

ANSYS – Car Rear Window

Type of Problem: Thermal-Electrical

Type of Analysis: Static and Transient

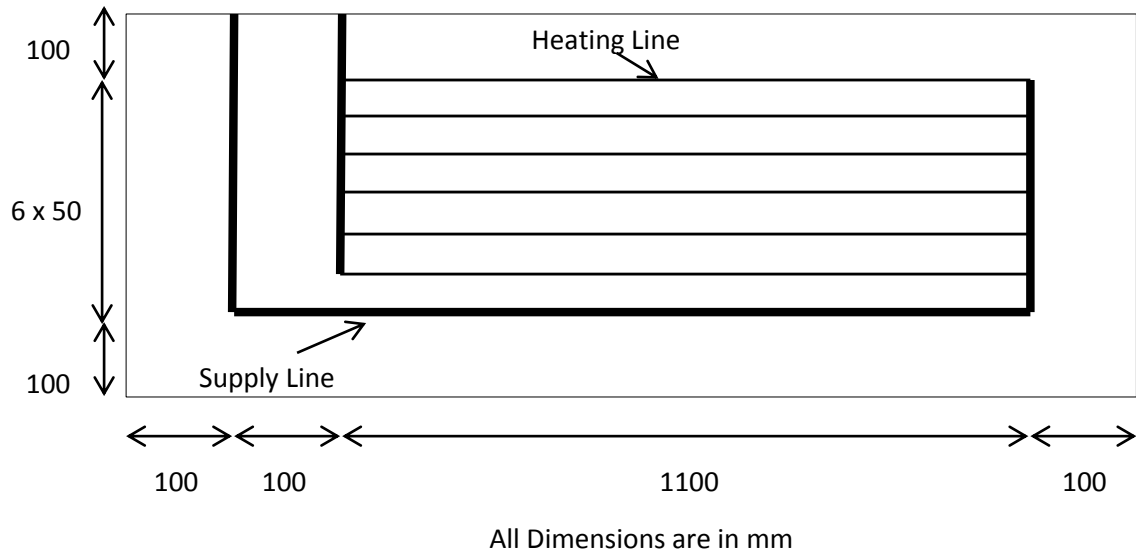
A heating wire is embedded into the glass of the rear window of a car. The position of the heating wire and of the supply line is shown on the sketch on page 2.

The two solutions we will determine are:

- Determine the maximum temperature change due to the heating wire.

- Determine the rate of change of temperature against time.

ANSYS – Car Rear Window



Data:

Rear Window

Overall Dimension	1400mm x 500mm
Glass Thickness	3mm
Thermal Conductivity	0.72 W/(mK)
Specific Heat	120 J/(kgK)
Density	2200 kg/m ³
Temperature of air	-8 C
Film Coefficient	10W/(m ² K)

Line

Supply Line Cross Sectional Area	5mm ²
Heating Line Cross Sectional Area	0.1mm ²
Voltage Output	6V
Voltage Input	12V
Material	Copper

Copper Properties

Specific Resistivity	0.15 Om2/m
Thermal Conductivity	380 W/(mK)
Specific Heat	120J / (kgK)
Density	6500 kg/m ³

ANSYS – Car Rear Window

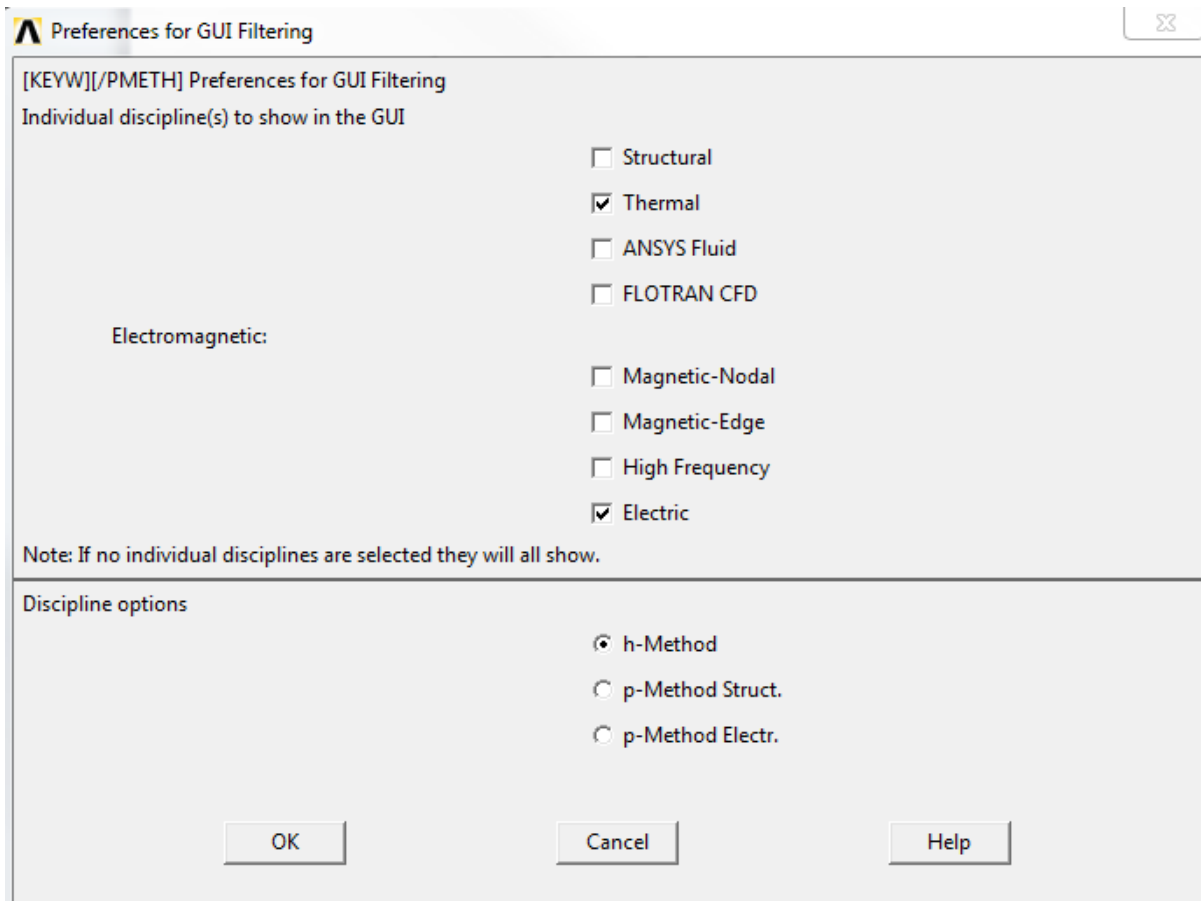
Step by Step Solution

Define Job-Name:

Menu Bar > File > Change Job-Name > Rear-Window > OK

Define Type of Calculation (In this case coupled Thermal-Electrical Calculation):

Main Menu > Preferences > Check Thermal > Check Electric > OK



Select Element Types:

Main Menu > Preprocessor > Element Type > Add/Edit/Delete > Add >
Thermal Mass > Shell > 3D 4node 57 > Apply

Main Menu > Preprocessor > Element Type > Add/Edit/Delete > Add >
Coupled Field > 3D Line 68 > OK > Close

ANSYS – Car Rear Window

Add Real Constants:

Main Menu > Preprocessor > Real Constants > Add/Edit/Delete > Add
 Now add 3 Sets with the following data

Set	Type	Value
1	Type 1 Shell 57	0.003 (thickness of windshield)
2	Type 2 Link 68	5.0e-6 (cross section of wire 1)
3	Type 2 Link 68	0.1e-6 (cross section of wire 2)

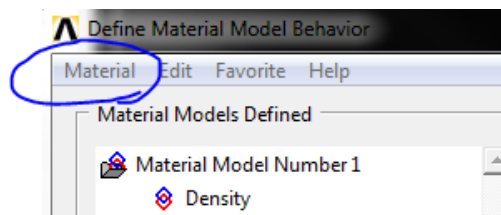
Define Material Data:

Main > Preprocessor > Material Props > Material Models > Select Material
 Model Number 1

For the Glass

Thermal > Conductivity > Isotropic	KXX	0.72
Density	DENS	2200
Specific Heat	C	120

Select *Material* in the Define Material Model Behaviour Window and Select *New Material*



For the Wire

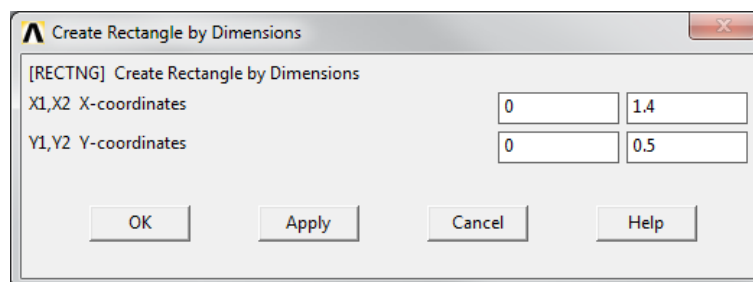
Thermal > Conductivity > Isotropic	KXX	380
Density	DENS	6500
Specific Heat	C	120
Electromagnetics>Resistivity>Constant	RSVX	0.15e-6

Material > Exit

Generate Geometry:

Main Menu > Preprocessor > Modelling > Create > Areas >
 Rectangle > By Dimensions:

Area 1: 0 1.4
 0 0.5 ok



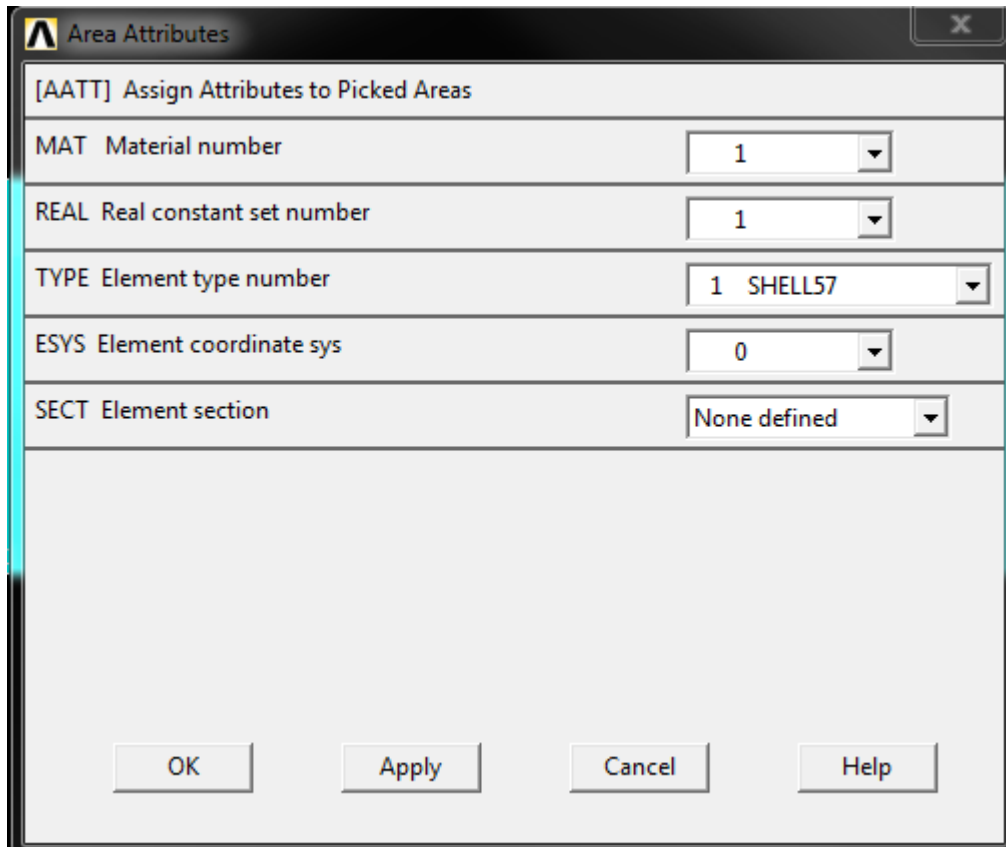
ANSYS – Car Rear Window

Assign Element Type, Real Constant Set and Material Data to area:

Main Menu > Preprocessor > Meshing > Mesh Attributes > Picked Areas >
Select the Rectangle > OK

Area Attributes:	
Material	1
Real Constant Set	1
Element Type	1

As Below:



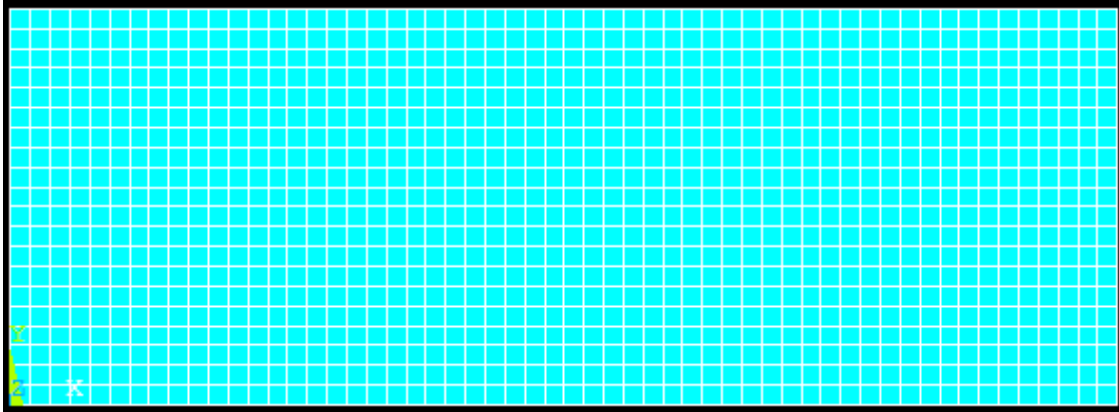
Choose Element Size:

Main Menu > Preprocessor > Meshing > Size Cntrls > Manual Size >
Global > Size > Set SIZE as 0.025 > OK

ANSYS – Car Rear Window

Create Elements and Nodes on geometry:

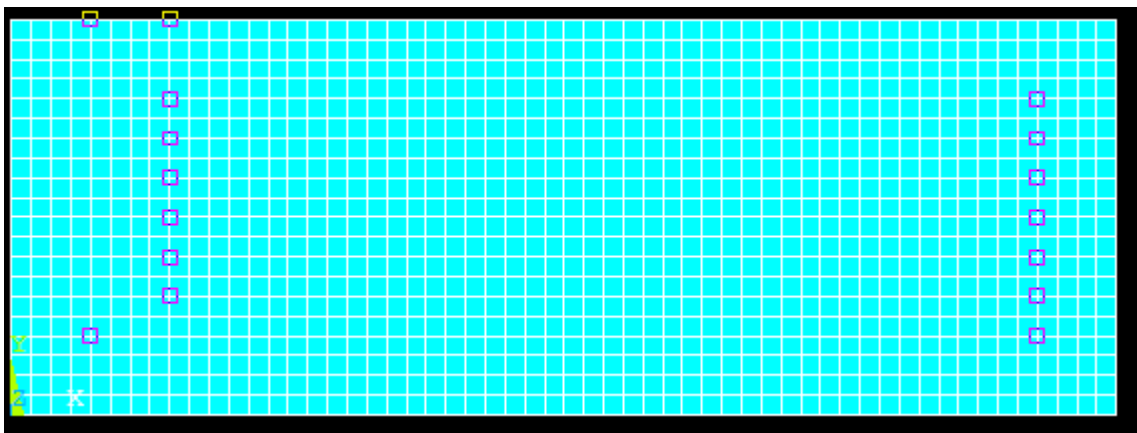
Main Menu > Preprocessor > Meshing > Mesh > Areas > Mapped > 3 to 4 sided > Pick all



Generate Heating Wire:

Main Menu > Preprocessor > Modelling > Create > Keypoints > On Working Plane

Select the Keypoints that define the copper heating wire. We set previously each little cube as being 25mm. I.e 4 squares is 100mm. Press OK.

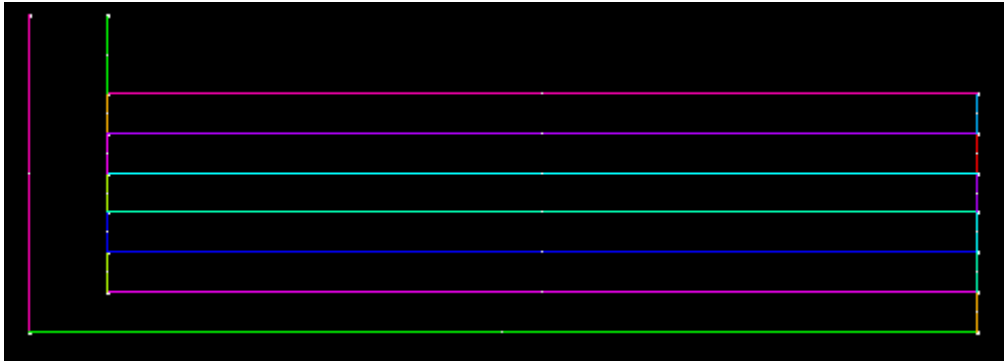


Menu Bar> Plot > Keypoints > Keypoints

Main Menu > Preprocessor > Create > Lines> Lines>Straight Line >Pick Keypoints to draw wireframe.

IMPORTANT!: Make sure each line connects each keypoint. You should have a rainbow effect of colors as in the pic below.

ANSYS – Car Rear Window

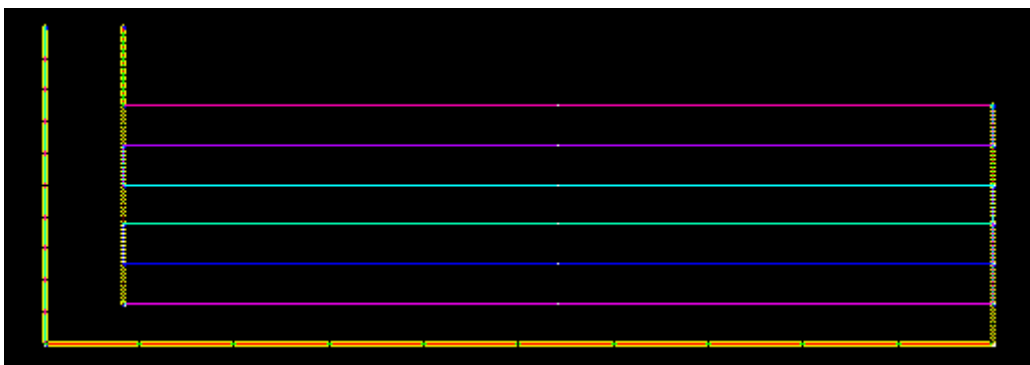


Assign Element Type, Real Constant Set and Material Data to area:

Main Menu > Preprocessor > Meshing > Mesh Attributes > Picked Lines > Pick all the Supply lines > OK

Area Attributes:	
Material	2
Real Constant Set	2
Element Type	2

As Below:



Assign Element Type, Real Constant Set and Material Data to area:

Main Menu > Preprocessor > Meshing > Mesh Attributes > Picked Lines > Pick all the Heating Lines > OK

Area Attributes:	
Material	2
Real Constant Set	3
Element Type	2

Mesh Copper Wire:

Main Menu > Preprocessor > Meshing > Mesh > Lines

Pick ONLY the Supply and Heating Lines

ANSYS – Car Rear Window

Couple Glass and Wire:

Main Menu > Preprocessor > NumberingCtrls > Merge Items > Nodes > OK

Define Loads:

Main Menu > Preprocessor > Loads > Define Loads > Apply > Thermal > Convection > On Areas > Select Window Area

Apply CONV on Areas:	
VALI Film Coefficient	10
VAL2I Bulk Temperature	-8

Menu Bar > plot > Lines

Main Menu > Preprocessor > Loads > Define Loads > Apply > Electric > Boundary > Voltage > On Keypoints

Select Supply Line	
Input Line	12V
Output Line	6V

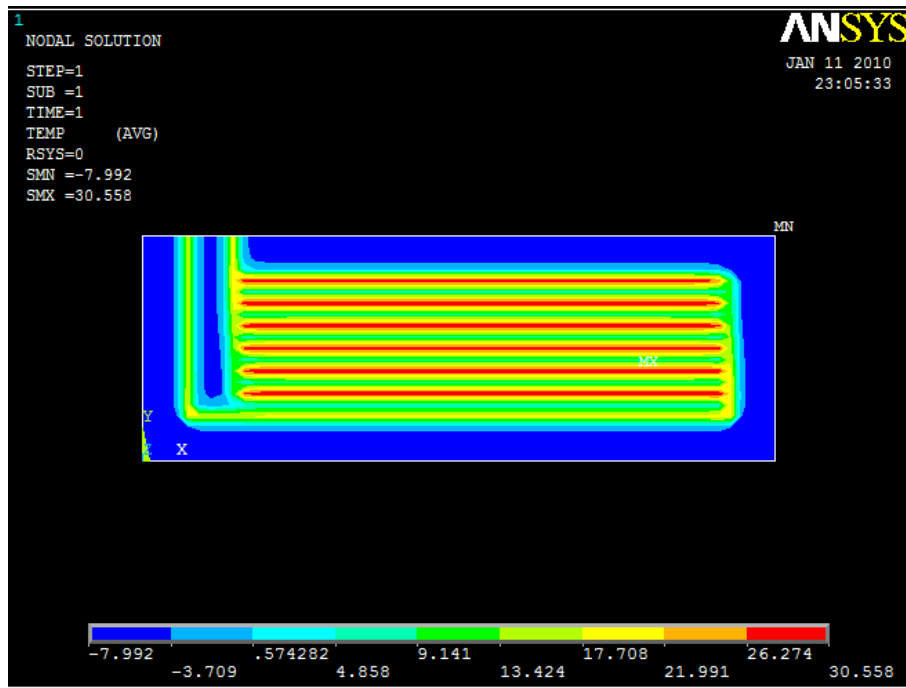
Static Analysis

Main Menu > Solution > Analysis Type > New Analysis > Steady State

Main Menu > Solution > Solve > Current LS

Plot Results:

Main Menu > General Postproc > Plot Results > Contour Plot > Nodal Solution > DOF Solution > Temperature



ANSYS – Car Rear Window

Transient Analysis

Main Menu > Solution > Analysis Type > New Analysis > Transient
Main Menu > Solution > Load Step Opts > Output Ctrl > DB/Results File >
Every Substep > OK
Main Menu > Solution > Load Step Opts > Time/Frequency > Time and Substeps

TIME	Time at end of load step	240
NSUBST	Number of Substeps	20
KBC	Stepped or ramped b.c.	Stepped
AUTOTS	Automatic Time Stepping	OFF

Main Menu > Solution > Define Loads > Apply > Initial Conditions >
Define > Pick All Nodes > TEMP -8

Main Menu > Solution > Solve > Current LS
Main Menu > General Postproc > Read Results > First Set
Main Menu > General Postproc > Plot Results > Contour Plot > Nodal Solution
> DOF Solution > Temperature
Main Menu > General Postproc > Read Results > Next Set
Main Menu > TimeHist Postpro (Close window that pops u) > Define Variables > Add

Select Nodal DOF Results > Pick a node on the heating wire > Select temperature
TEMP

Pick a node between the heating wires

Select Temperature TEMP

Main Menu > TimeHistPostpro > Graph Variables > NVAR1 2 > NVAR2

