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UNIVERSITY OF WINDSOR

Faculty of Engineering

Heat Transfer – MECH 3228

Heat Transfer COMSOL Assignment 3

Due date: July 9th, 2021

Q 1. Oil flow in a journal bearing can be treated as parallel flow between two large plates with one moving at a constant velocity of 12 m/s and the other stationary. Consider such a flow with a uniform spacing of 0.7 mm between the plates. The temperatures of the upper and lower plates are 40°C and 15°C, respectively. Determine:

- Velocity and temperature distributions in the oil
- Maximum temperature and where it occurs
- The heat flux from the oil to each plates

Tasks and deliverables:

1. Compare your answer with the answer obtained during the lecture. 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

Problem 1:

The results from class were 103degC for the inner surface temperature. The heat flux at temperature L is 5.71E4 W/m. The values I received when simulating on COMSOL is 313.15K for the inner max temperature, a heat transfer value of 0.03625W and normal conductive heat flux magnitude of 5178.6W/m^2. The reasoning for my numbers being off is due to no specific material being provided so I had guessed transformer oil, instead of engine oil. In the material properties I had input all the values I could, but the specific heat ratio was not possible to find as I could not find Cv online anywhere to find the ratio between Cp and Cv. Other than that, within my actual COMSOL file all the steps and constraints were applied to run the simulation however due to the material properties I think this is the reason why my solution differed from the example provided in class.

Problem 2:

Mesh

Build All

Element Quality

Quality measure: Skewness

Statistics

Complete mesh

Mesh vertices: 6808

Element type: All elements

Triangles: 11322

Quads: 816

Edge elements: 660

Vertex elements: 4

Domain element statistics

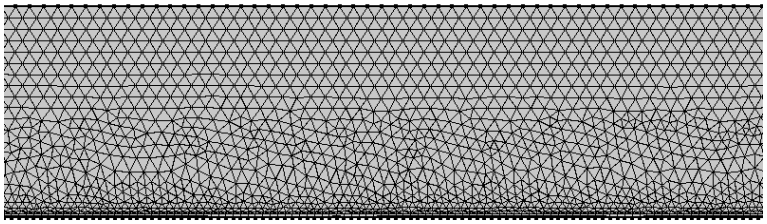
Number of elements: 12138

Minimum element quality: 0.3001

Average element quality: 0.8359

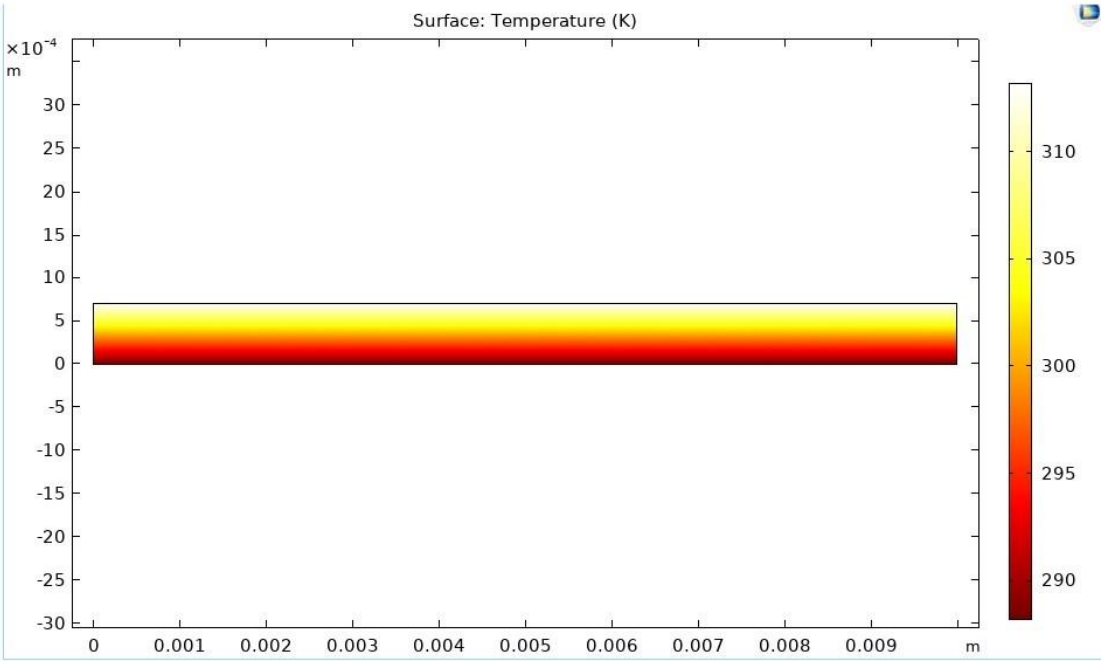
Element area ratio: 0.05478

Mesh area: 7.0E-6 m²

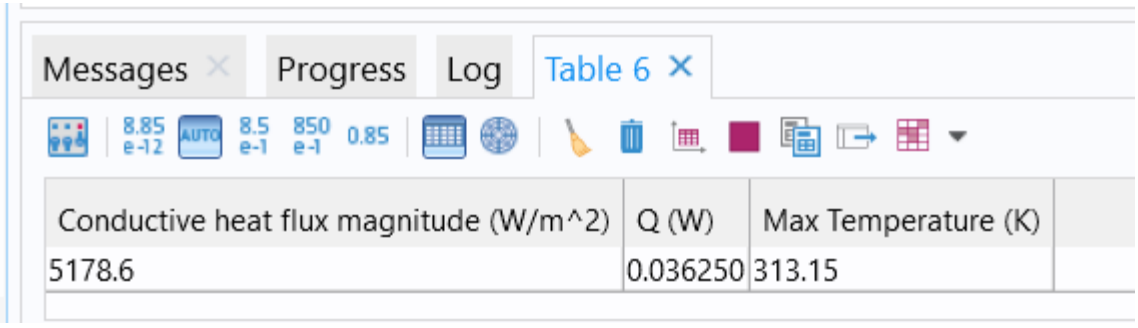


Problem 3:

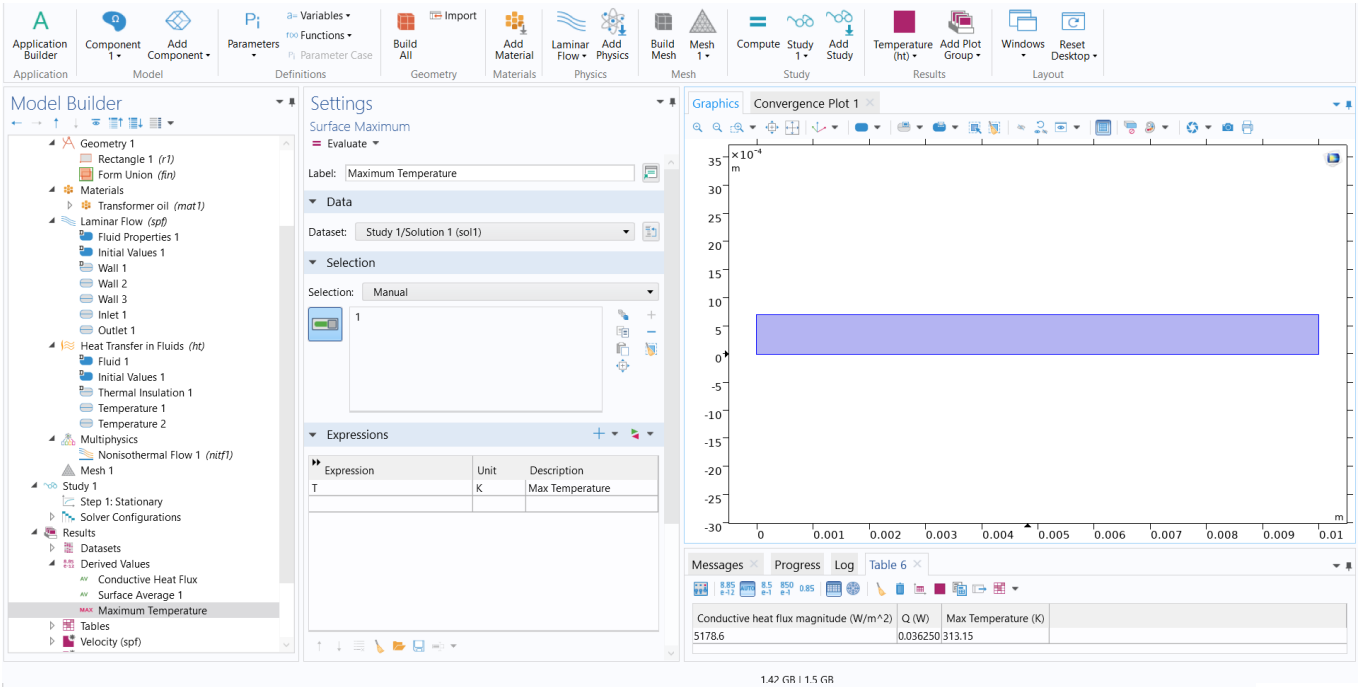
A)

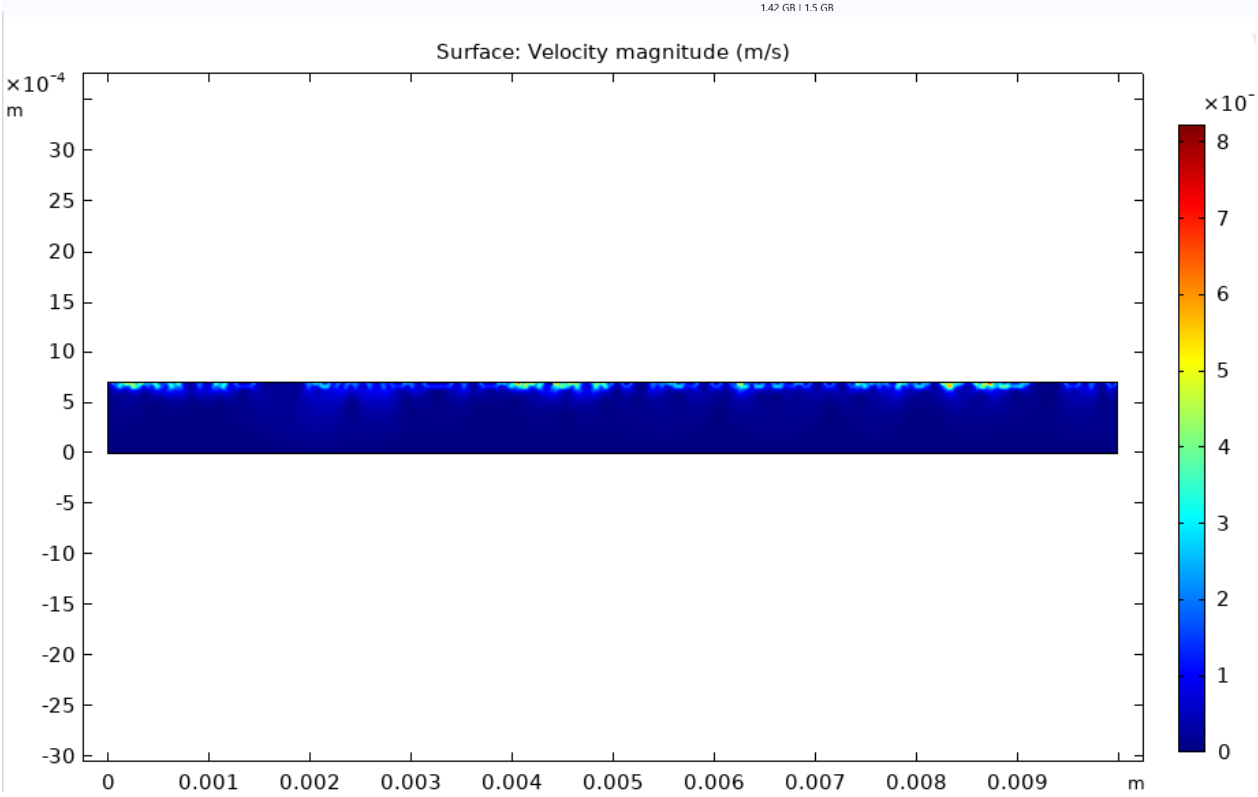

Surface: Temperature (K)
×10⁻⁴
m
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
m
310
305
300
295
290

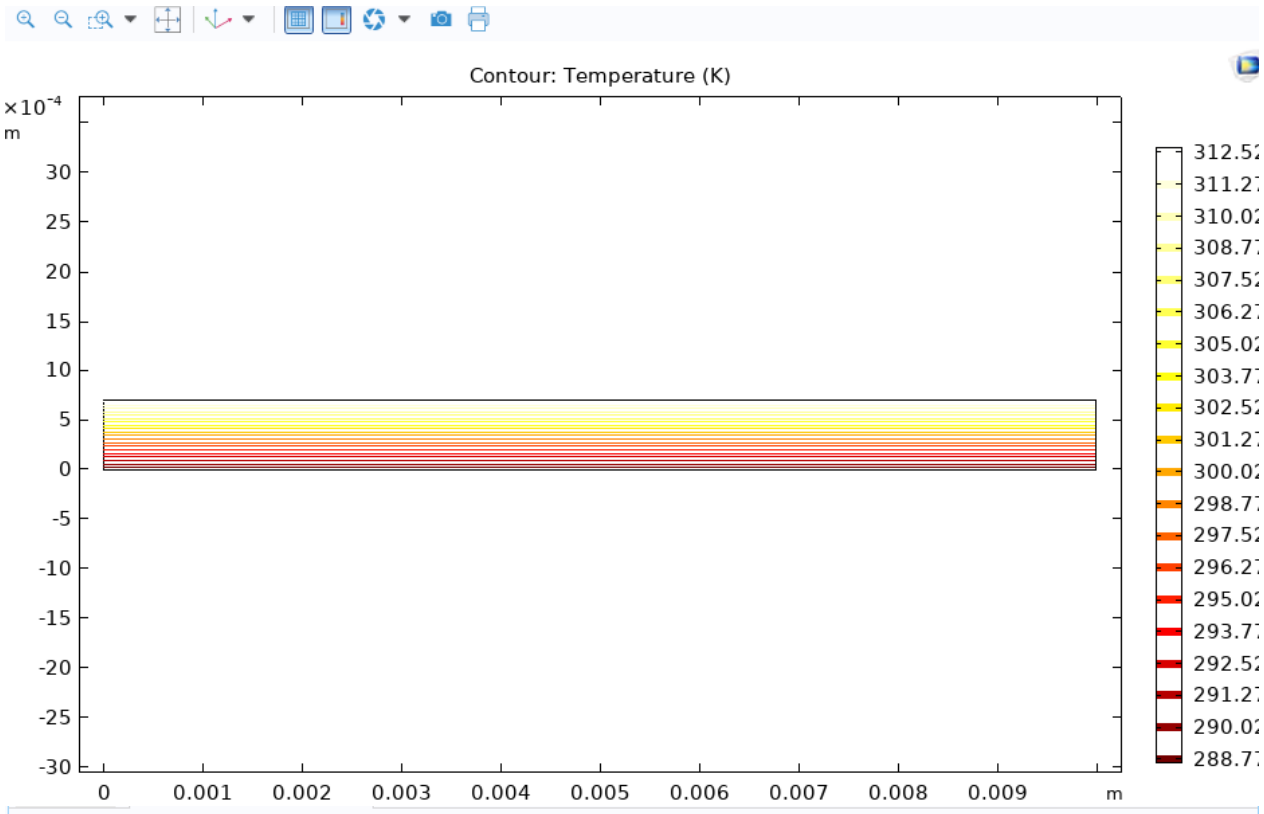
B)

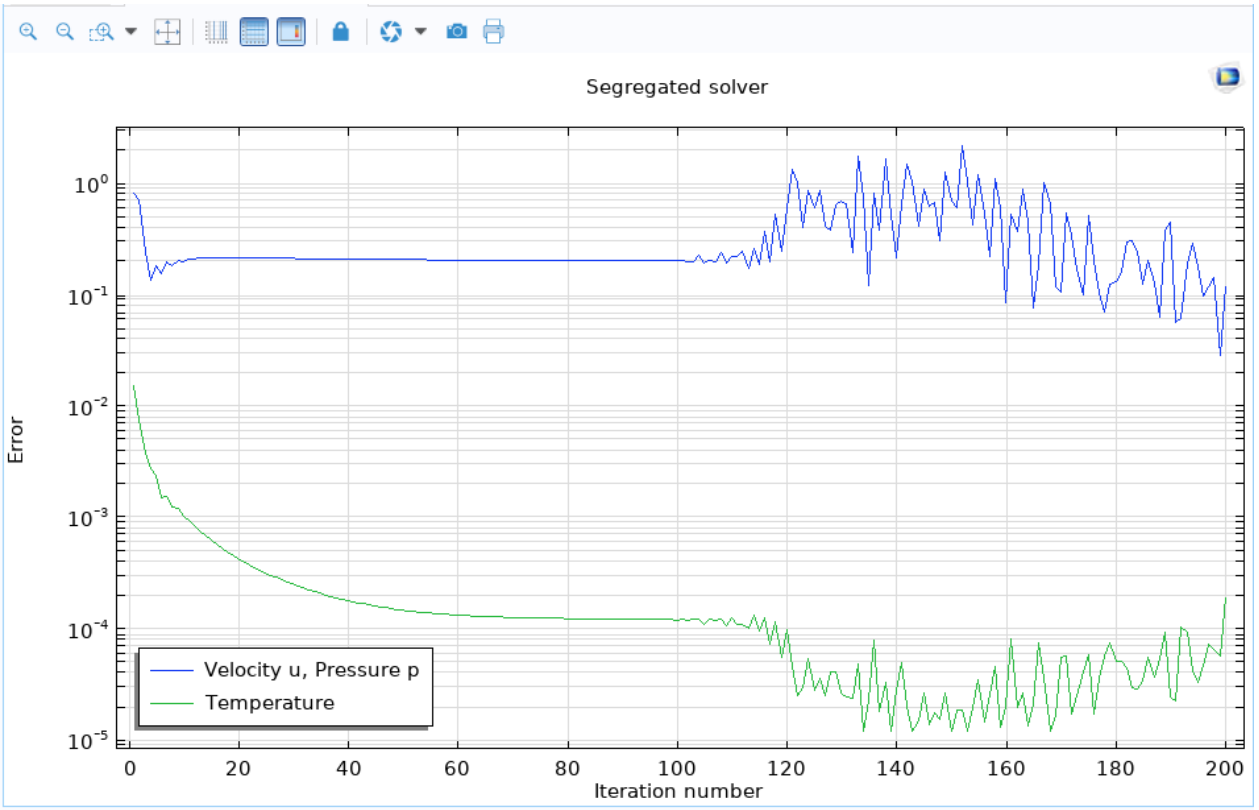

Messages
Progress
Log
Table 6
8.85 e-12
AUTO
8.5 e-1
850 e-1
0.85
Conductive heat flux magnitude (W/m^2)
Q (W)
Max Temperature (K)
5178.6
0.036250
313.15

Problem 4:


Application Builder
Component 1
Add Component
Parameters
Variables
Functions
Parameter Case
Build All
Import
Add Material
Laminar Flow
Add Physics
Build Mesh
Mesh 1
Compute
Study 1
Add Study
Temperature (ht)
Add Plot Group
Windows
Reset Desktop
Application
Model
Definitions
Geometry
Materials
Physics
Mesh
Study
Results
Layout
Model Builder
Geometry 1
Rectangle 1 (r1)
Form Union (fin)
Materials
Transformer oil (mat1)
Laminar Flow (spf)
Fluid Properties 1
Initial Values 1
Wall 1
Wall 2
Wall 3
Inlet 1
Outlet 1
Heat Transfer in Fluids (ht)
Fluid 1
Initial Values 1
Thermal Insulation 1
Temperature 1
Temperature 2
Multiphysics
Nonisothermal Flow 1 (nitf1)
Mesh 1
Study 1
Step 1: Stationary
Solver Configurations
Results
Datasets
Derived Values
Conductive Heat Flux
Surface Average 1
Maximum Temperature
Tables
Velocity (spf)
Settings
Surface Maximum
Evaluate
Label: Maximum Temperature
Data
Dataset: Study 1/Solution 1 (sol1)
Selection
Selection: Manual
Expressions
Expression
Unit
Description
T
K
Max Temperature
Graphics
Convergence Plot 1
Messages
Progress
Log
Table 6
Conductive heat flux magnitude (W/m^2)
Q (W)
Max Temperature (K)
5178.6
0.036250
313.15
1.42 GB | 1.5 GB


Surface: Velocity magnitude (m/s)
×10⁻⁴
m
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
m
×10⁻
8
7
6
5
4
3
2
1
0


Contour: Temperature (K)
×10⁻⁴
m
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
0.009
m
312.5
311.2
310.0
308.7
307.5
306.2
305.0
303.7
302.5
301.2
300.0
298.7
297.5
296.2
295.0
293.7
292.5
291.2
290.0
288.7


Segregated solver
Error
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0
20
40
60
80
100
120
140
160
180
200
Iteration number
Velocity u, Pressure p
Temperature