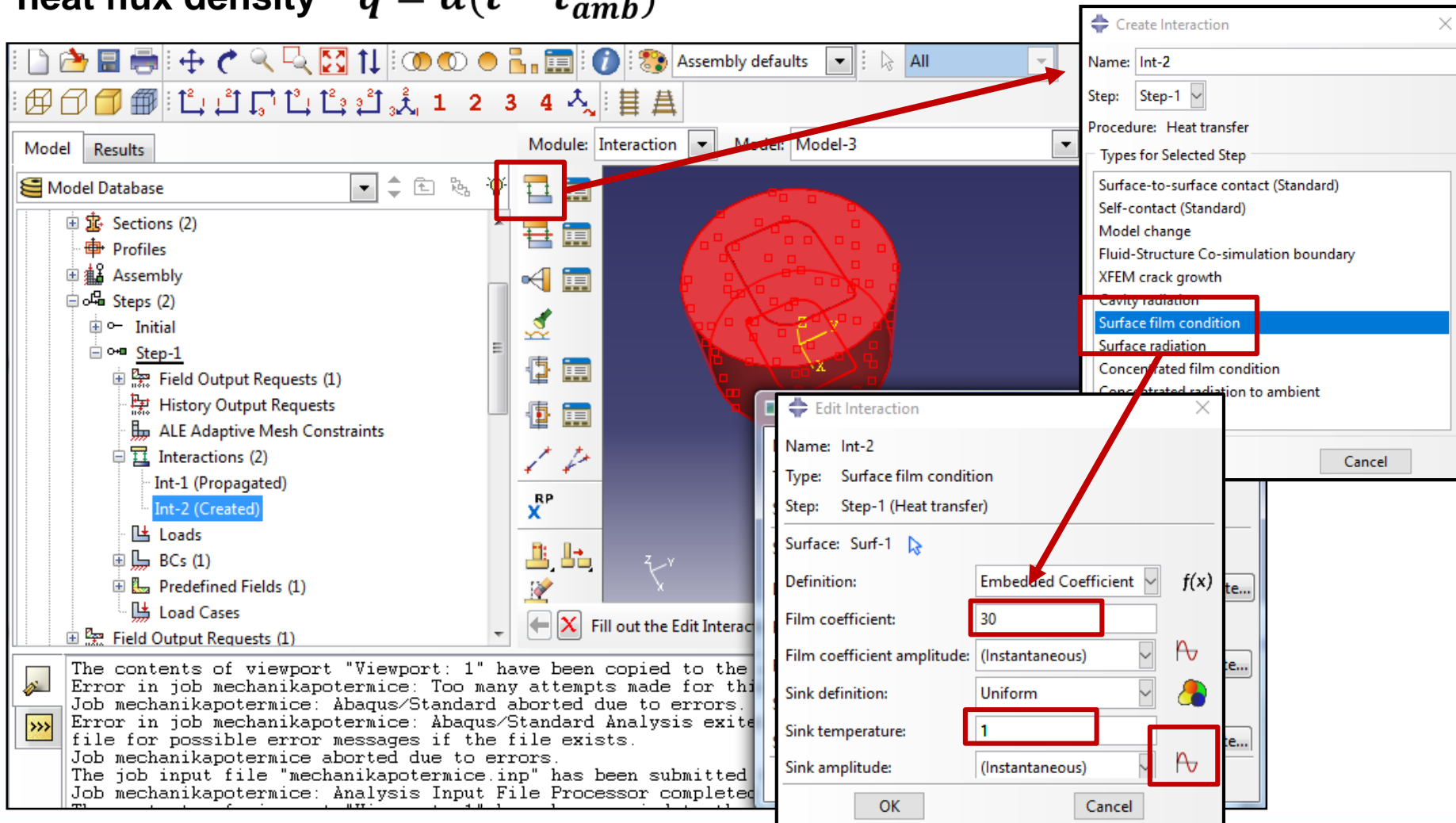


Predefined temperature



Boundary condition of convection

heat flux density $q = \alpha(t - t_{amb})$



The screenshot displays the Abaqus software interface for defining a boundary condition. The main window shows a 3D model of a red sphere with a yellow wireframe. The 'Model Database' on the left shows 'Int-2 (Created)' under 'Interactions (2)'. Two dialog boxes are open: 'Create Interaction' and 'Edit Interaction'.

The 'Create Interaction' dialog box shows the following settings:

- Name: Int-2
- Step: Step-1
- Procedure: Heat transfer
- Types for Selected Step:
 - Surface-to-surface contact (Standard)
 - Self-contact (Standard)
 - Model change
 - Fluid-Structure Co-simulation boundary
 - XFEM crack growth
 - Cavity radiation
 - Surface film condition** (highlighted)
 - Surface radiation
 - Concentrated film condition
 - Concentrated radiation to ambient

The 'Edit Interaction' dialog box shows the following settings:

- Name: Int-2
- Type: Surface film condition
- Step: Step-1 (Heat transfer)
- Surface: Surf-1
- Definition: Embedded Coefficient $f(x)$
- Film coefficient: 30
- Film coefficient amplitude: (Instantaneous)
- Sink definition: Uniform
- Sink temperature: 1
- Sink amplitude: (Instantaneous)

Red arrows indicate the flow of information from the software elements to the dialog boxes. A red box highlights the 'Surface film condition' option in the 'Create Interaction' dialog, and another red box highlights the 'Sink temperature' field in the 'Edit Interaction' dialog.

Outside temperature definition

Amplitude

Create Amplitude

Name: Amp-1

Type

- Tabular
- Equally spaced
- Periodic
- Modulated
- Decay
- Solution dependent
- Smooth step
- Actuator
- Spectrum
- User
- PSD Definition

Continue... Cancel

Edit Amplitude

Name: Amp-1

Type: Tabular

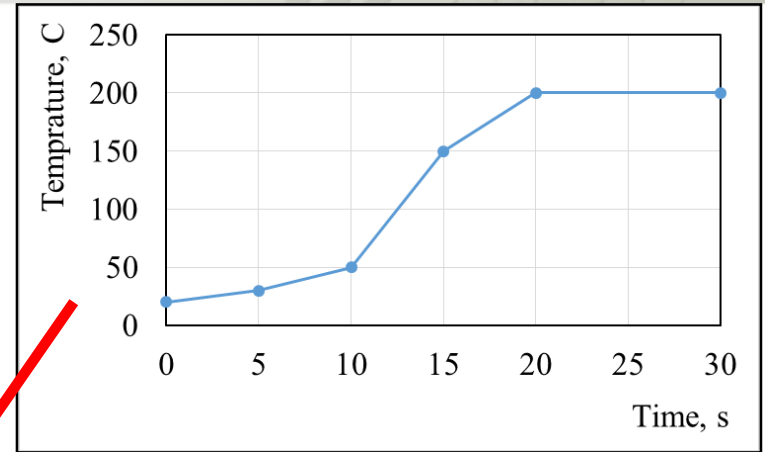
Time span: Step time

Smoothing: Use solver default
 Specify: []

Amplitude Data

	Time/Frequency	Amplitude
1	0	20
2	5	30
3	10	50
4	15	150
5	20	200
6	30	200

OK Cancel



Edit Interaction

Name: Int-2

Type: Surface film condition

Step: Step-1 (Heat transfer)

Surface: Surf-1

Definition: Embedded Coefficient $f(x)$

Film coefficient: 30

Film coefficient amplitude: (Instantaneous)

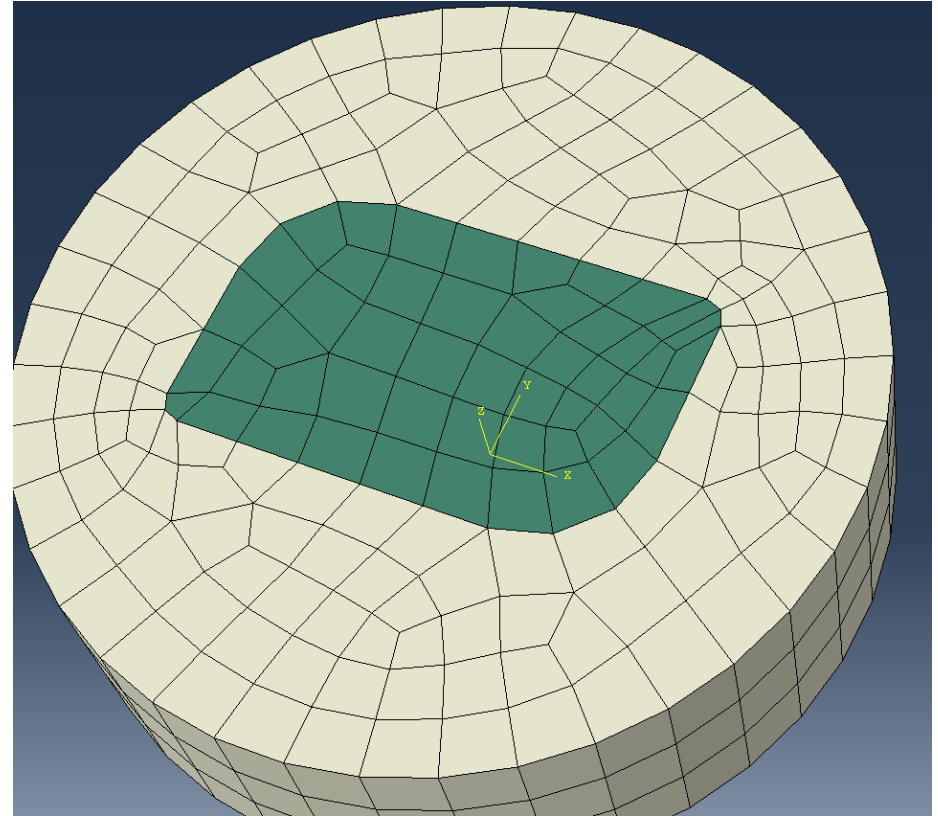
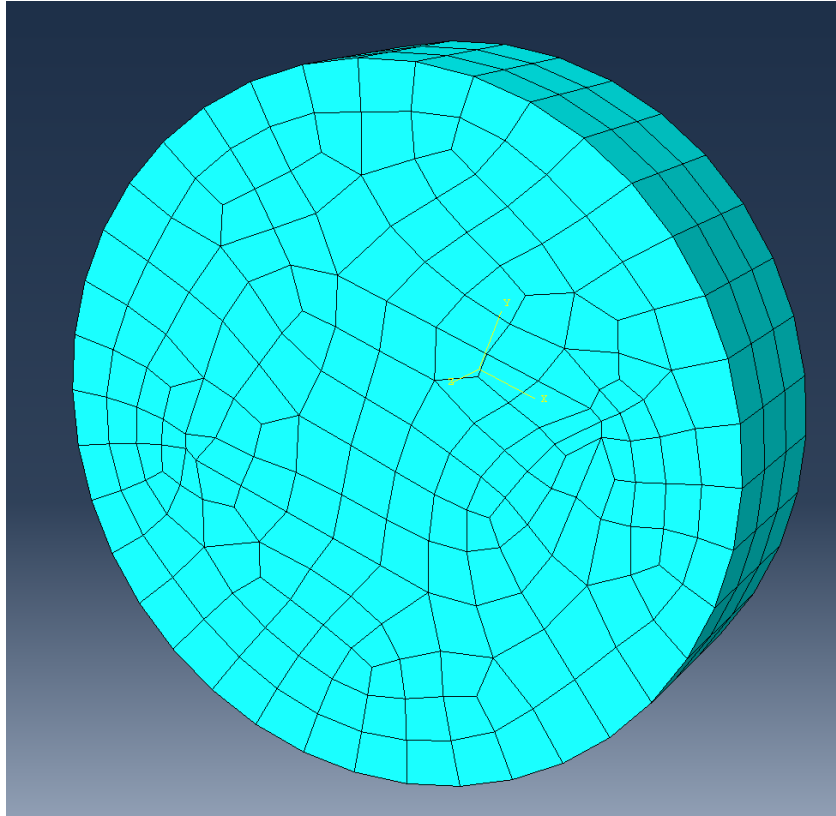
Sink definition: Uniform

Sink temperature: 1

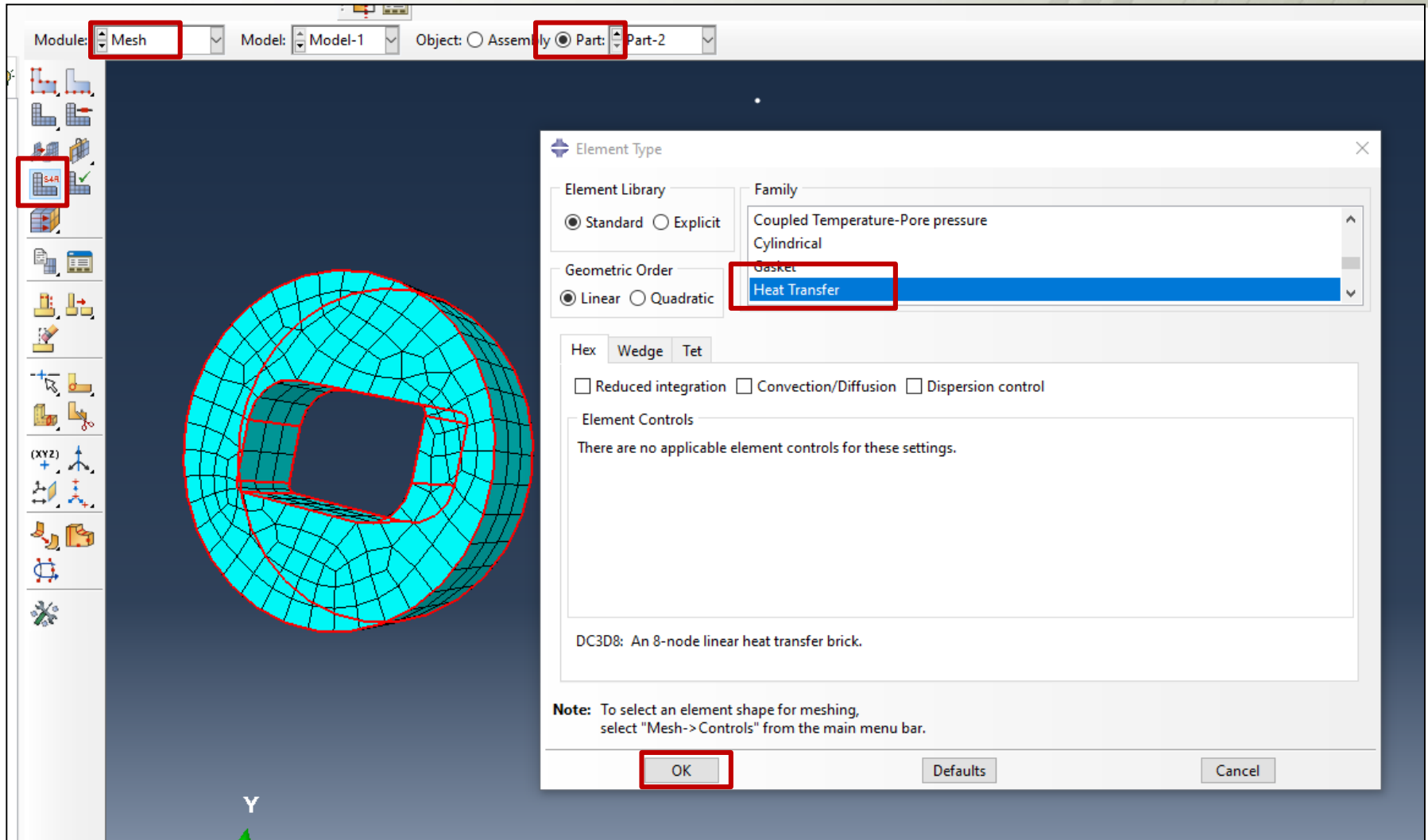
Sink amplitude: Amp-1

OK

FEM grid



FEM element type on part



The screenshot displays a software interface for selecting an FEM element type. The top bar shows the following settings:

- Module: Mesh
- Model: Model-1
- Object: Assembly Part: Part-2

The left sidebar contains a list of icons, with the 'S4R' icon highlighted. The main workspace shows a 3D model of a cylindrical part with a central hole, meshed with a cyan-colored brick element type.

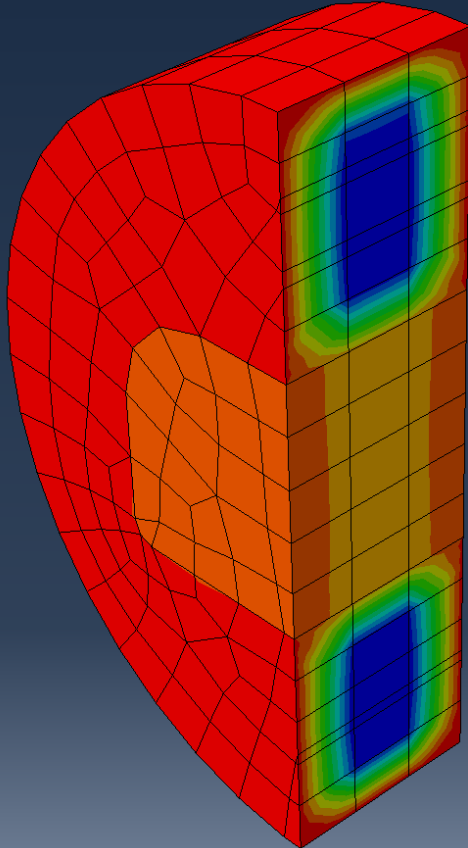
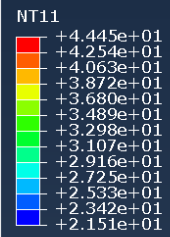
The 'Element Type' dialog box is open, showing the following configuration:

- Element Library: Standard Explicit
- Geometric Order: Linear Quadratic
- Family: Coupled Temperature-Pore pressure, Cylindrical, Gasket, **Heat Transfer**
- Hex Wedge Tet
- Reduced integration Convection/Diffusion Dispersion control
- Element Controls: There are no applicable element controls for these settings.
- DC3D8: An 8-node linear heat transfer brick.

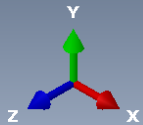
Note: To select an element shape for meshing, select "Mesh->Controls" from the main menu bar.

The 'OK' button is highlighted.

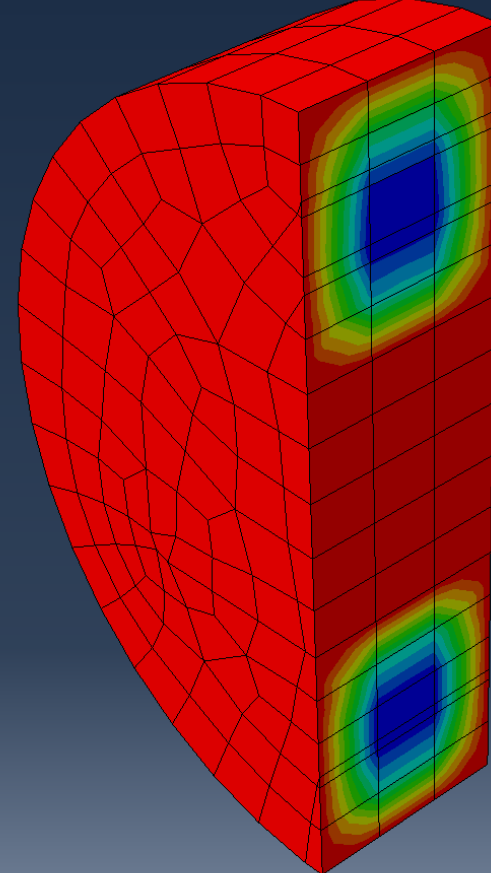
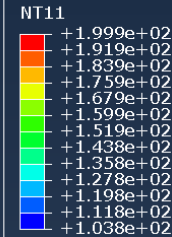
Results



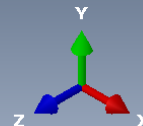
ODB: Job-1.odb Abaqus/Standard Learning Edition 2024



Step: Step-1
 Increment: 15; Step Time = 8.694
 Primary Var: NT11
 Deformed Var: not set Deformation Scale Factor: not set



ODB: Job-1.odb Abaqus/Standard Learning Edition 2024



Step: Step-1
 Increment: 60; Step Time = 50.71
 Primary Var: NT11
 Deformed Var: not set Deformation Scale Factor: not set