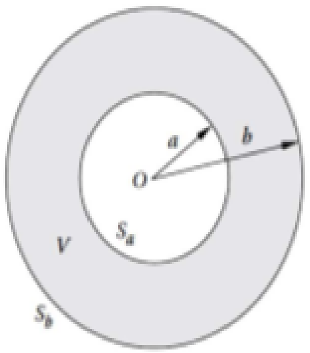
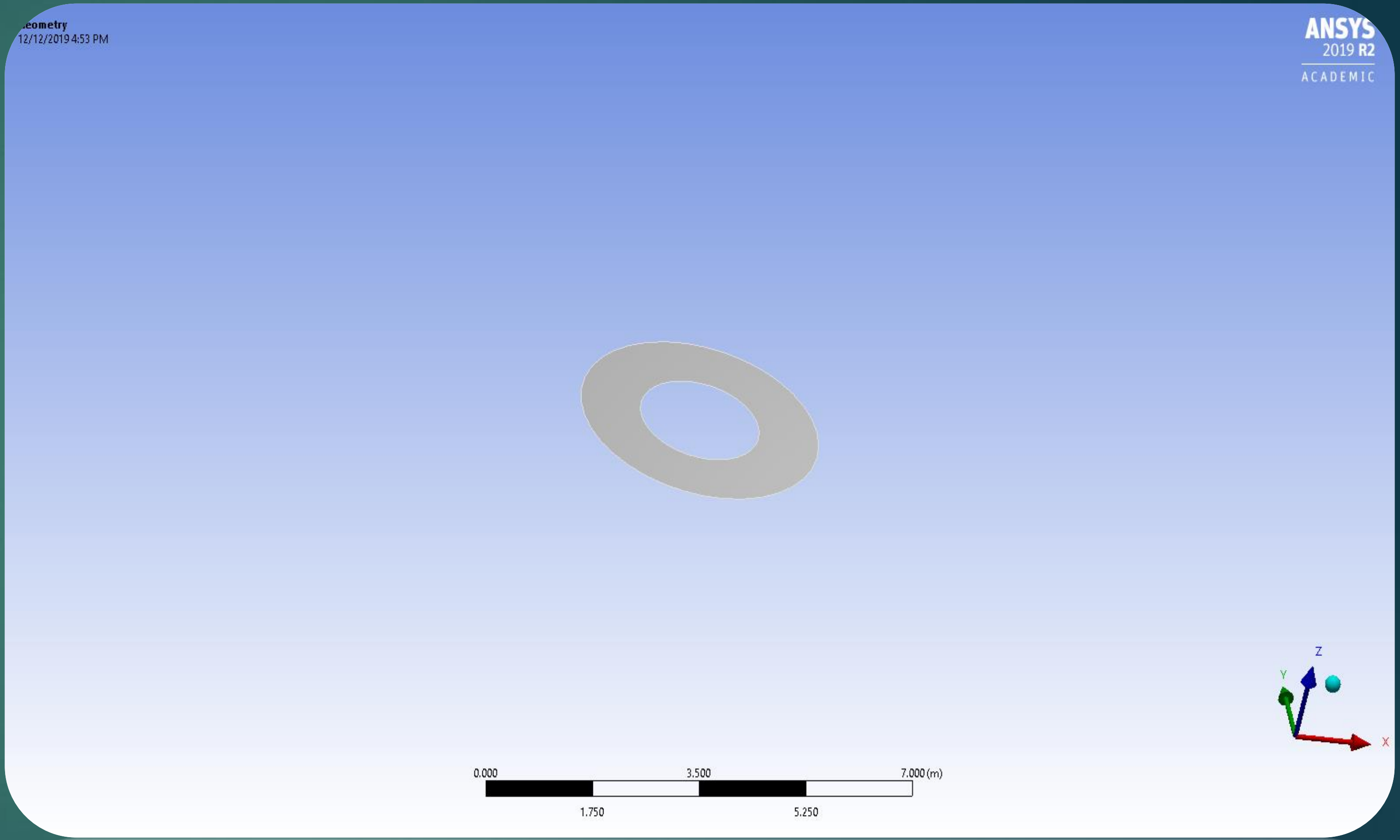
Q1

Problem -1

Study the heat conduction problem in a simple annular region shown below, using the FEA. Assume a = 1 m, b = 2 m, Ta = 100°C, and heat flux Qb = 200 W/m2. Using structural steel with thermal conductivity k = 60.5 W/(m°C) for the region, determine the temperature field and heat flux in this region.



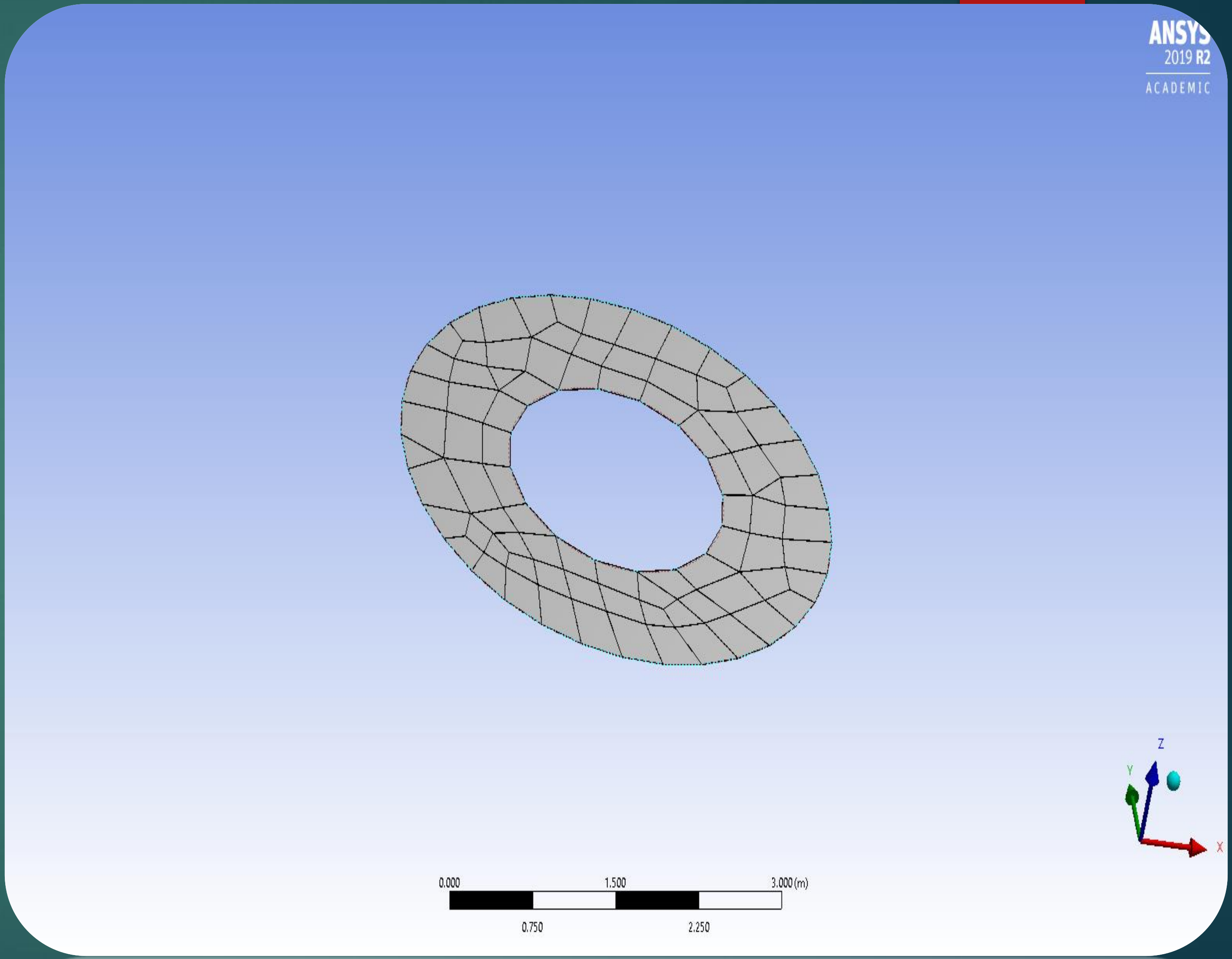
Geometry


eometry
12/12/2019 4:53 PM
ANSYS
2019 R2
ACADEMIC
0.000
3.500
7.000 (m)
1.750
5.250
Z
Y
X

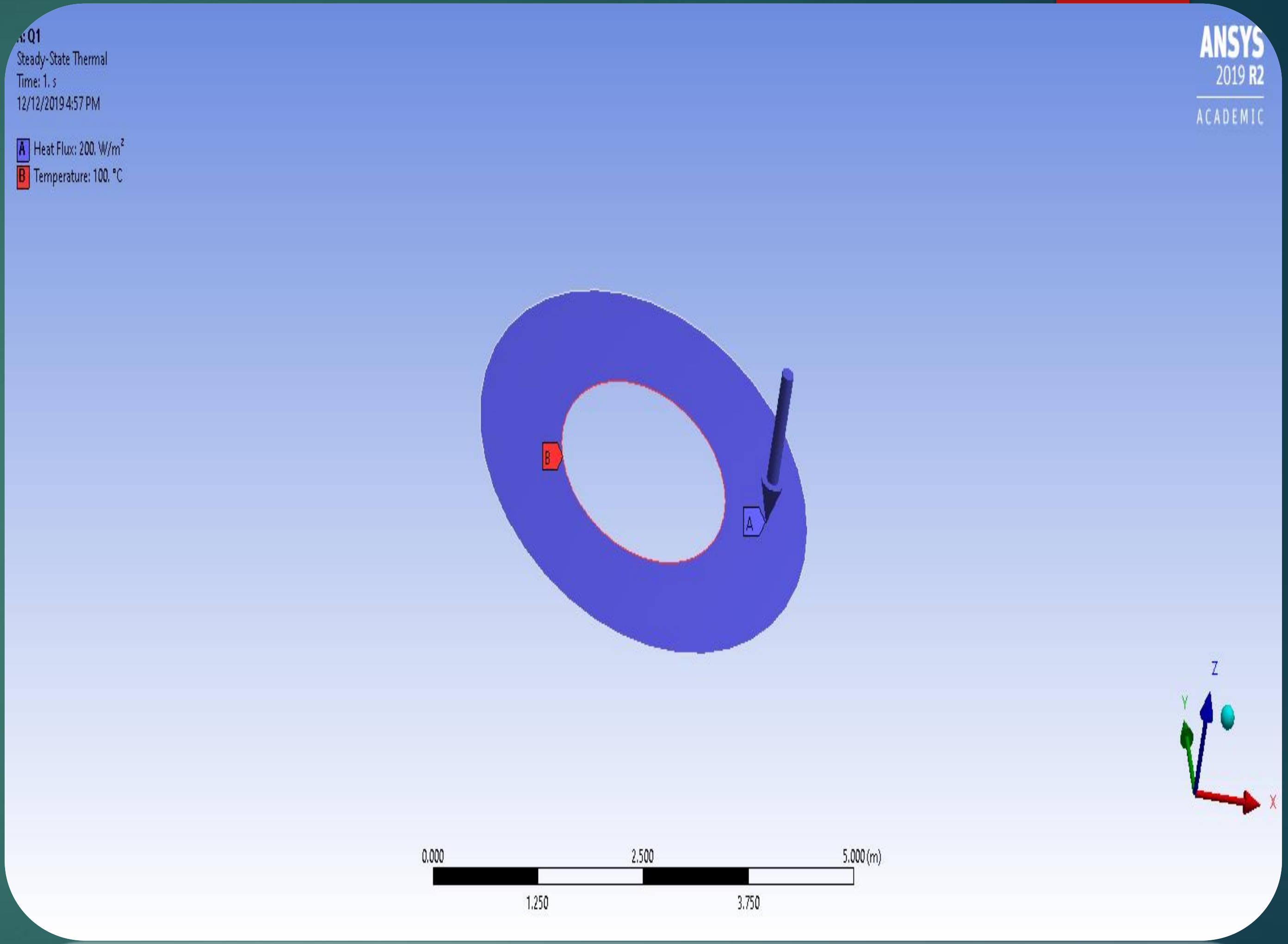
Mesh

Details of "Mesh"

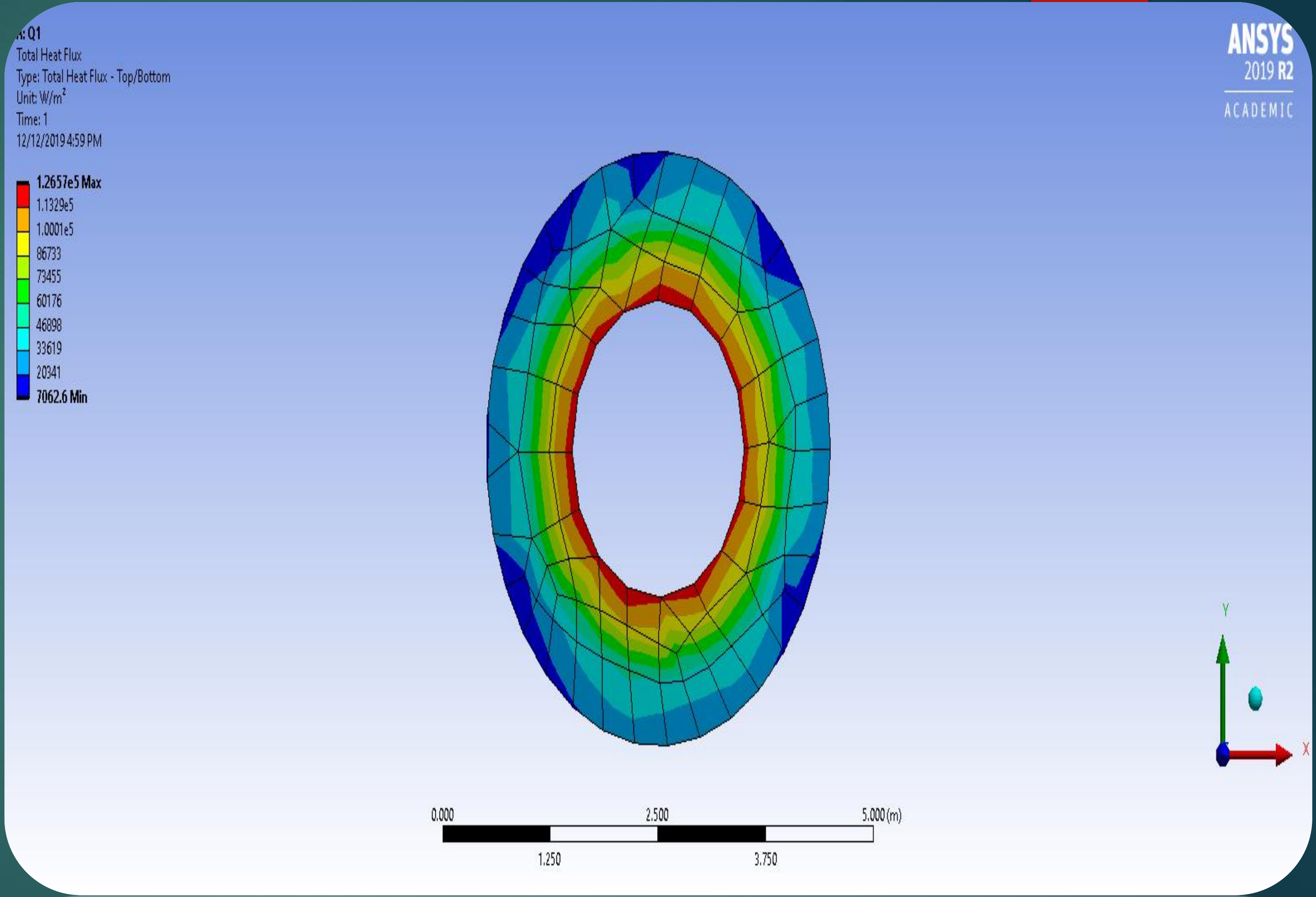
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default (0.38284 m)
Sizing	
Quality	
Inflation	
Batch Connections	
Advanced	
Statistics	
Nodes	105
Elements	82



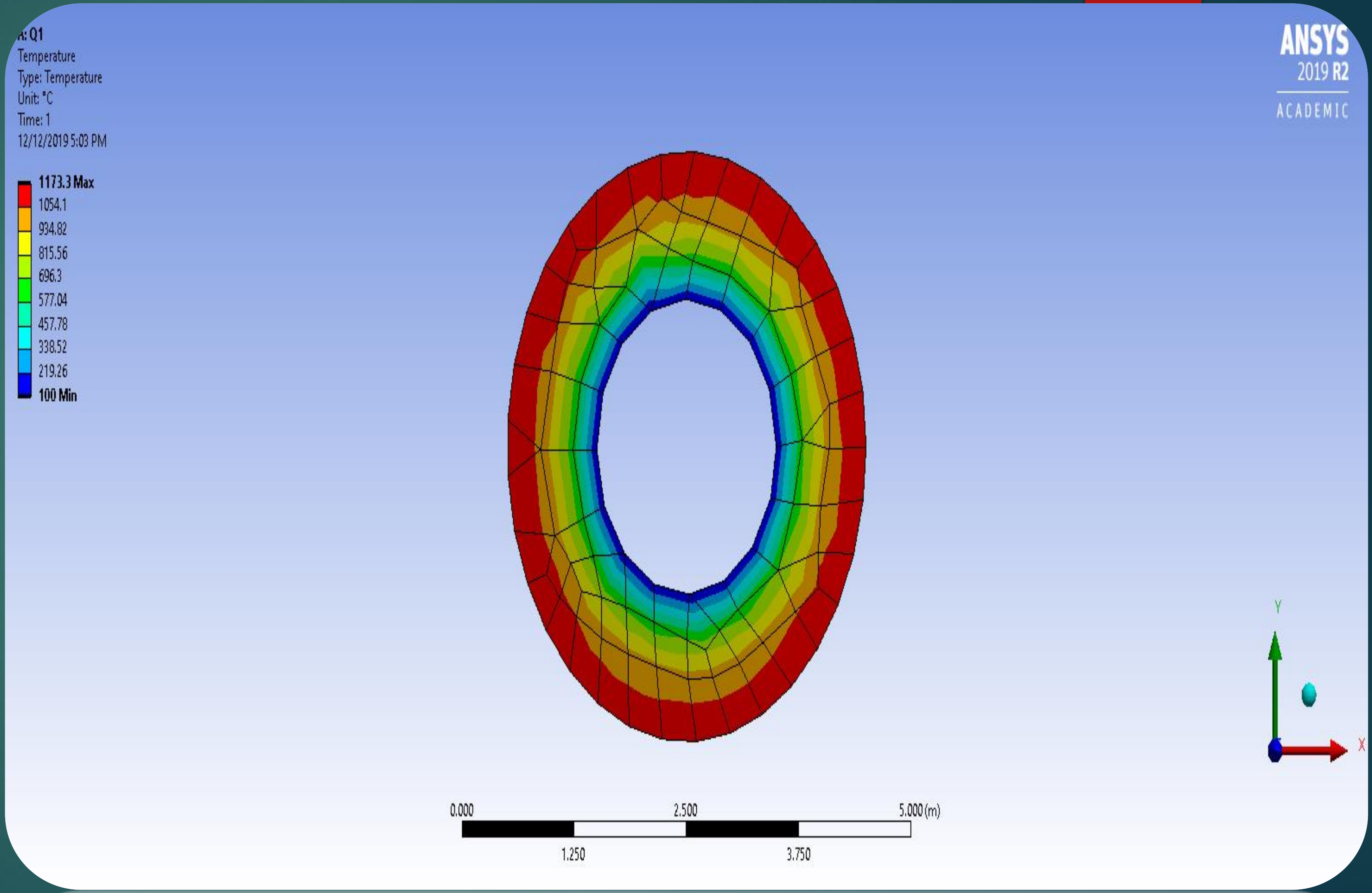
Boundary Conditions



Results:


A: Q1
Total Heat Flux
Type: Total Heat Flux - Top/Bottom
Unit: W/m²
Time: 1
12/12/2019 4:59 PM
1.2657e5 Max
1.1329e5
1.0001e5
86733
73455
60176
46898
33619
20341
7062.6 Min
ANSYS
2019 R2
ACADEMIC
0.000
2.500
5.000 (m)
1.250
3.750
Y
X

Results:

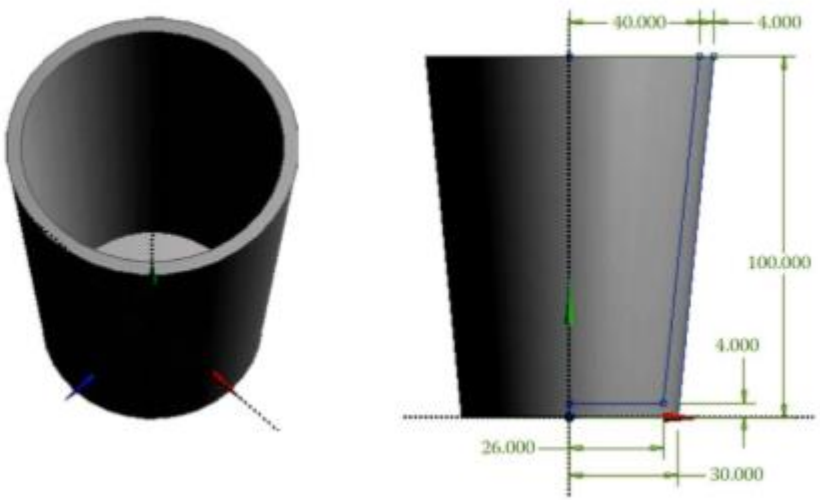

A: Q1
Temperature
Type: Temperature
Unit: °C
Time: 1
12/12/2019 5:03 PM
1173.3 Max
1054.1
934.82
815.56
696.3
577.04
457.78
338.52
219.26
100 Min
ANSYS
2019 R2
ACADEMIC
0.000
2.500
5.000 (m)
1.250
3.750
Y
X

Q2

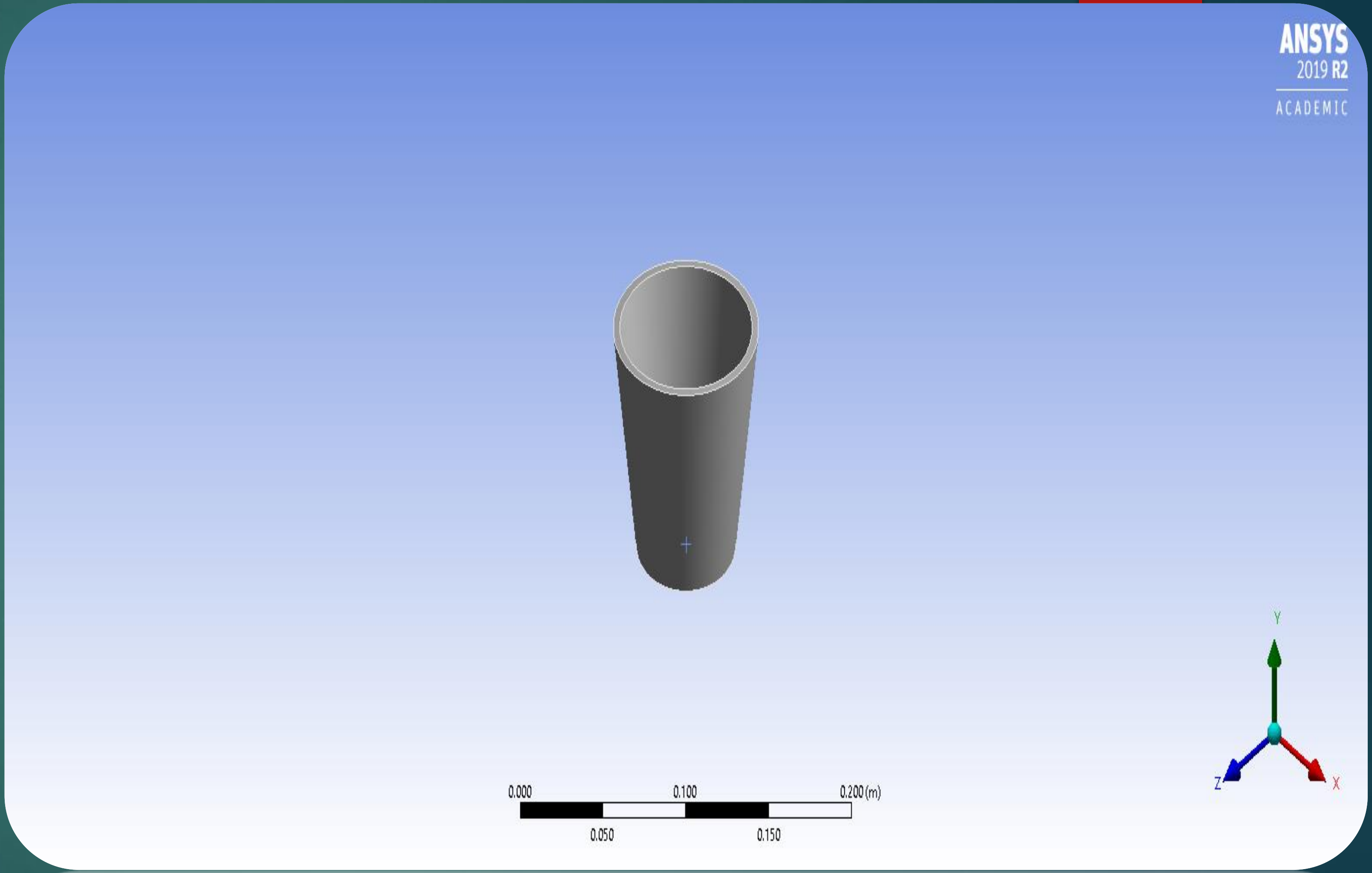
Problem -2

For the glass cup shown in the figure below, determine the thermal stresses when the inner surfaces of the cup experience a temperature change from 20°C to 60°C while all other surfaces are kept at 20°C. For glass, use Young's modulus E = 70 GPa, Poisson's ratio ν = 0.17, thermal conductivity k = 1.4 W/(m°C), and coefficient of thermal expansion α = 8.0 $\times$ 10−6/°C.

All dimensions are in millimeters.



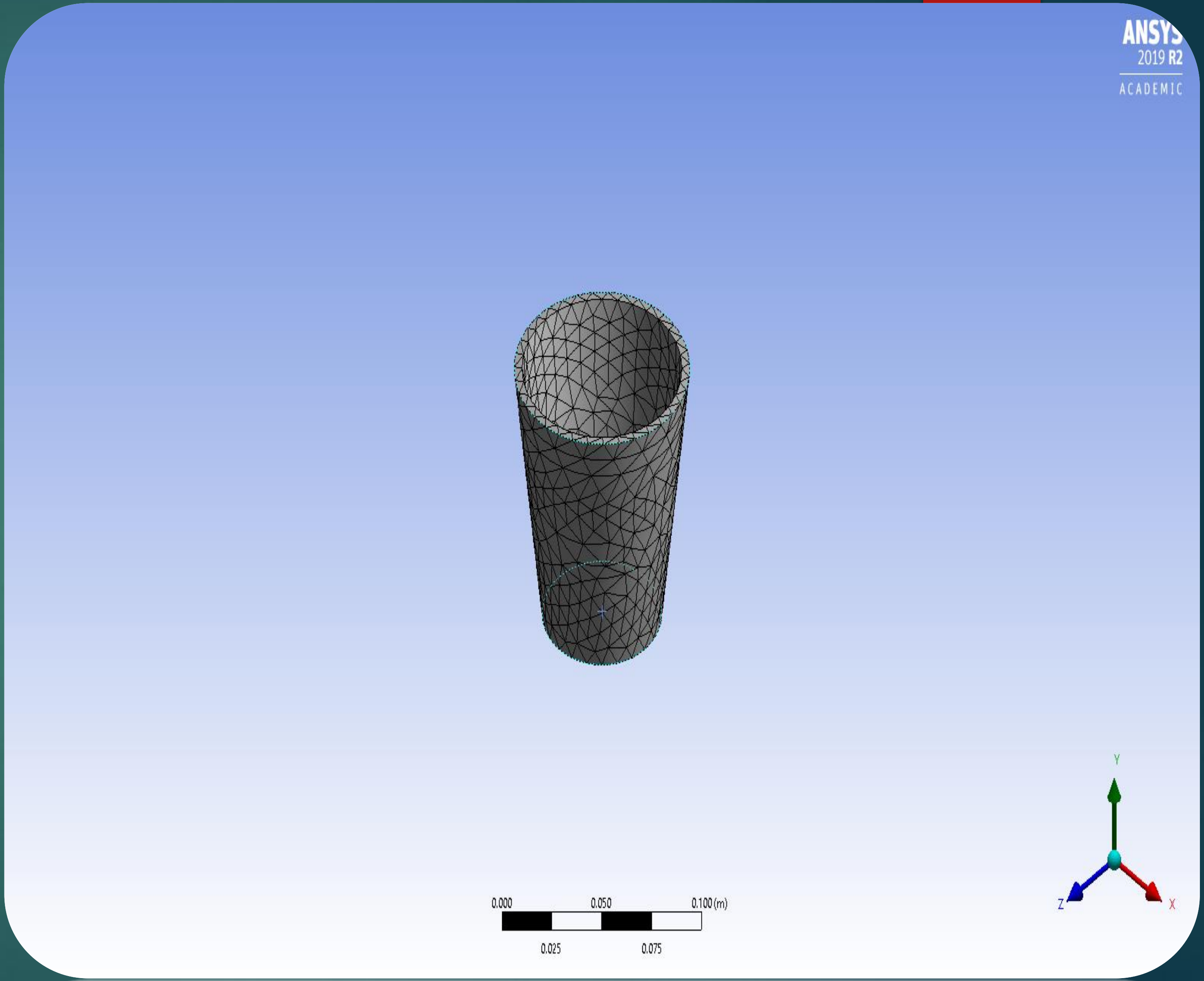
Geometry



Mesh

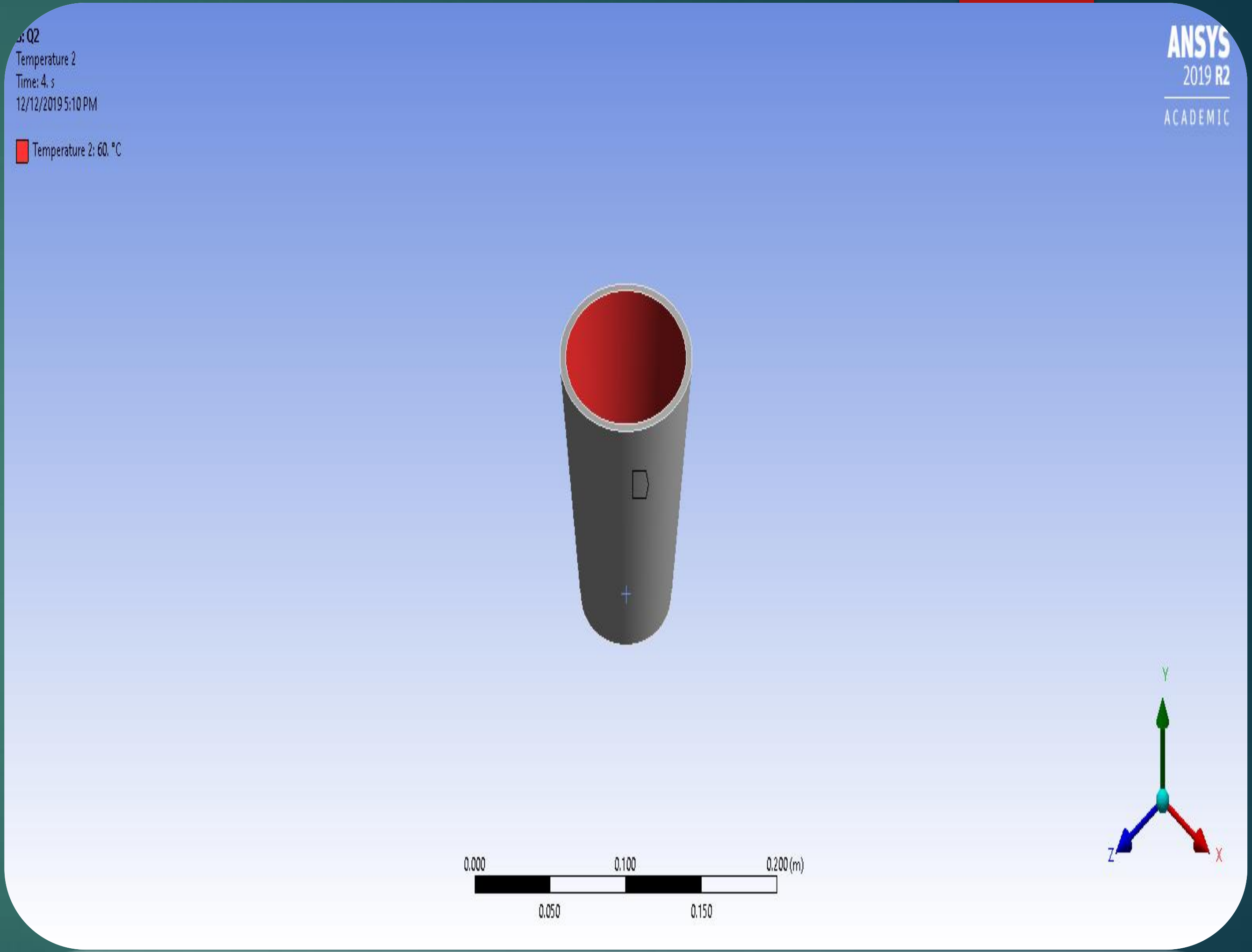
Details of "Mesh"

Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Quality	
Inflation	
Advanced	
Statistics	
Nodes	4172
Elements	2036

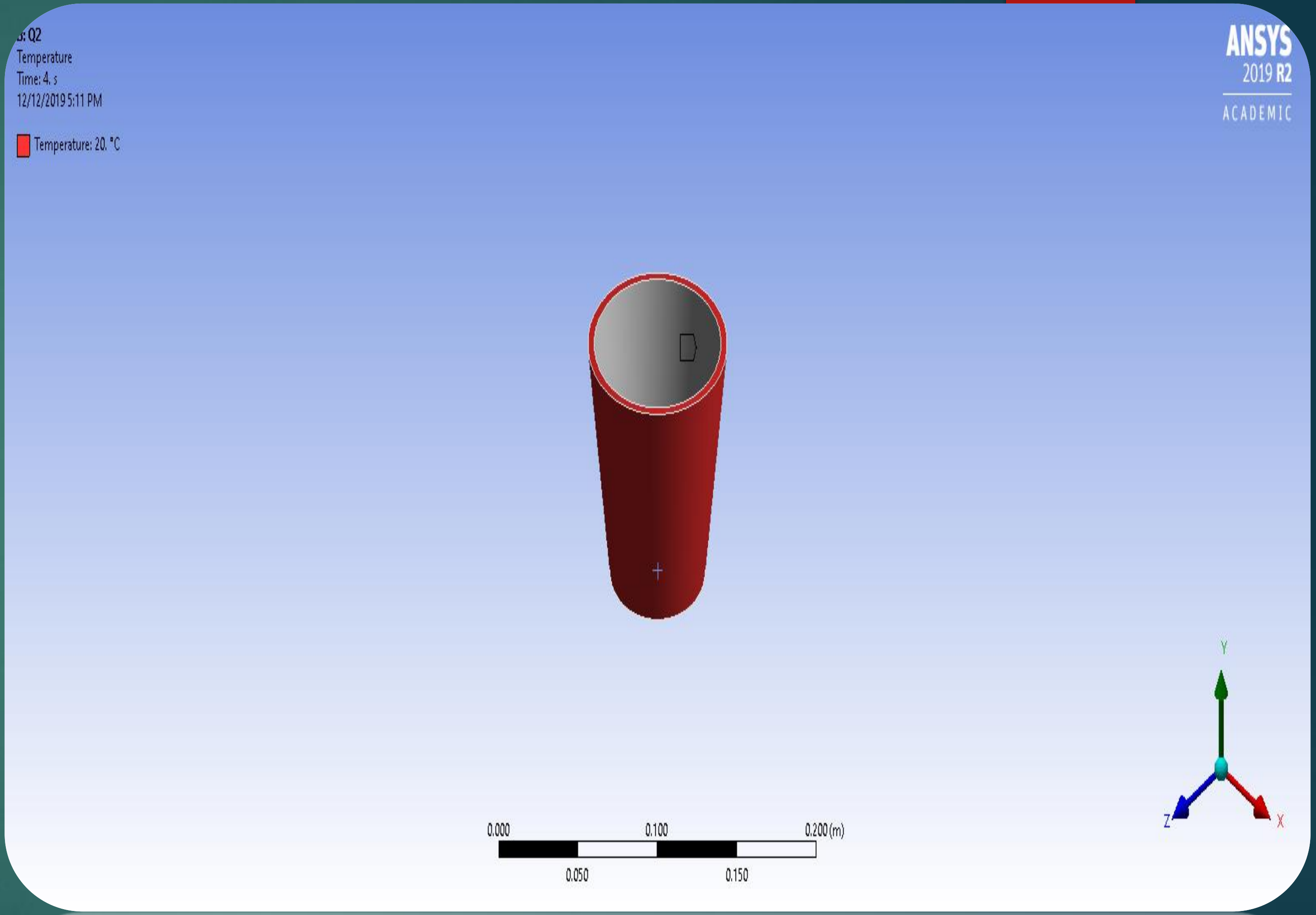


Boundary Conditions

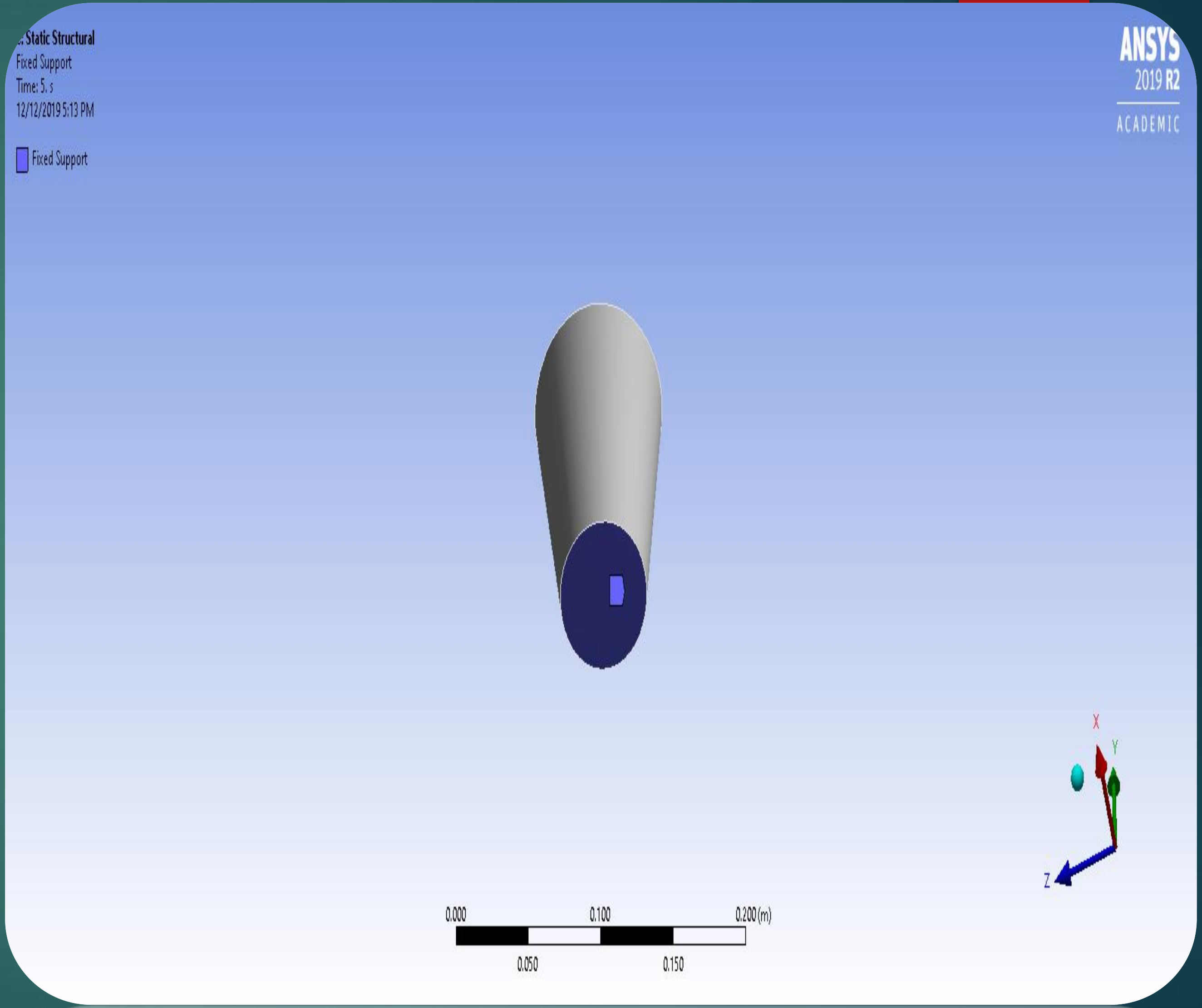
	Steps	Time [s]	Temperature [°C]
1	1	0.	20.
2	1	1.	30.
3	1	2.	40.
4	1	3.	50.
5	1	4.	60.



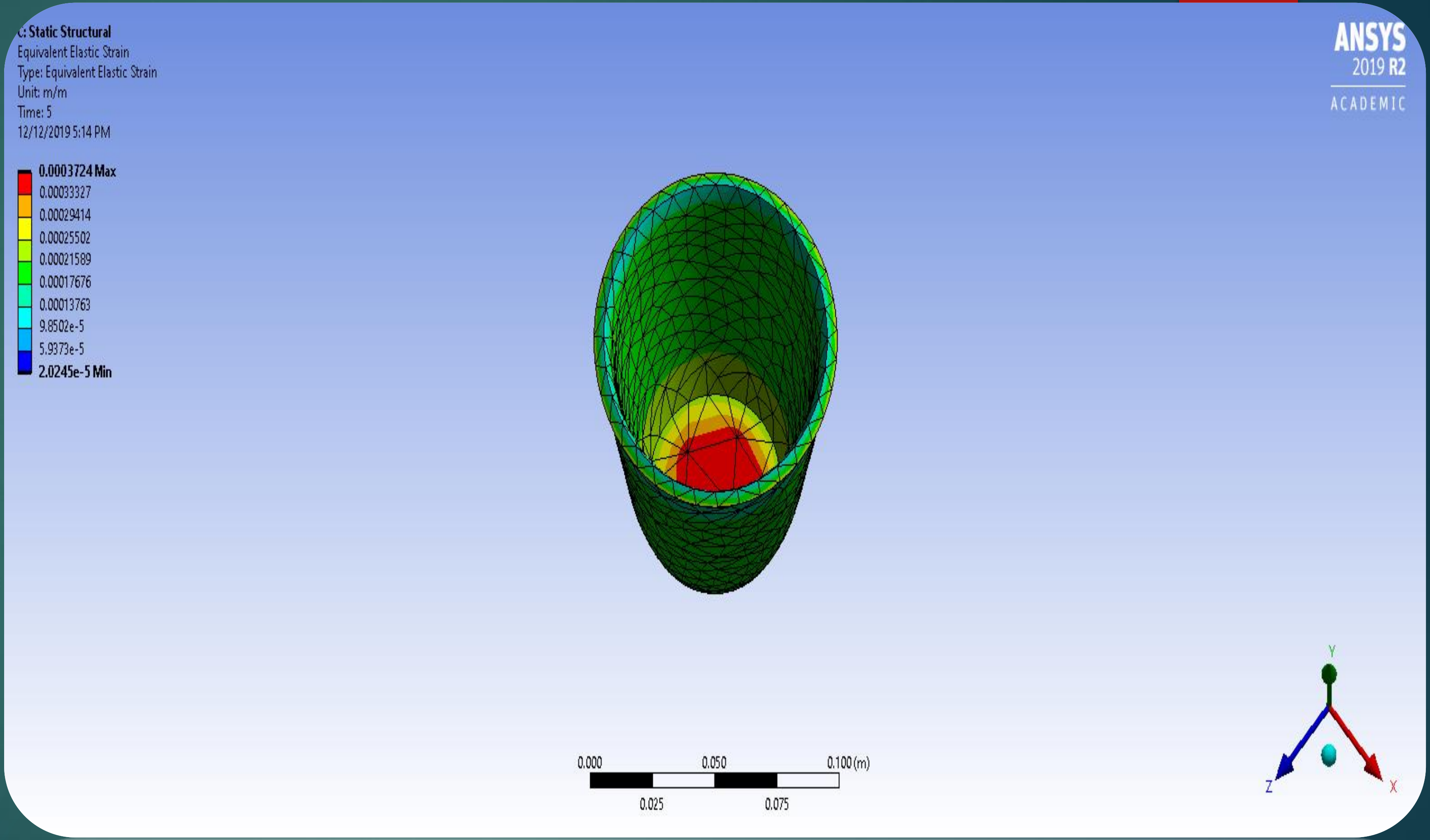
Boundary Conditions



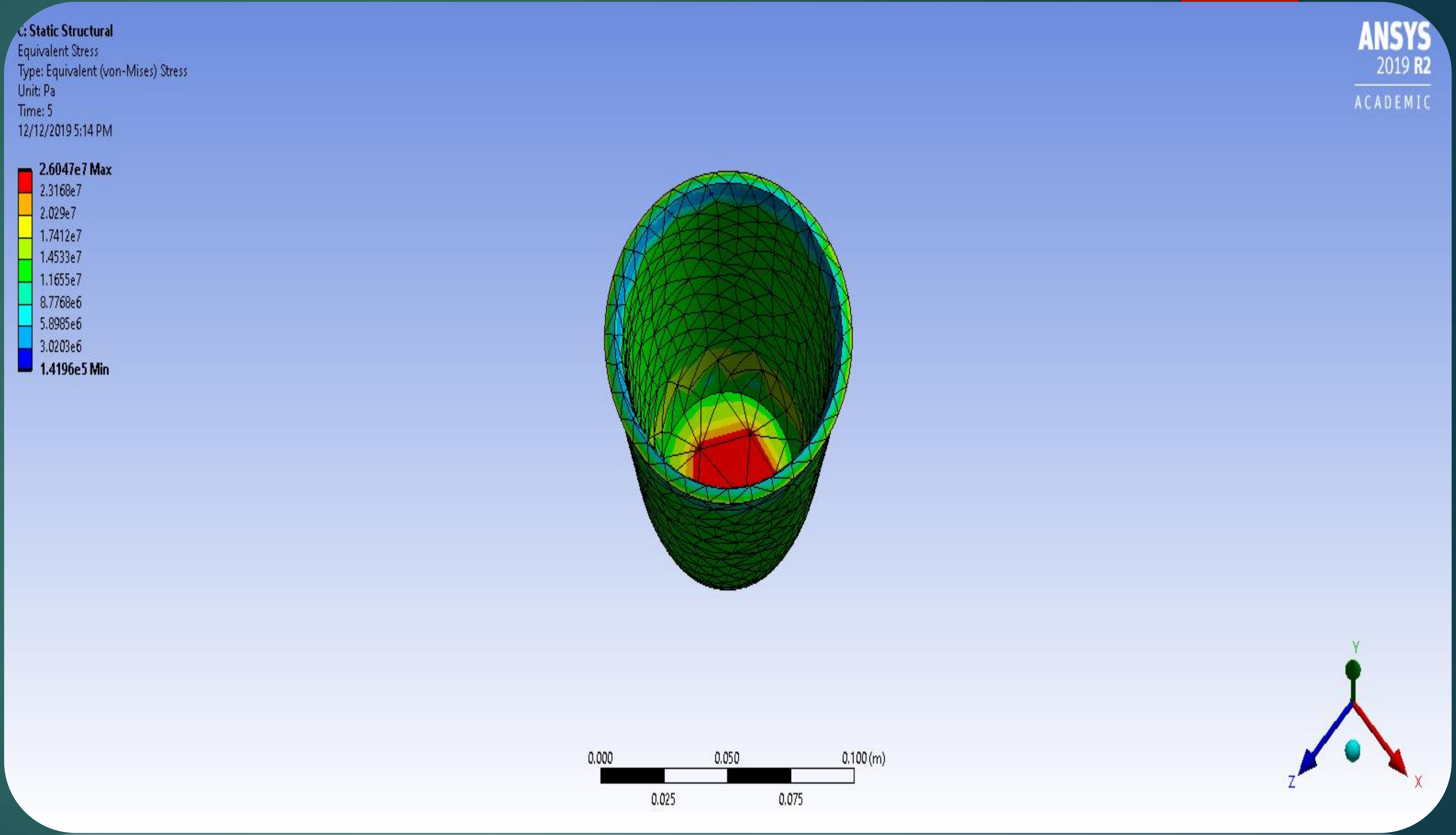
Boundary Conditions



Results:


C: Static Structural
Equivalent Elastic Strain
Type: Equivalent Elastic Strain
Unit: m/m
Time: 5
12/12/2019 5:14 PM
0.0003724 Max
0.00033327
0.00029414
0.00025502
0.00021589
0.00017676
0.00013763
9.8502e-5
5.9373e-5
2.0245e-5 Min
ANSYS
2019 R2
ACADEMIC
0.000
0.050
0.100 (m)
0.025
0.075
Y
Z
X

Results:

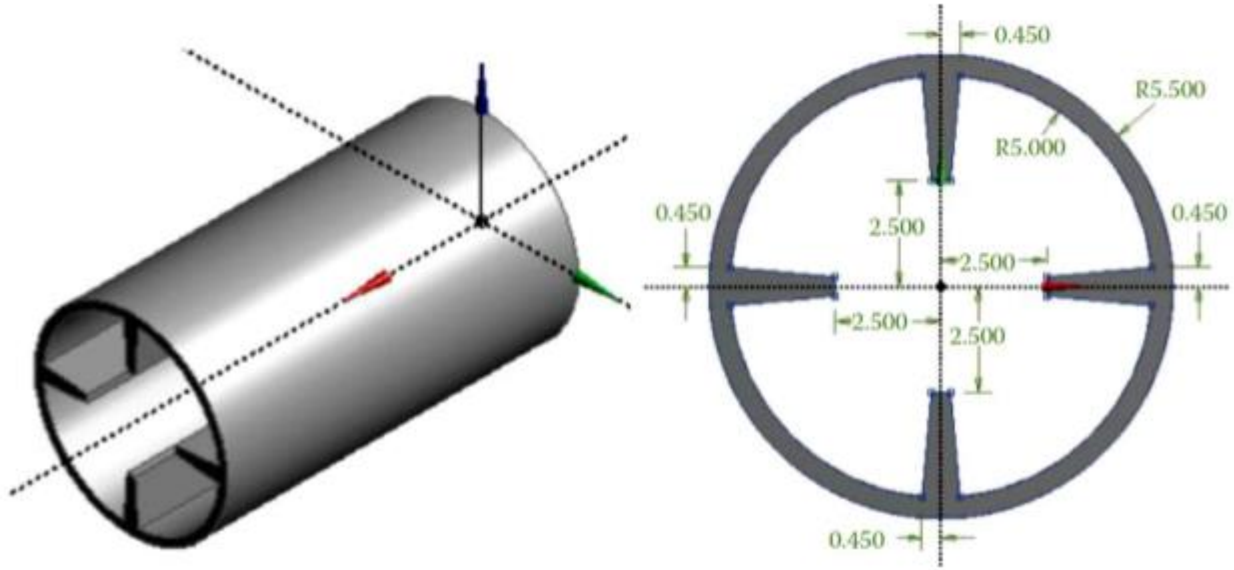

C: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: Pa
Time: 5
12/12/2019 5:14 PM
2.6047e7 Max
2.3168e7
2.029e7
1.7412e7
1.4533e7
1.1655e7
8.7768e6
5.8985e6
3.0203e6
1.4196e5 Min
ANSYS
2019 R2
ACADEMIC
0.000
0.050
0.100 (m)
0.025
0.075
Y
Z
X

Q3

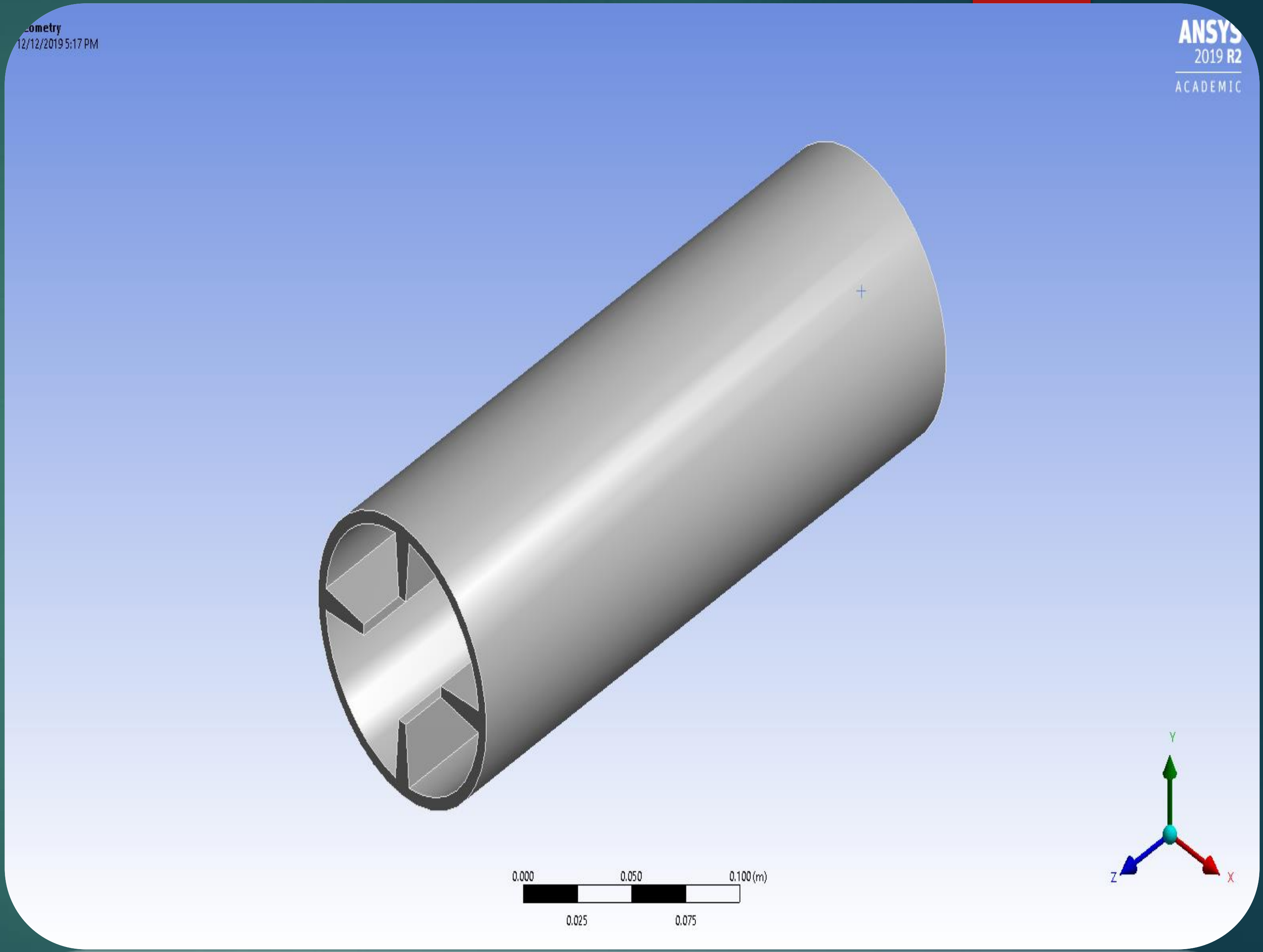
Problem -3

Determine the temperature and heat flux distributions inside the following heat transfer pipe with internal ribs. A bulk temperature of 80°C and 20°C with a film coefficient of 100 W/(m2°C) and 30 W/(m2°C) is specified for the interior and exterior convective heat transfer, respectively. Assume that the pipe is 30 cm long with a thermal conductivity of 230 W/(m K) and that the two ends of the pipe are perfectly insulated.

All dimensions are in centimeters.



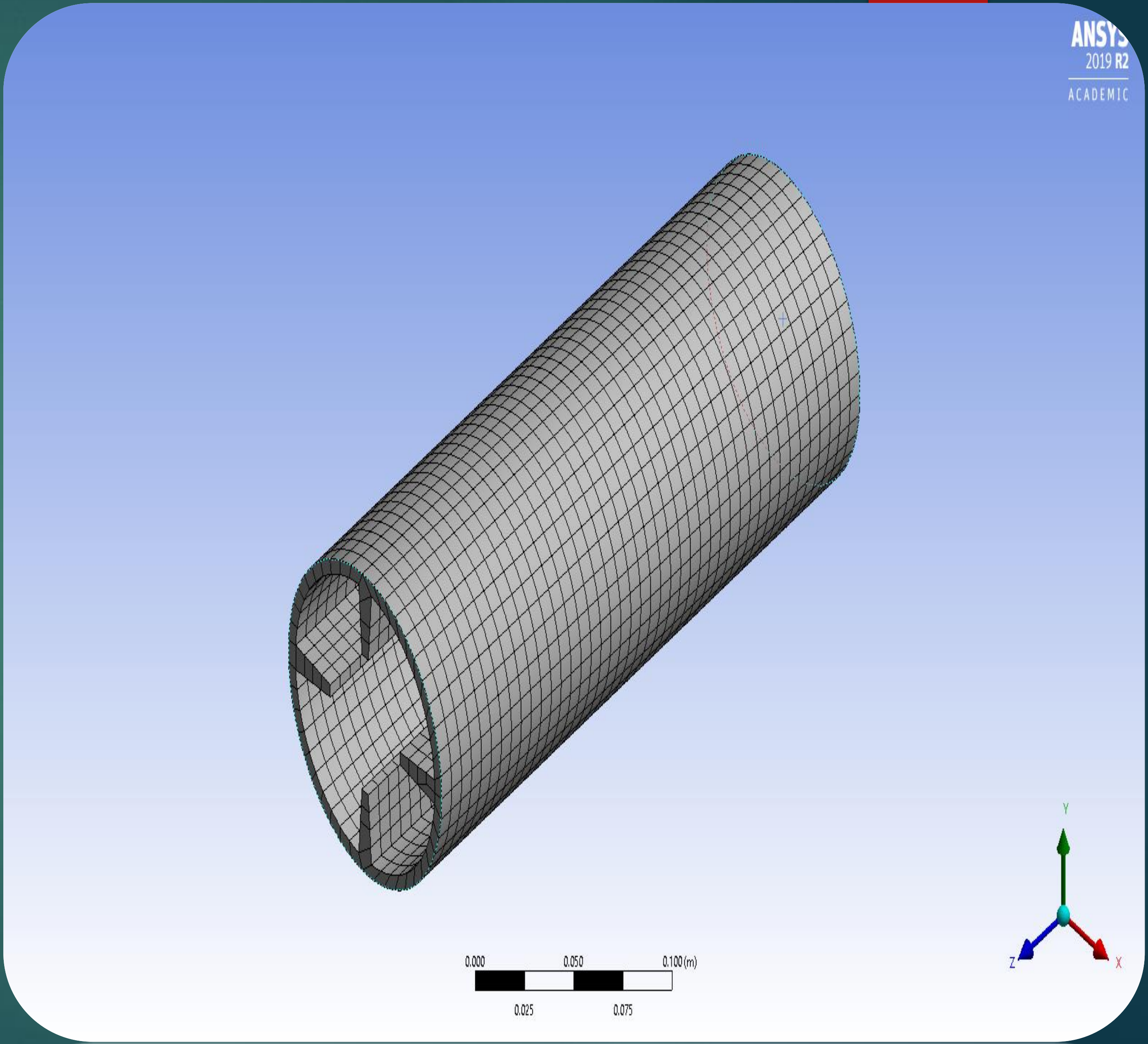
Geometry



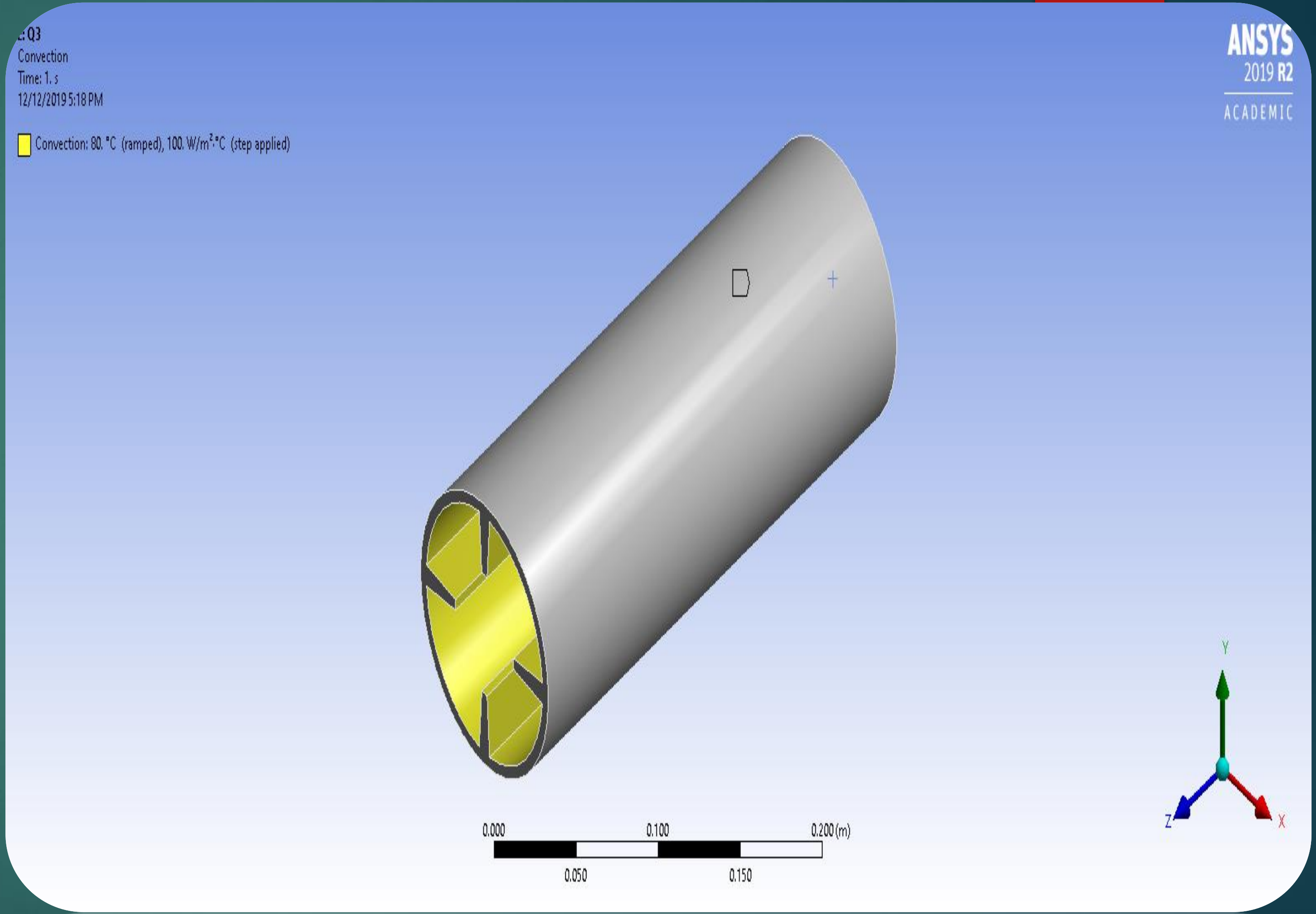
Geometry
12/12/2019 5:17 PM
ANSYS
2019 R2
ACADEMIC
0.000
0.050
0.100 (m)
0.025
0.075
Y
Z
X

Mesh

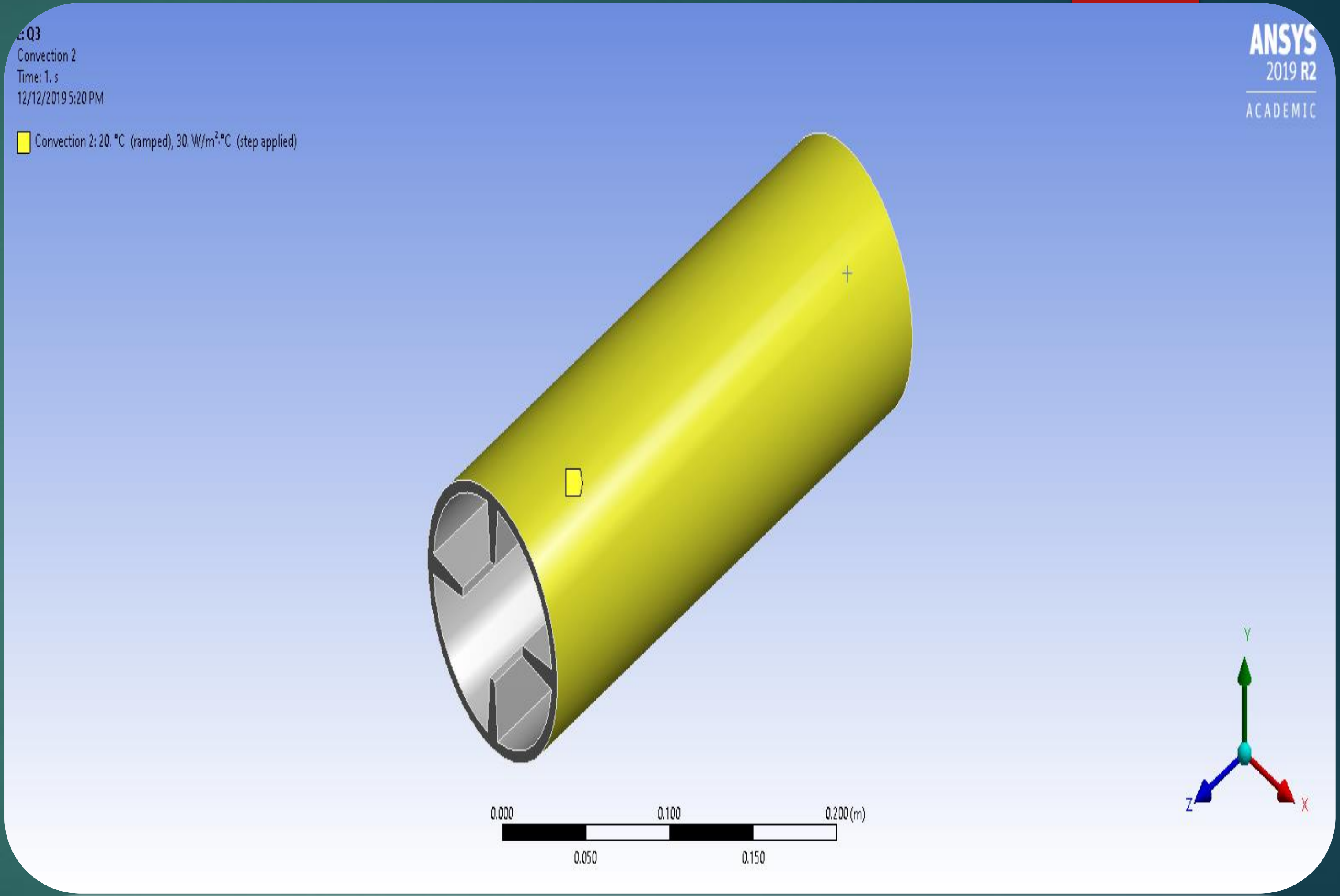
Details of "Mesh"	
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Quality	
Inflation	
Advanced	
Statistics	
Nodes	17684
Elements	2520



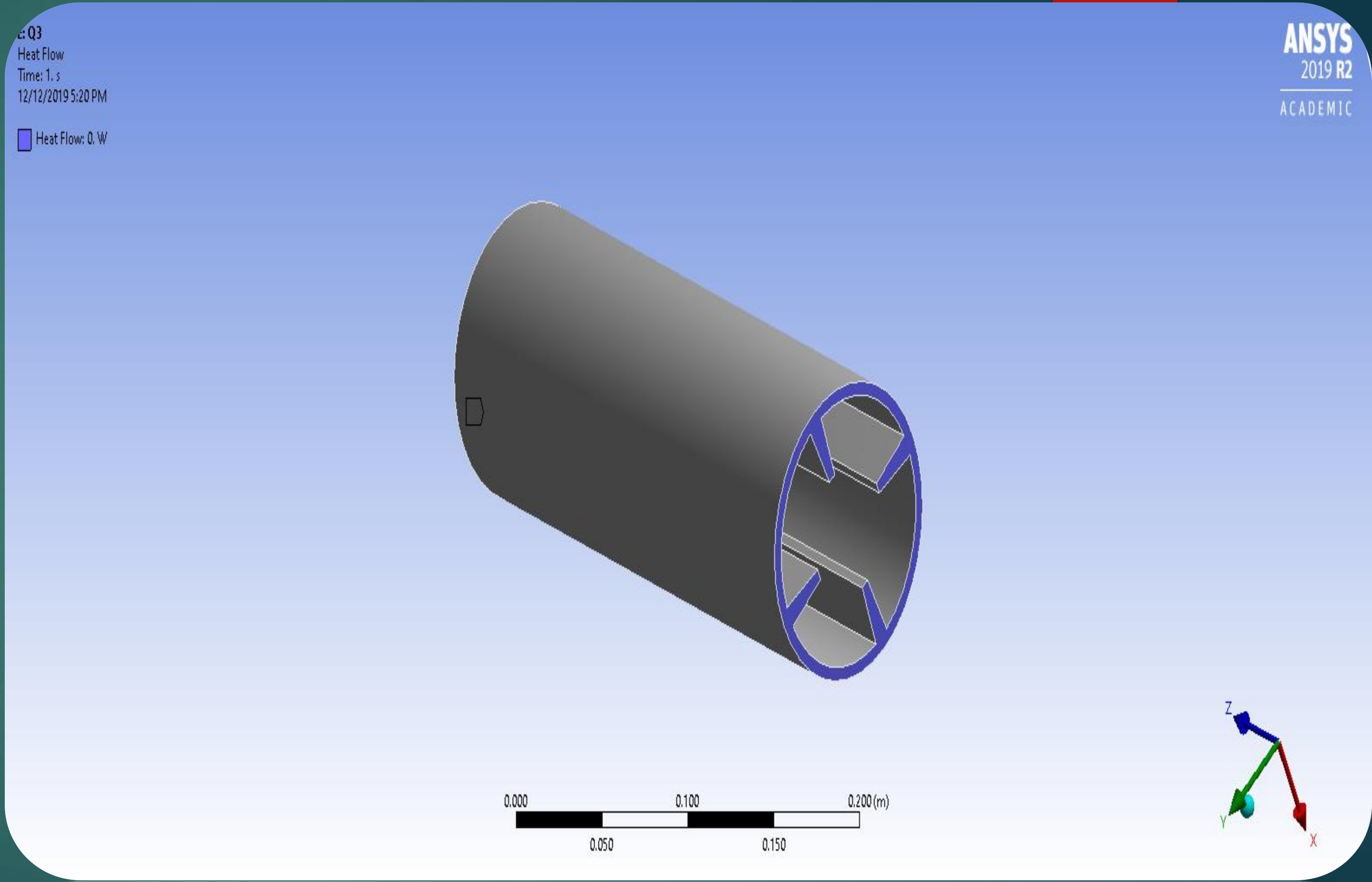
Boundary Conditions



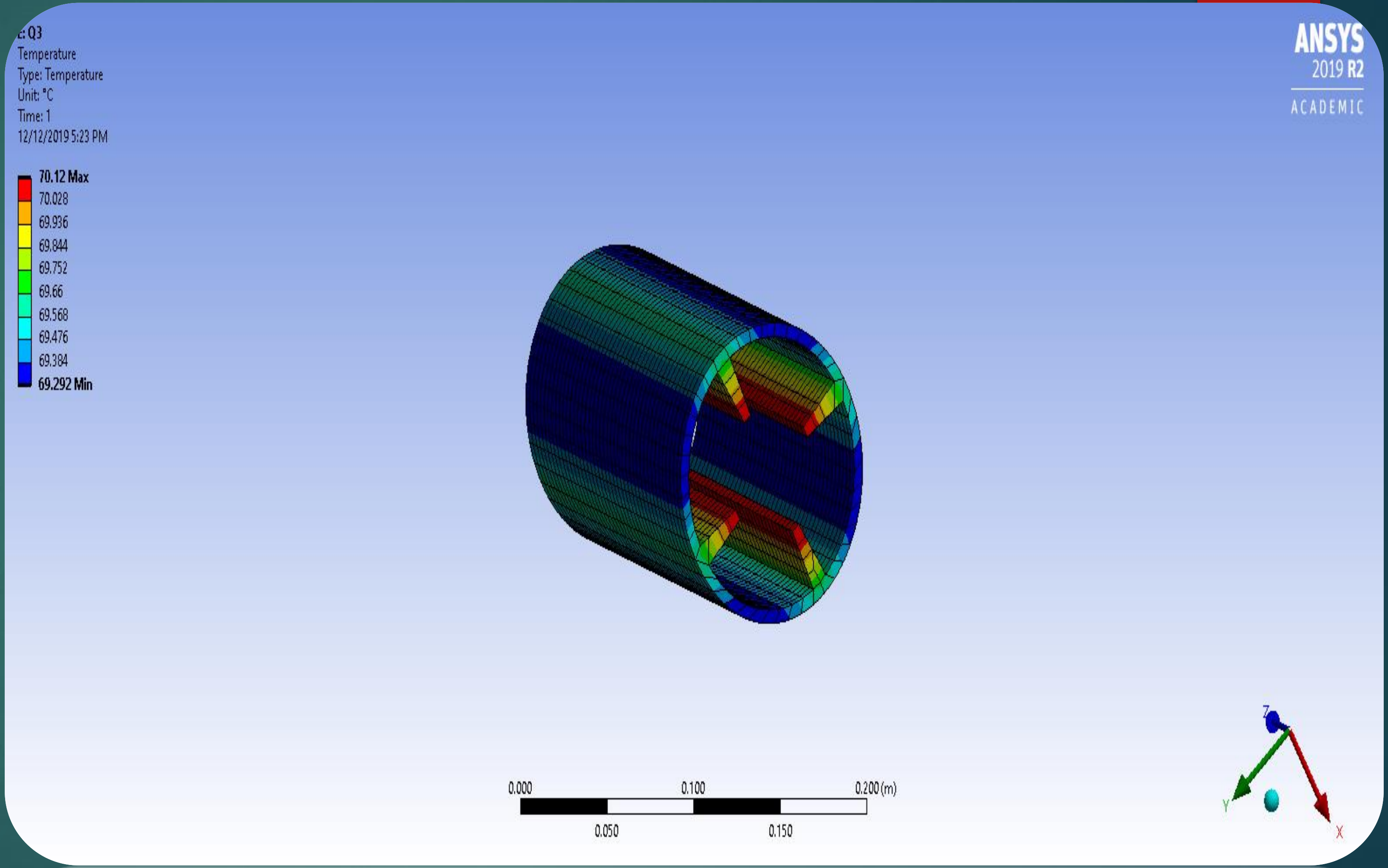
Boundary Conditions



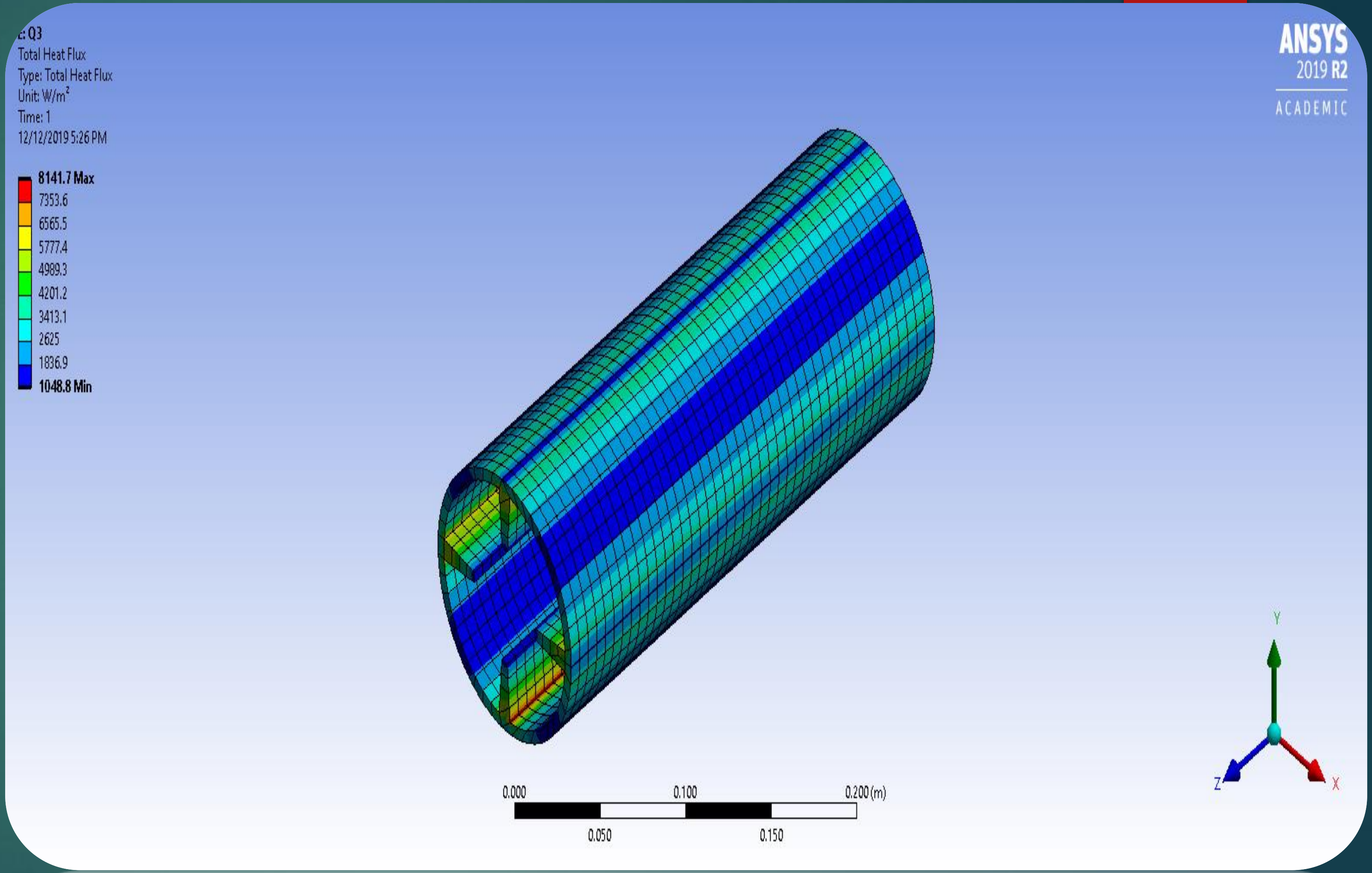
Boundary Conditions



Results:


E: Q3
Temperature
Type: Temperature
Unit: °C
Time: 1
12/12/2019 5:23 PM
70.12 Max
70.028
69.936
69.844
69.752
69.66
69.568
69.476
69.384
69.292 Min
ANSYS
2019 R2
ACADEMIC
0.000
0.100
0.200 (m)
0.050
0.150

Results:

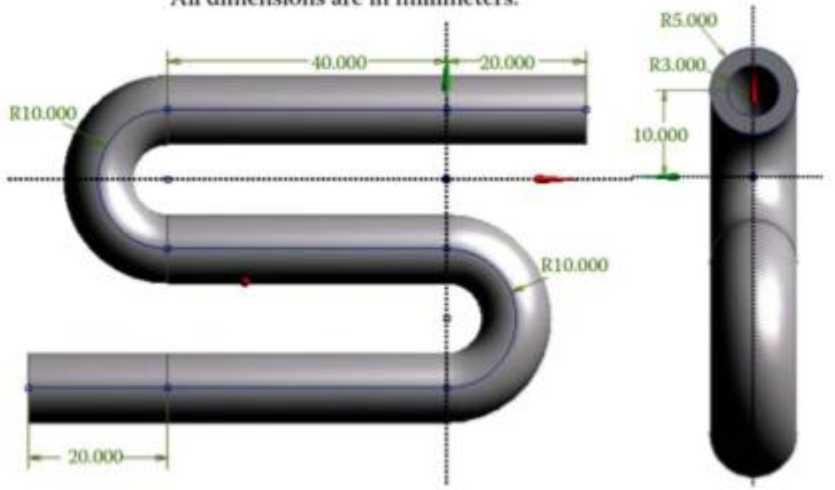

E: Q3
Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
12/12/2019 5:26 PM
8141.7 Max
7353.6
6565.5
5777.4
4989.3
4201.2
3413.1
2625
1836.9
1048.8 Min
ANSYS
2019 R2
ACADEMIC
0.000
0.100
0.200 (m)
0.050
0.150
Y
Z
X

Q4

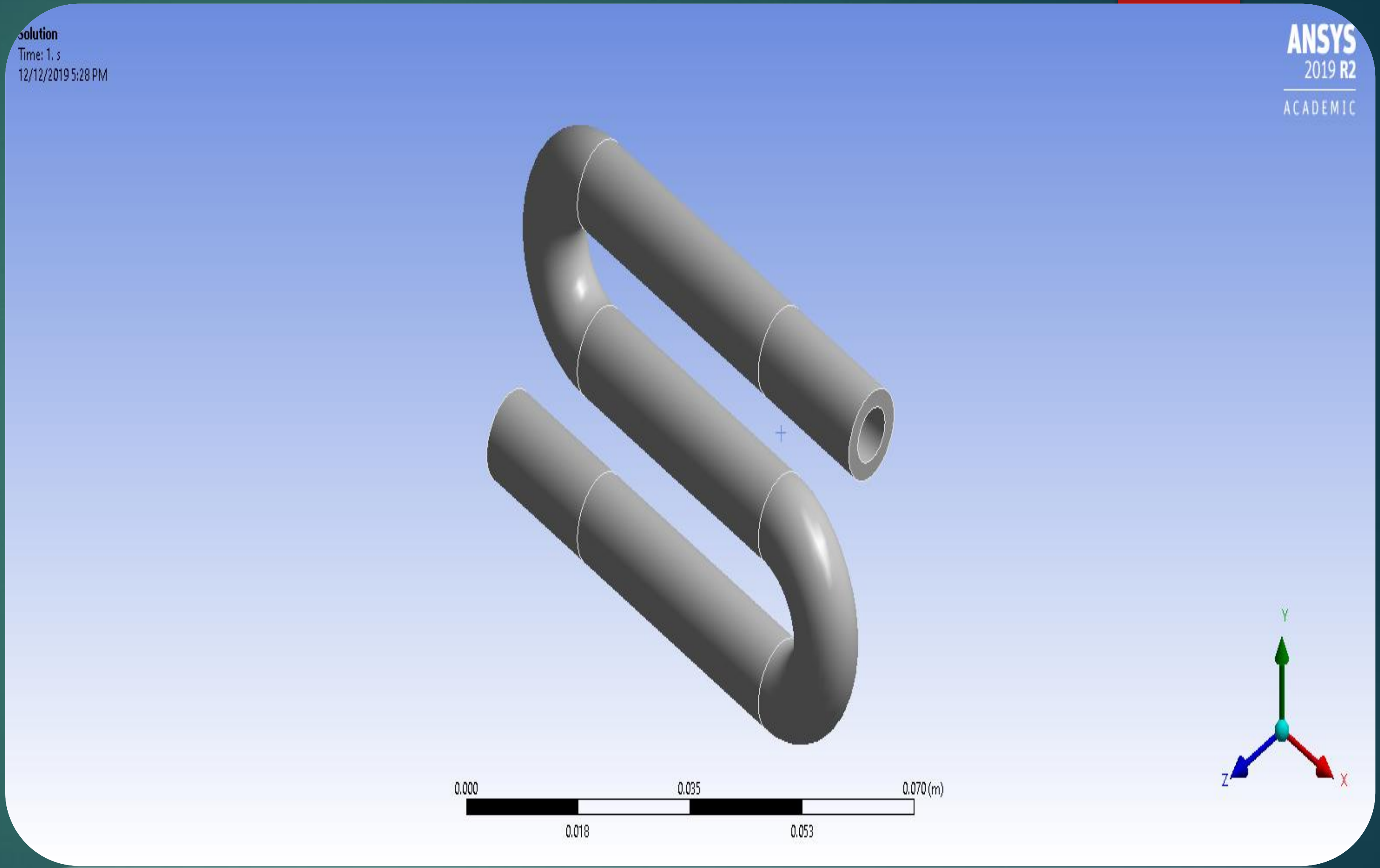
Problem -4

The air to water heat exchanger shown below is made of copper with thermal conductivity k = 400 W/(m K), Young's modulus E = 100 GPa, Poisson's ratio ν = 0.3, and thermal expansion coefficient α = 18 × 10−6/°C. The exterior surfaces are in contact with cold water with a film coefficient of 30 W/(m2°C) and a bulk temperature of 20°C. The interior surfaces are in contact with hot air with a film coefficient of 100 W/(m2°C) and a bulk temperature of 80°C. (1) Determine the steady-state thermal response of the heat exchanger. (2) Suppose the two annulus faces at the ends of the heat exchanger are fixed. Determine the thermal deformation and stresses induced in the exchanger.

All dimensions are in millimeters.



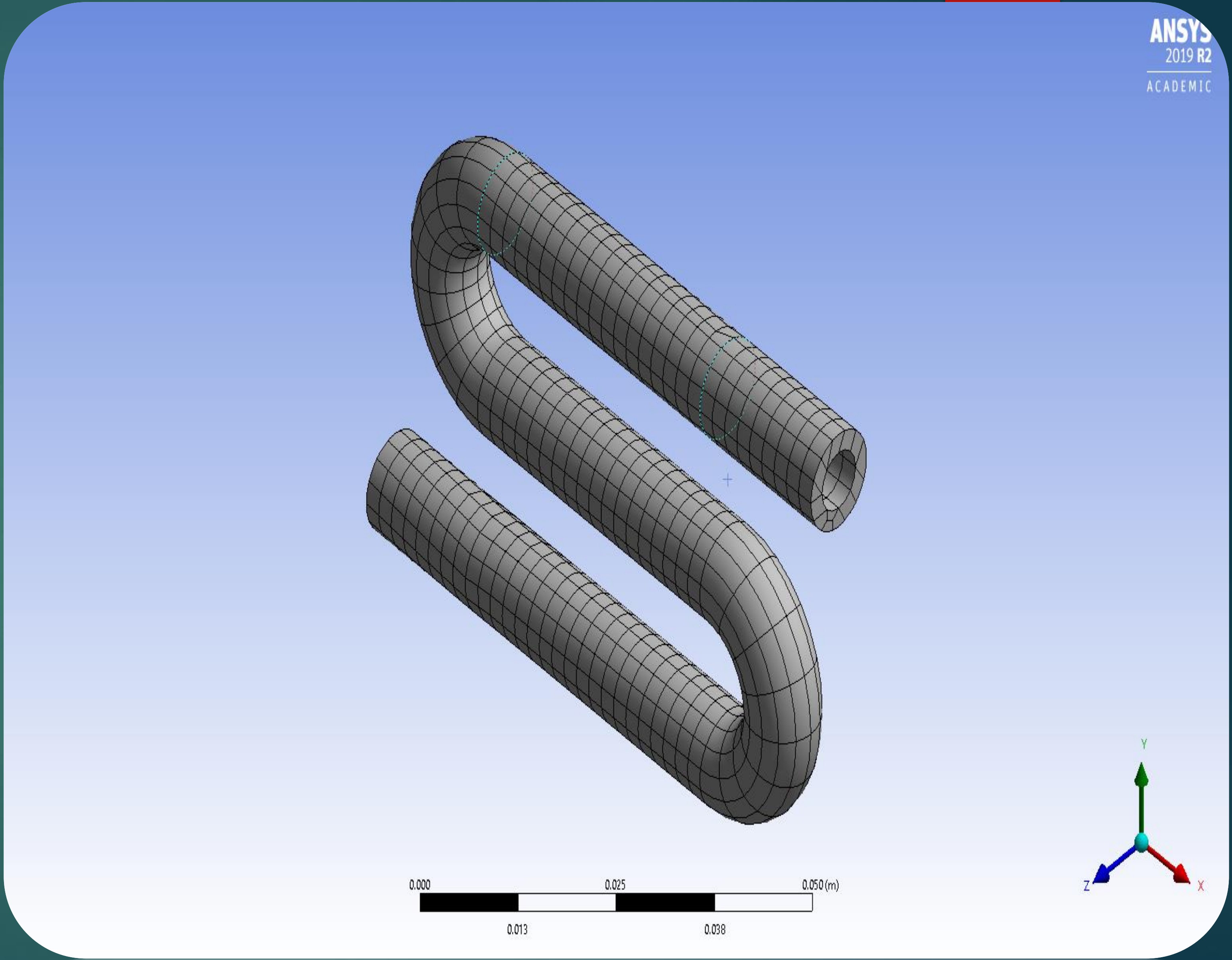
Geometry


Solution
Time: 1. s
12/12/2019 5:28 PM
ANSYS
2019 R2
ACADEMIC
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X

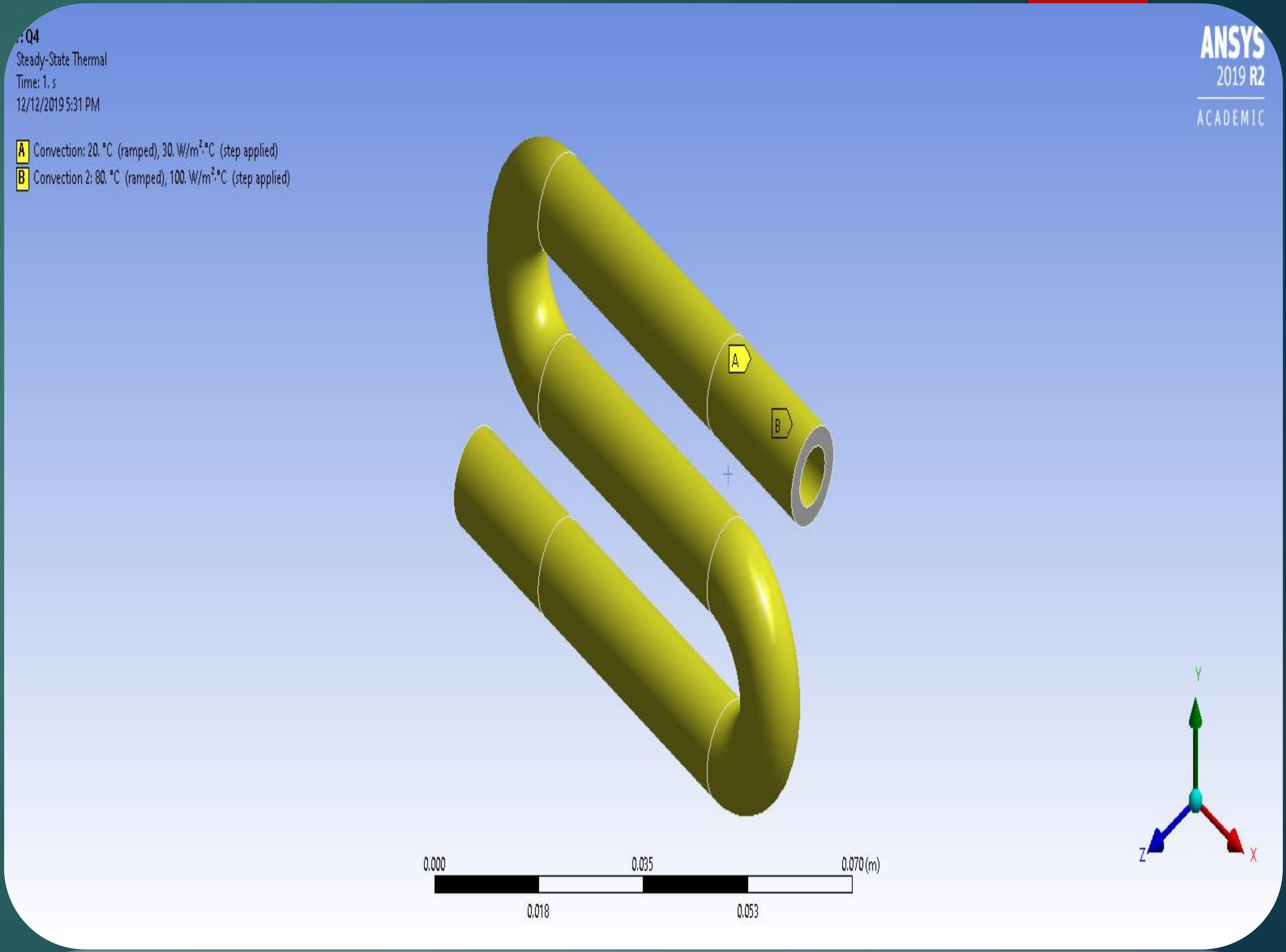
Mesh

Details of "Mesh"

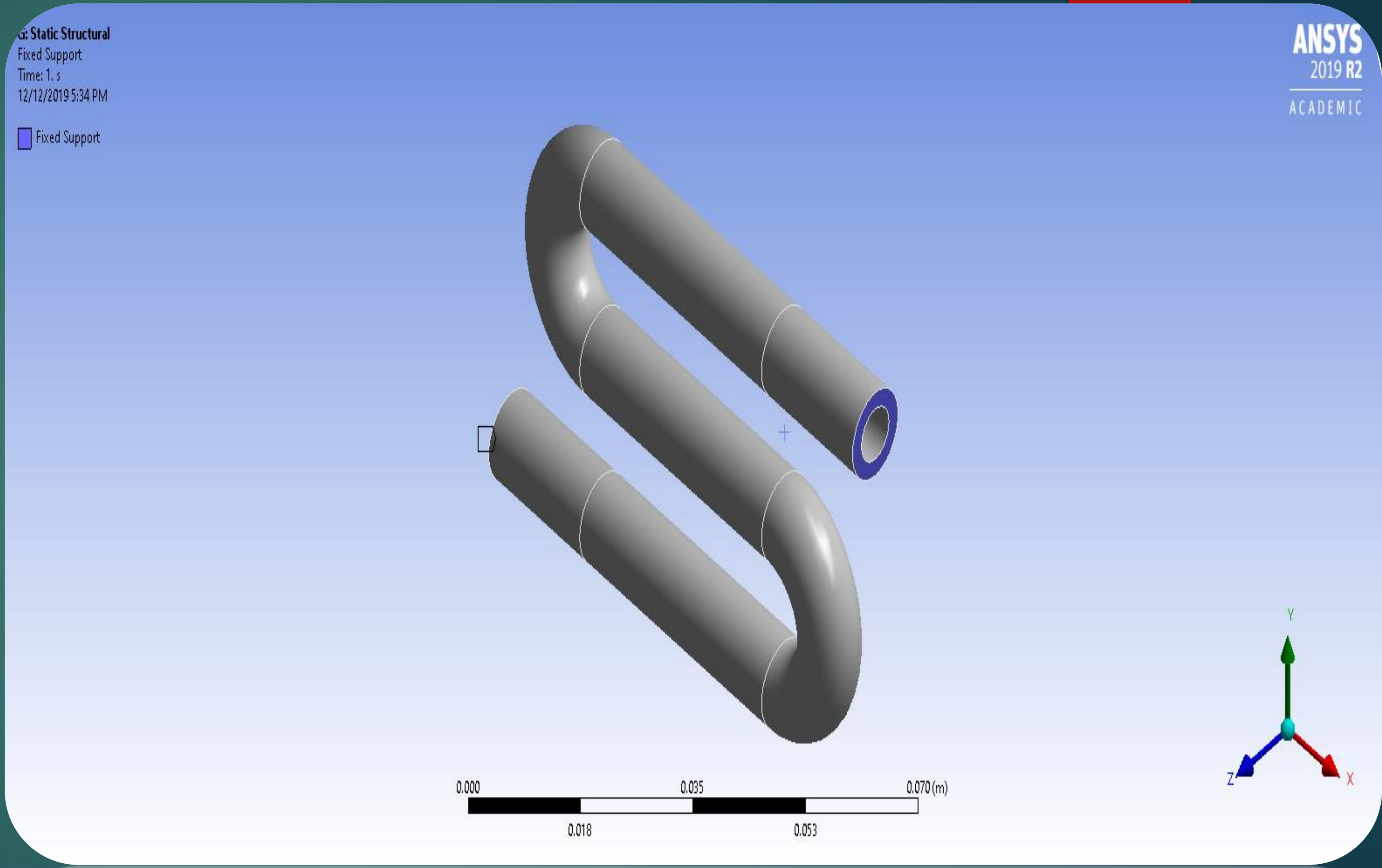
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Quality	
Inflation	
Advanced	
Statistics	
Nodes	7716
Elements	1246



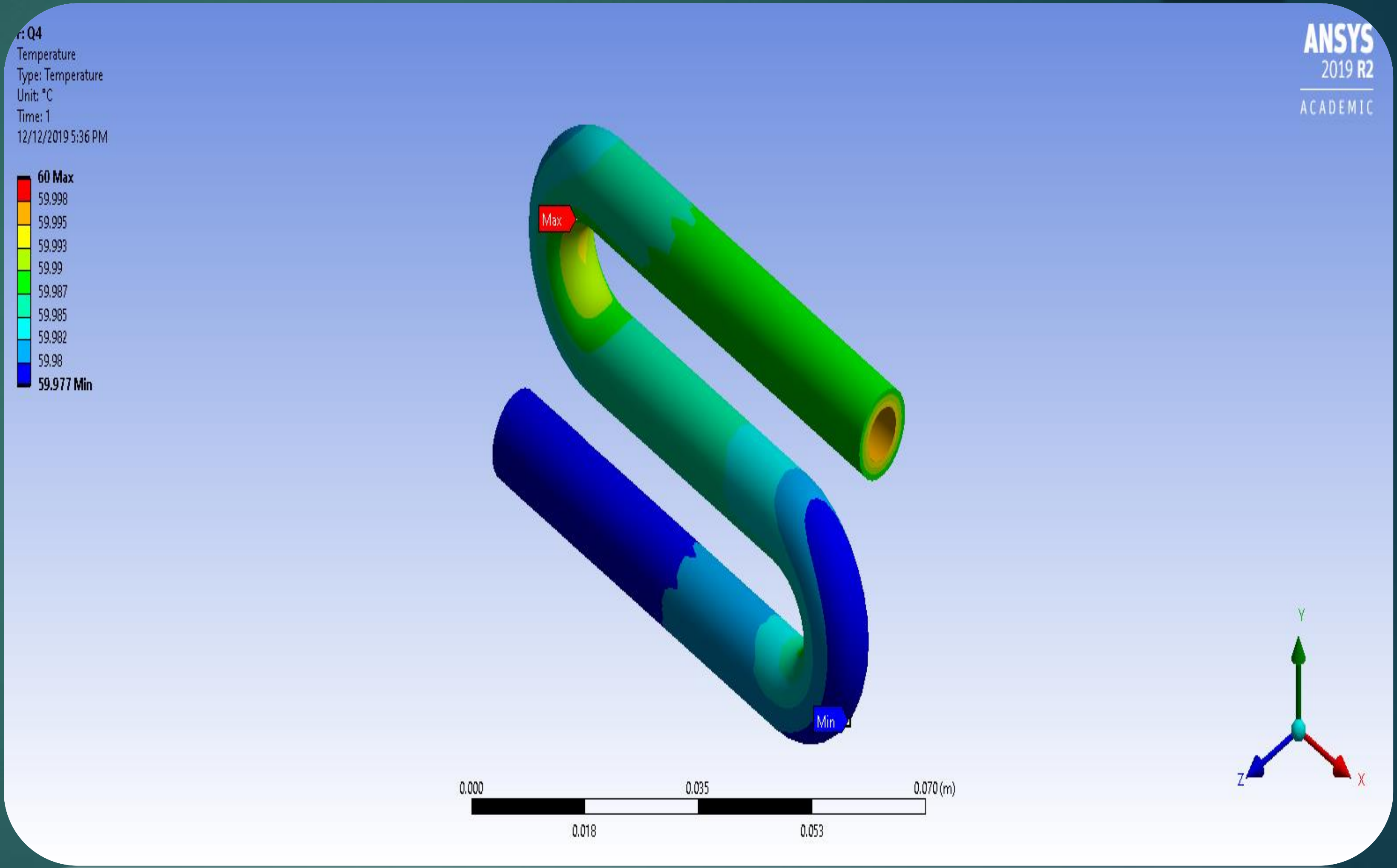
Boundary Conditions



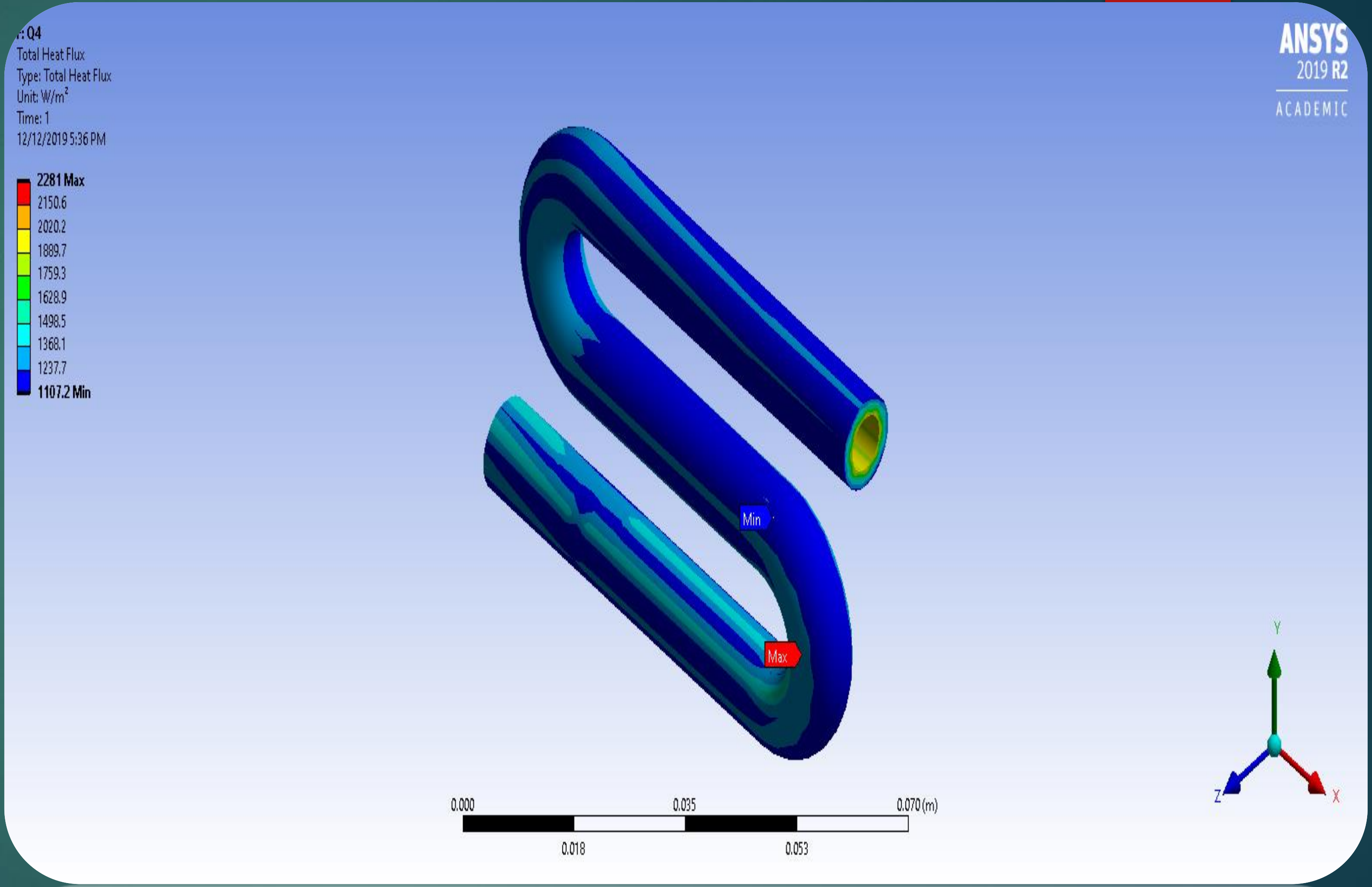
Boundary Conditions



Results:

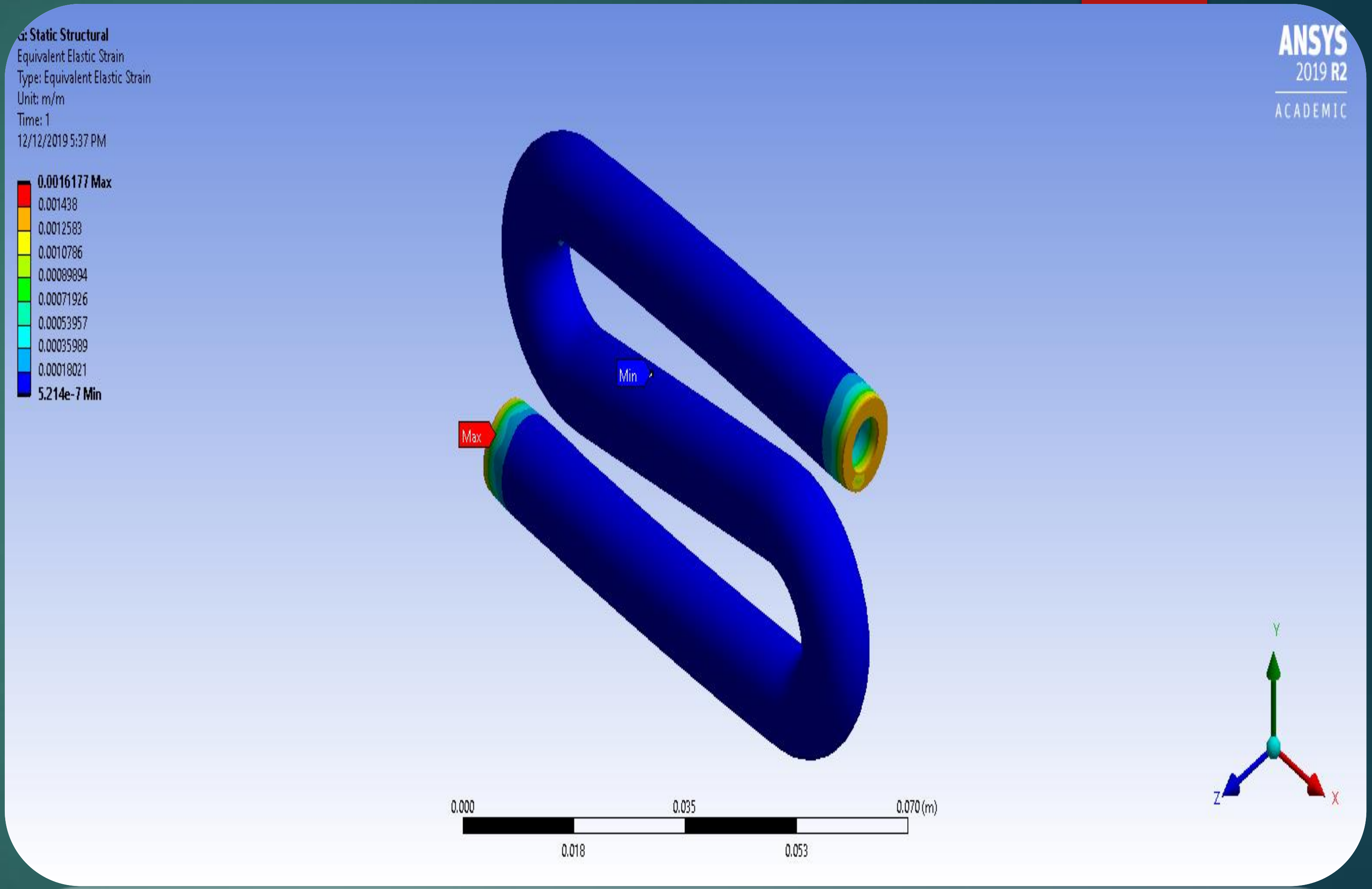

F: Q4
Temperature
Type: Temperature
Unit: °C
Time: 1
12/12/2019 5:36 PM
60 Max
59.998
59.995
59.993
59.99
59.987
59.985
59.982
59.98
59.977 Min
Max
Min
ANSYS
2019 R2
ACADEMIC
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X

Results:

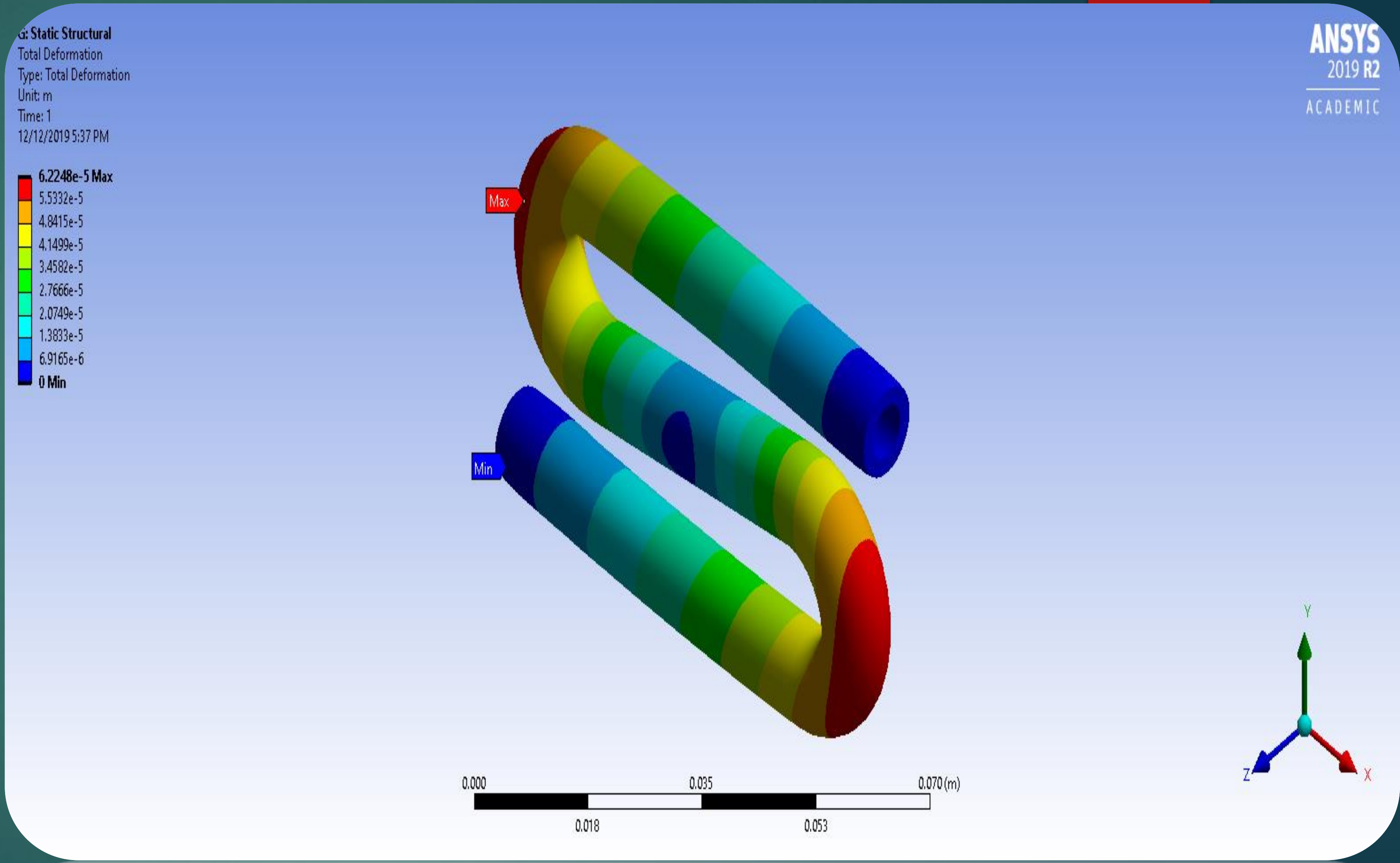


: Q4
Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
12/12/2019 5:36 PM
2281 Max
2150.6
2020.2
1889.7
1759.3
1628.9
1498.5
1368.1
1237.7
1107.2 Min
ANSYS
2019 R2
ACADEMIC
Min
Max
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X

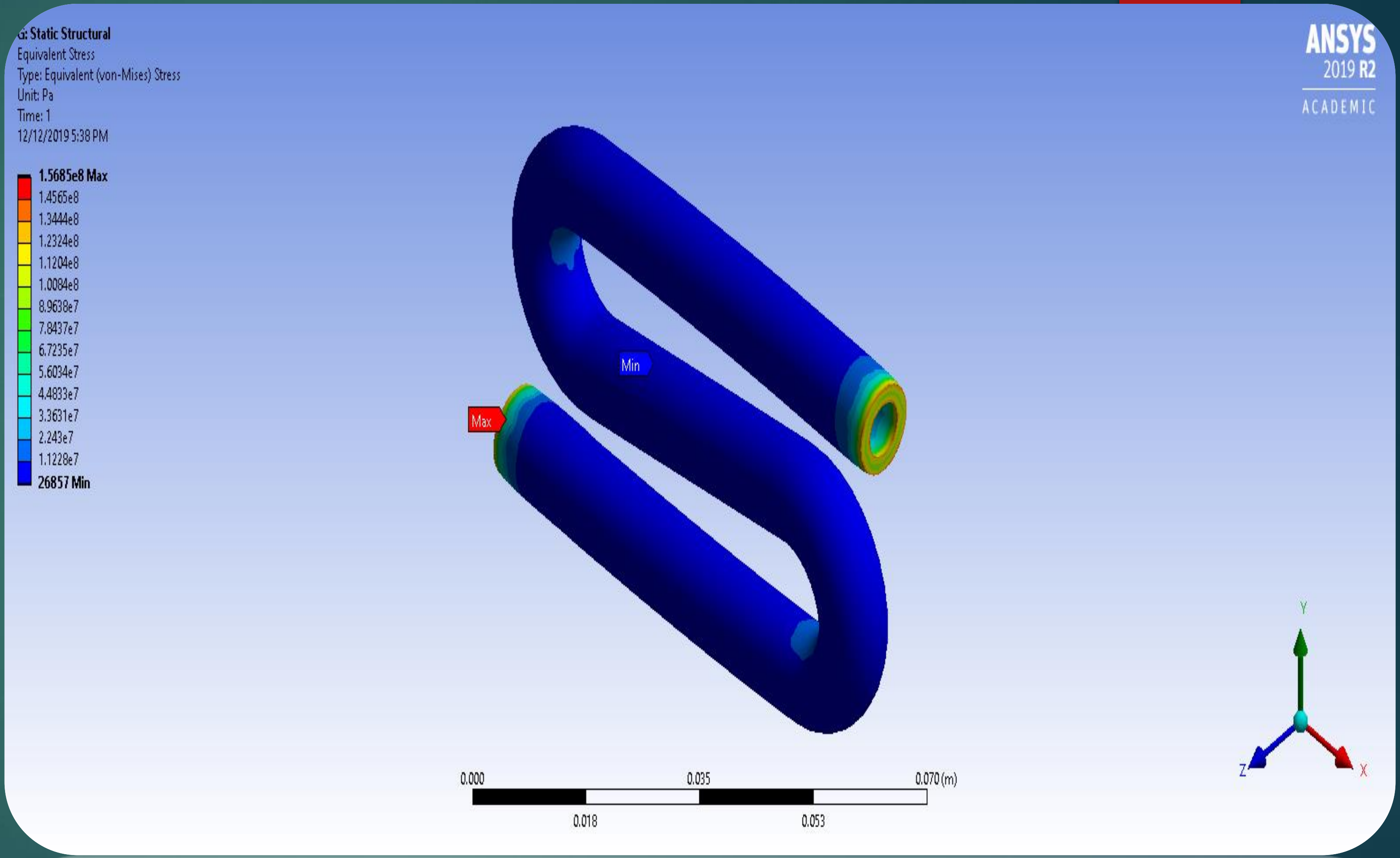
Results:


Static Structural
Equivalent Elastic Strain
Type: Equivalent Elastic Strain
Unit: m/m
Time: 1
12/12/2019 5:37 PM
0.0016177 Max
0.001438
0.0012583
0.0010786
0.00089894
0.00071926
0.00053957
0.00035989
0.00018021
5.214e-7 Min
ANSYS
2019 R2
ACADEMIC
Max
Min
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X

Results:


G: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
12/12/2019 5:37 PM
6.2248e-5 Max
5.5332e-5
4.8415e-5
4.1499e-5
3.4582e-5
2.7666e-5
2.0749e-5
1.3833e-5
6.9165e-6
0 Min
Max
Min
ANSYS
2019 R2
ACADEMIC
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X

Results:



G: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: Pa
Time: 1
12/12/2019 5:38 PM
1.5685e8 Max
1.4565e8
1.3444e8
1.2324e8
1.1204e8
1.0084e8
8.9638e7
7.8437e7
6.7235e7
5.6034e7
4.4833e7
3.3631e7
2.243e7
1.1228e7
26857 Min
ANSYS
2019 R2
ACADEMIC
Max
Min
0.000
0.035
0.070 (m)
0.018
0.053
Y
Z
X