Name: Arjun Posarajah

UWin: Posaraj@uwindsor.ca

Signature: AP

UNIVERSITY OF WINDSOR

Faculty of Engineering

Heat Transfer – MECH 3228

Heat Transfer COMSOL Assignment 2

Due date: July 2nd, 2021

Q 1. A metal alloy structure (k = 17 W/m·K) has a length of 5.3 cm, a perimeter of 11 cm, and a cross-sectional area of 5.13 cm^2. The structure is exposed to hot gas from the combustion chamber at 973°C with a convection heat transfer coefficient of 538 $W/m^2 \cdot K$. The base of the structure maintains a constant temperature of 450°C. Determine the heat transfer rate to the metal structure and temperature at the tip by performing two COMSOL simulations:
Simulation 1: rectangular shape, 1.19x4.31 cm
Simulation 2: circular shape with diameter given by the hydraulic diameter (i.e. D = 4A/p)

Tasks and deliverables:

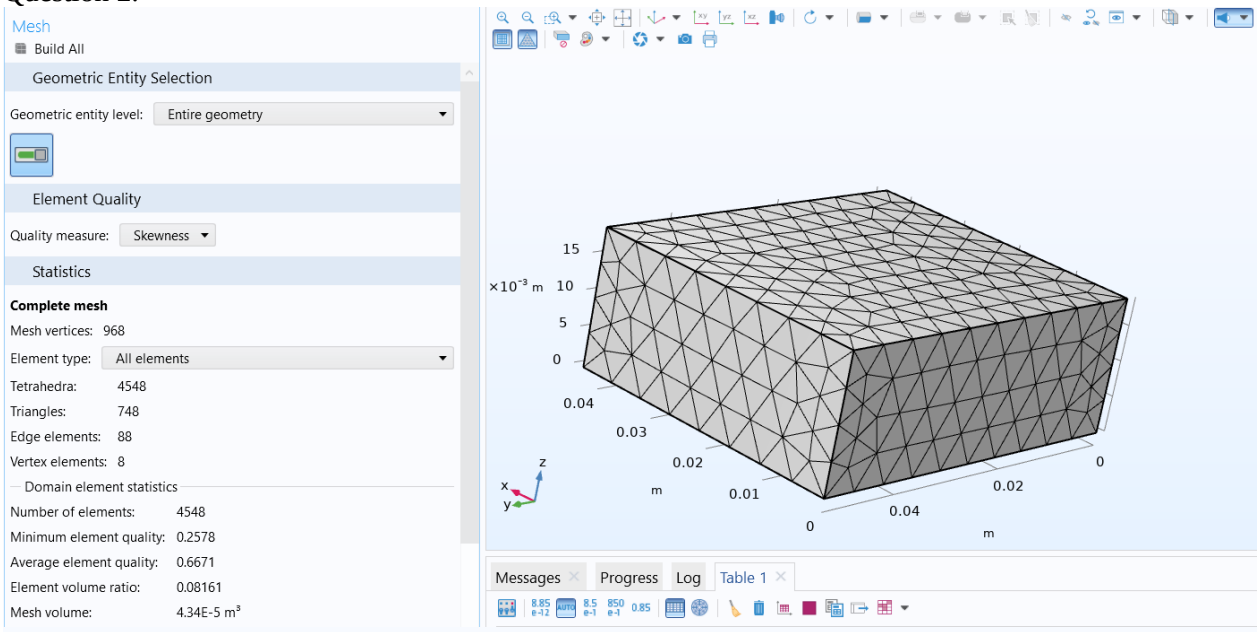
1. Compare your answer with the answer obtained in the tutorial. Are the results different? If yes, discuss what could be the reason.
2. Provide a screenshot of your mesh and mesh information (i.e. Quads; Edge elements; Vertex elements; and Domain element statistics)
3. Provide a screenshot of your results in COMSOL
    a. Temperature distribution within the structure
    b. Results: Normal conductive heat flux; Heat Transfer rate; Inner surface temperature
4. Provide a screenshot of your entire COMSOL window containing your results with the Study being visible

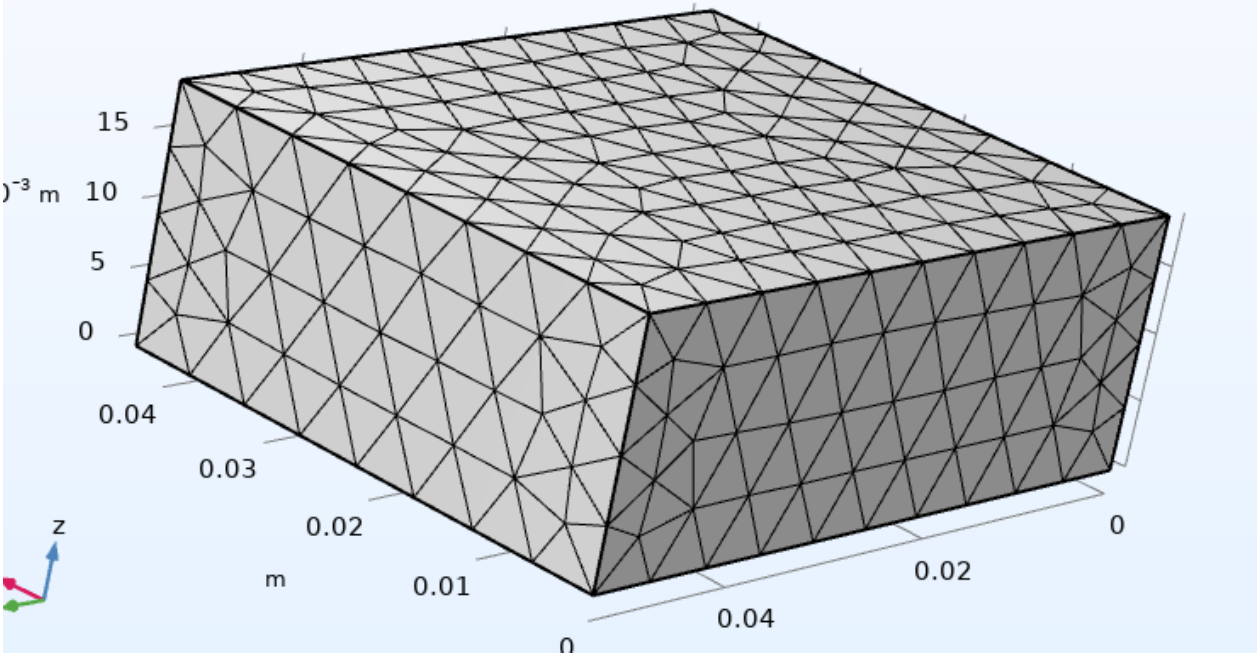
Analysis:

Question 1:

My values compared to the tutorial solutions were different. For my rectangular fin tip, I got 5.71E5 W/m^2 for normal conductive heat flux, 293.02 W for heat transfer rate, and 1200 K (926degC) for the inner surface temperature. For the cylinder fin the normal conductive heat flux is 4.198E5 W/m^2, the heat transfer rate is 215.36W and the inner surface temperature was 918.79degC. The tutorial results were 370.1W for heat transfer and 960degC for the inner surface temperature. The reason for this big of a difference could possible be due to different shapes however the surface area of the heat transfer technically should be the same. A more plausible reason is because there was no actual material provided except for the thermal properties of the metal and gas applied, so I had chosen High strength alloy steel for my rectangular fin simulation and structural steel for my cylinder fin simulation. This is most likely the reason for the discrepancies between all 3 solutions.

Question 2:


Mesh
Build All
Geometric Entity Selection
Geometric entity level: Entire geometry
Element Quality
Quality measure: Skewness
Statistics
Complete mesh
Mesh vertices: 968
Element type: All elements
Tetrahedra: 4548
Triangles: 748
Edge elements: 88
Vertex elements: 8
Domain element statistics
Number of elements: 4548
Minimum element quality: 0.2578
Average element quality: 0.6671
Element volume ratio: 0.08161
Mesh volume: 4.34E-5 m³
×10⁻³ m
15
10
5
0
0.04
0.03
0.02
0.01
0
m
0.02
0.04
z
x
y
Messages
Progress
Log
Table 1


15
10
5
0
0.04
0.03
0.02
0.01
0
m
0.02
0.04
z

Mesh

Build All

Geometric Entity Selection

Geometric entity level: Entire geometry

Element Quality

Quality measure: Skewness

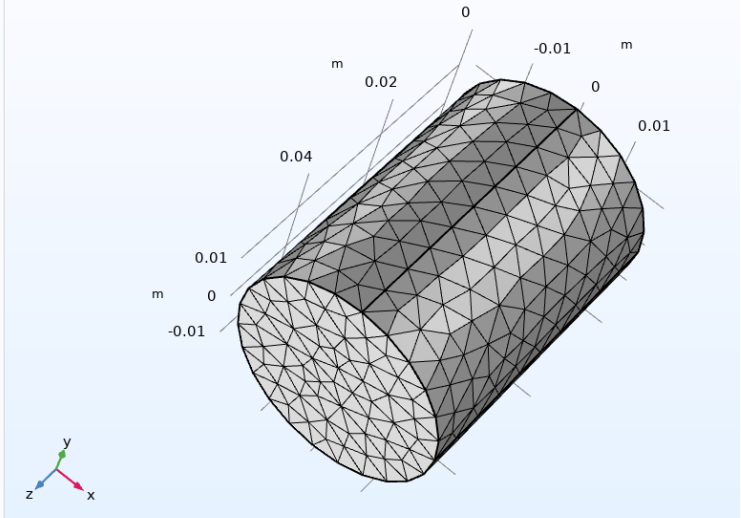
Statistics

Complete mesh

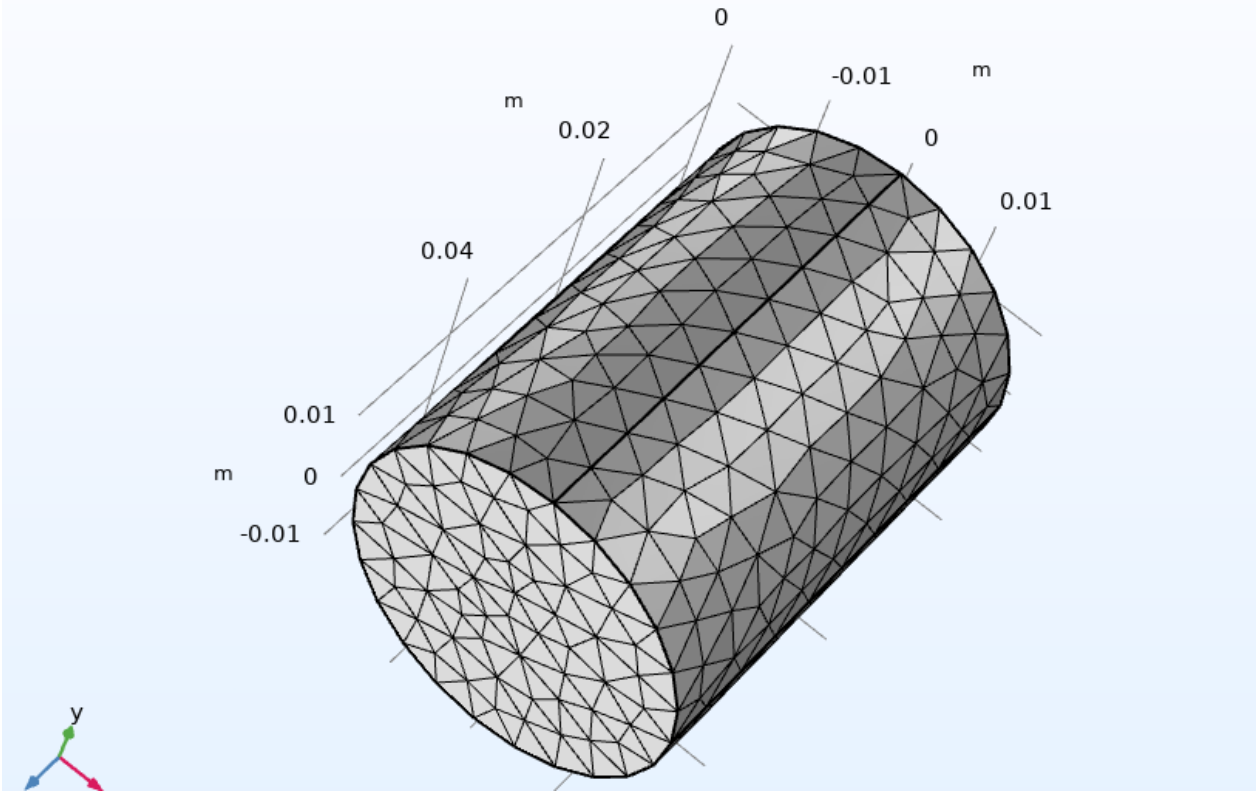
Mesh vertices:	1302
Element type:	All elements
Tetrahedra:	6401
Triangles:	852
Edge elements:	88
Vertex elements:	8

Domain element statistics

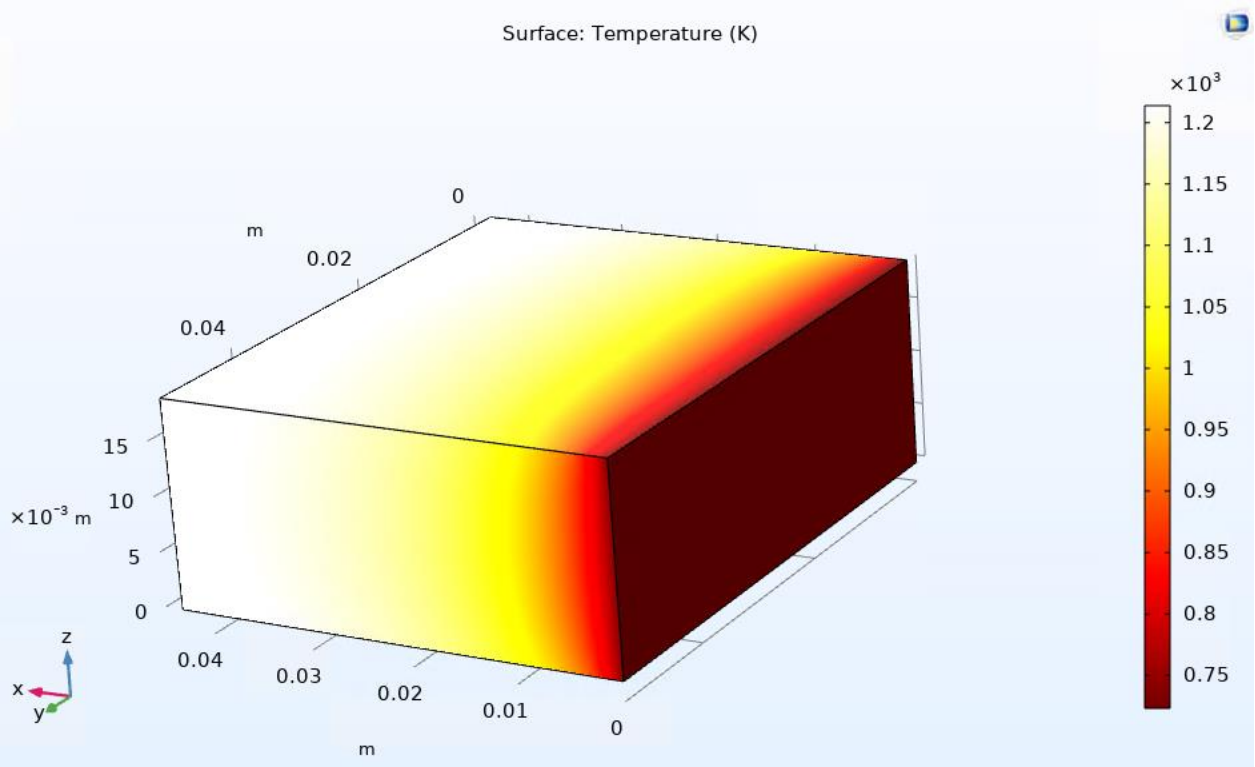
Number of elements:	6401
Minimum element quality:	0.286
Average element quality:	0.6712
Element volume ratio:	0.1053
Mesh volume:	5.744E-5 m³

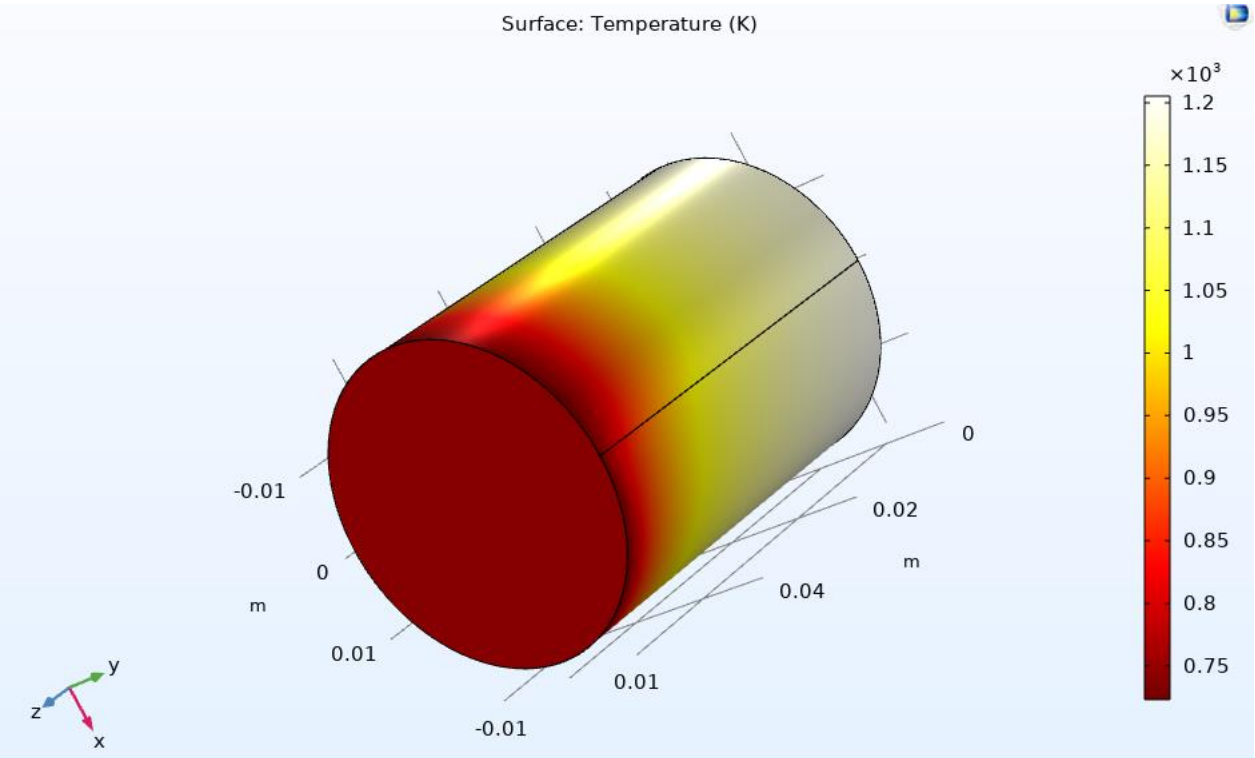


Messages | Progress | Log | Table 1



Question 3:
PART A:





PARTB:

Rectangular Fin:

Messages | Progress | Log | Table 2

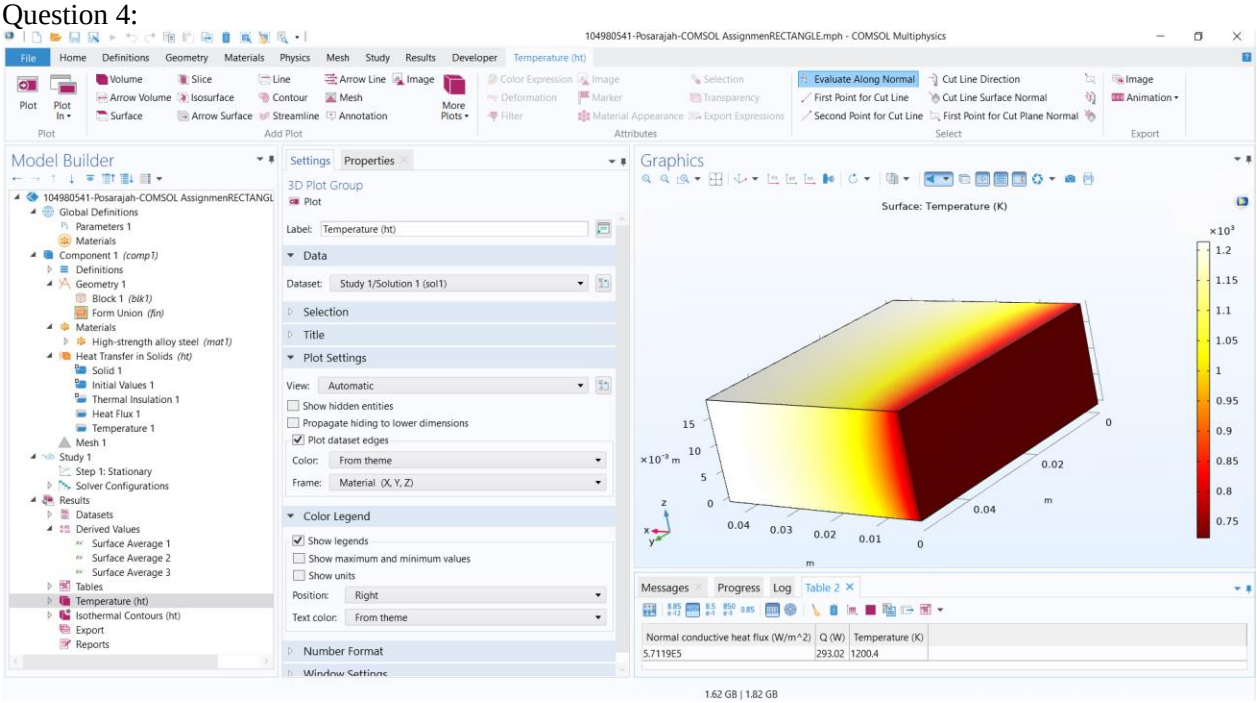
Normal conductive heat flux (W/m^2)	Q (W)	Temperature (K)
5.7119E5	293.02	1200.4

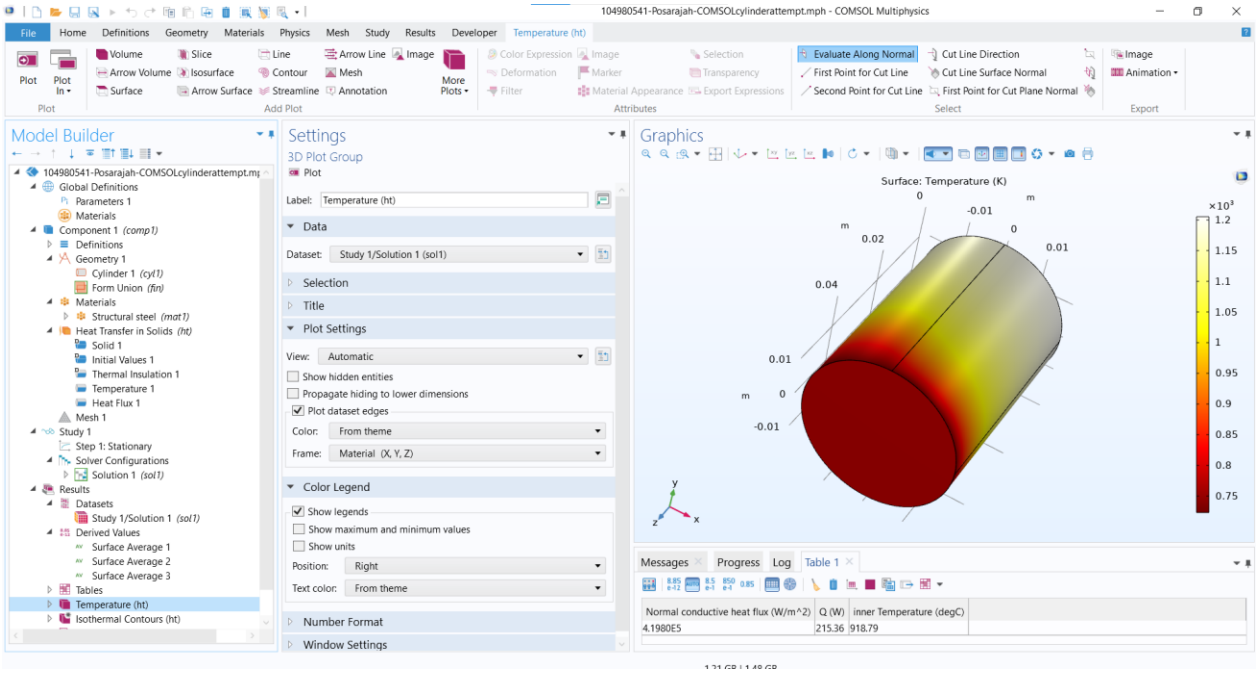
Cylinder:

Messages | Progress | Log | Table 1

Normal conductive heat flux (W/m^2)	Q (W)	inner Temperature (degC)
4.1980E5	215.36	918.79

Question 4:




104980541-Posarajah-COMSOLcylinderattempt.mph - COMSOL Multiphysics
File
Home
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Developer
Temperature (ht)
Model Builder
Settings
3D Plot Group
Plot
Label: Temperature (ht)
Data
Dataset: Study 1/Solution 1 (sol1)
Selection
Title
Plot Settings
View: Automatic
Show hidden entities
Propagate hiding to lower dimensions
Plot dataset edges
Color: From theme
Frame: Material (X, Y, Z)
Color Legend
Show legends
Show maximum and minimum values
Show units
Position: Right
Text color: From theme
Number Format
Window Settings
Graphics
Surface: Temperature (K)
×10³
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
Messages
Progress
Log
Table 1
Normal conductive heat flux (W/m^2)
Q (W)
inner Temperature (degC)
4.1980E5
215.36
918.79