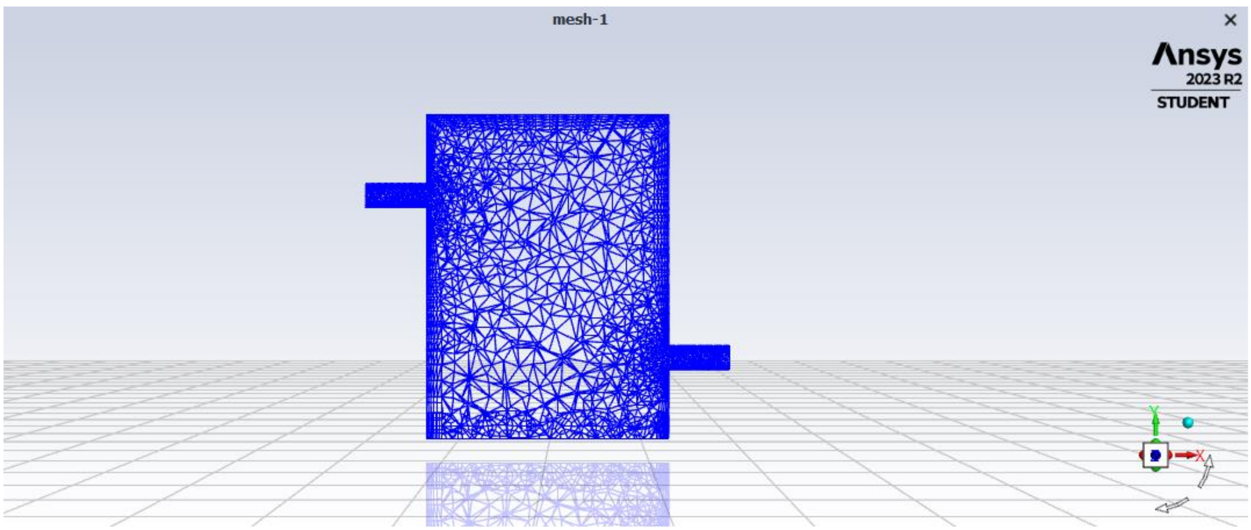
Task 1

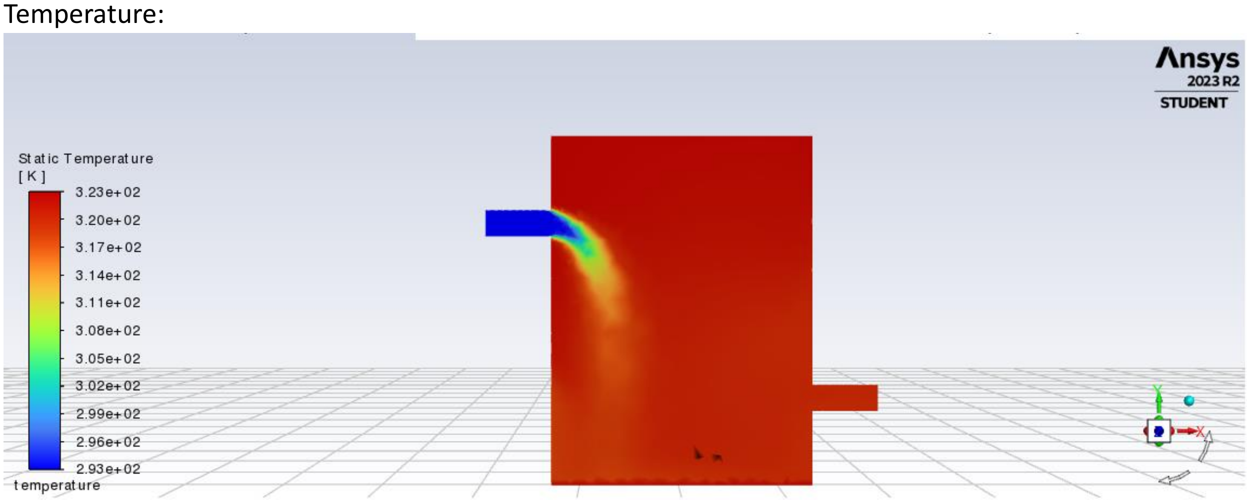
D1)

Operating temperature: 308 Kelvin
Operating density: 994.03 kg/m^3
Thermal expansion: 0.000346/Kelvin
Time step size: 1 second
Maximum number of iterations: 15
Operating temperature was found but taking the average temperature of the system which was 50 degrees Celsius plus the 20 degrees Celsius divided by 2. Operating density was found through NIST formula. By using the operating density, the thermal expansion value was then calculated. To calculate at 5 min, time step size of 1 second was used where it was run for 300 times to reach 5 minutes. 15 maximum number of iteration was used where that was the maximum iteration that was used per 1 second.

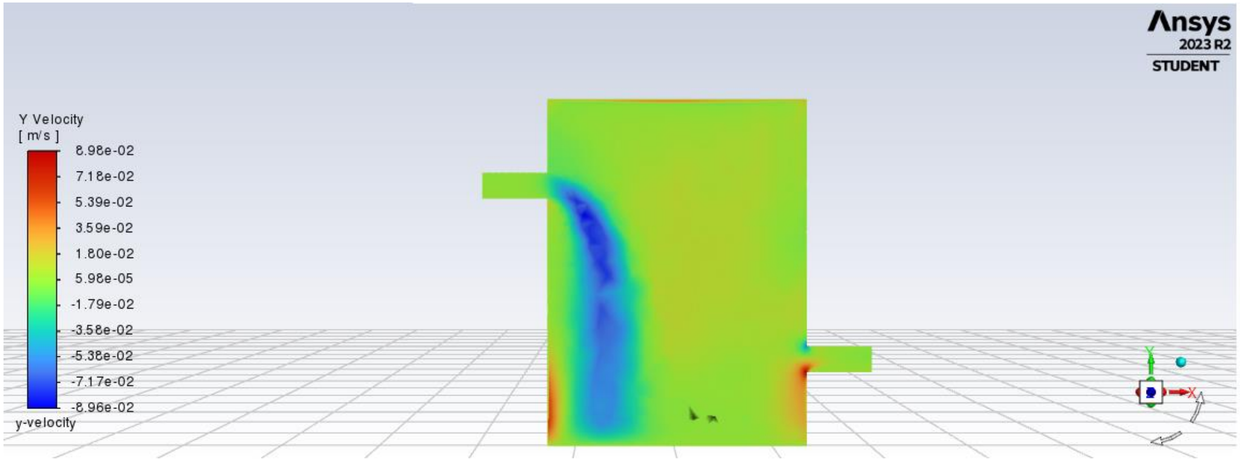


D2)

Temperature:

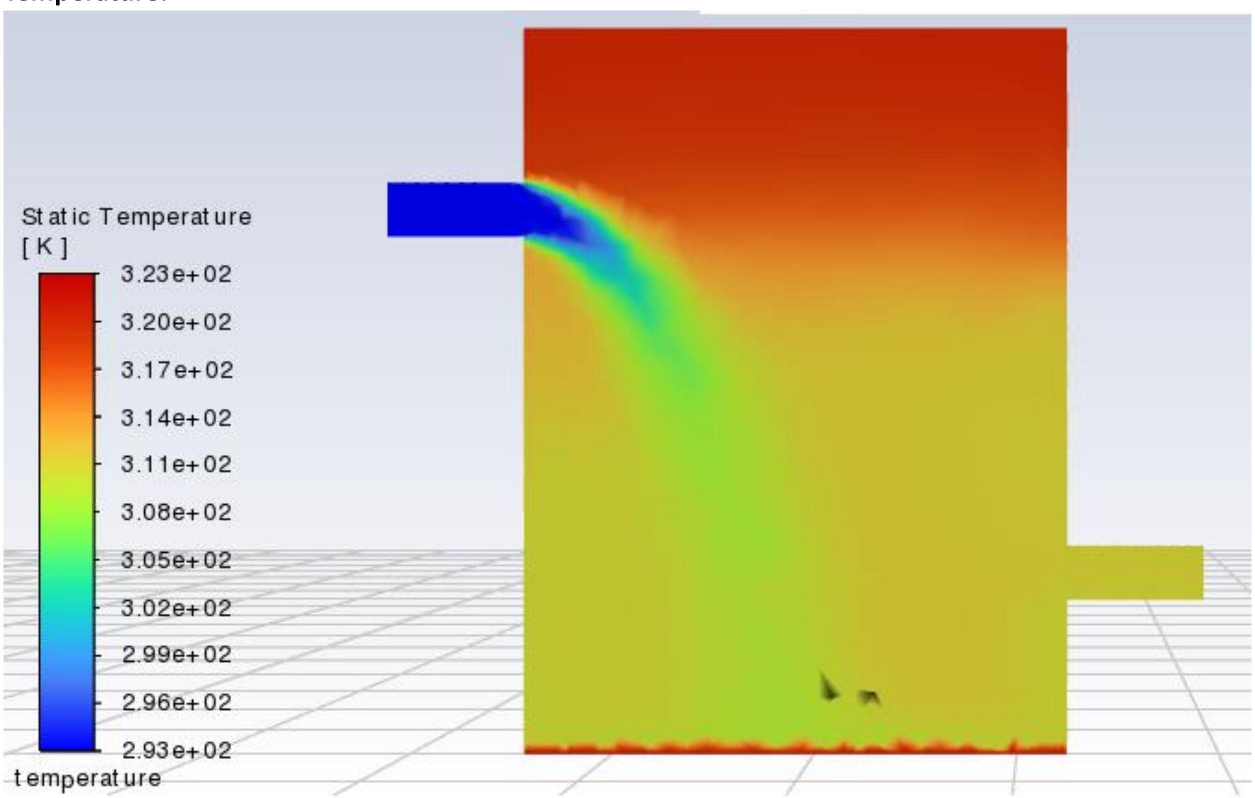


y-velocity:

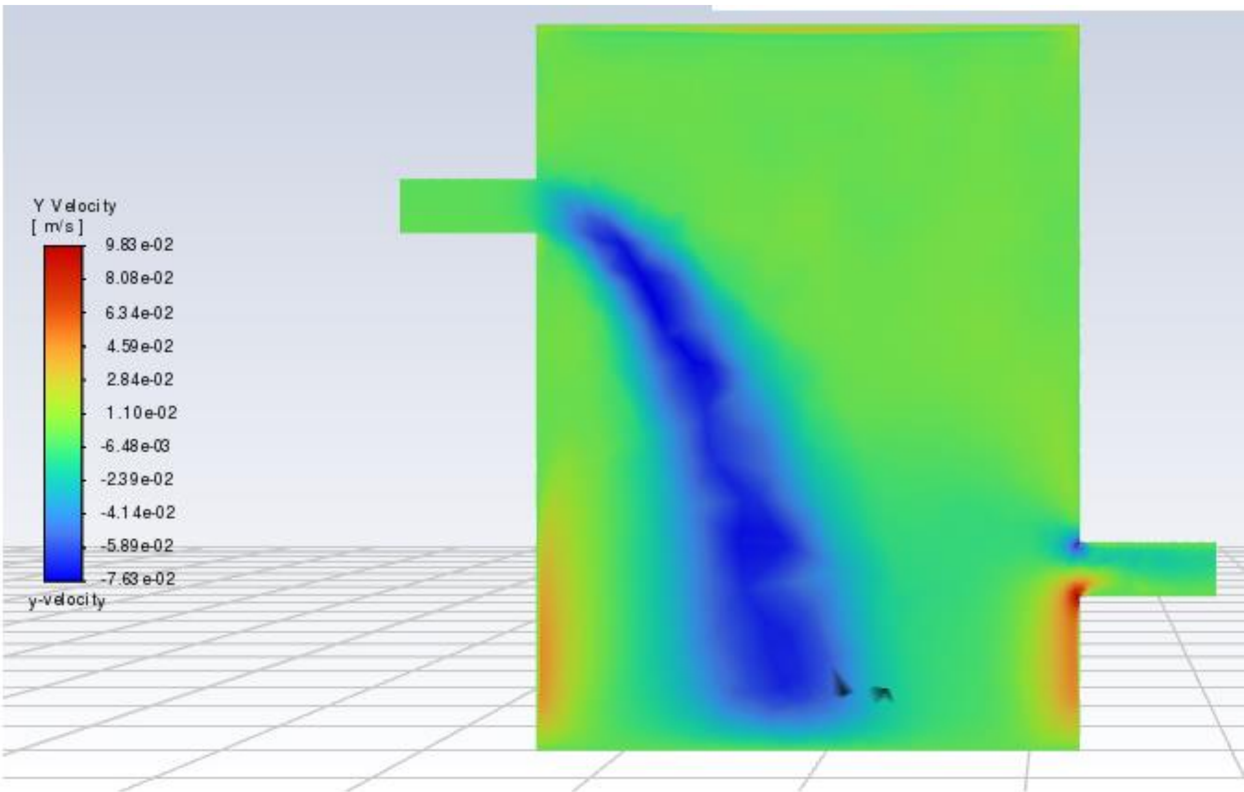


D3)

Temperature:



y-velocity:



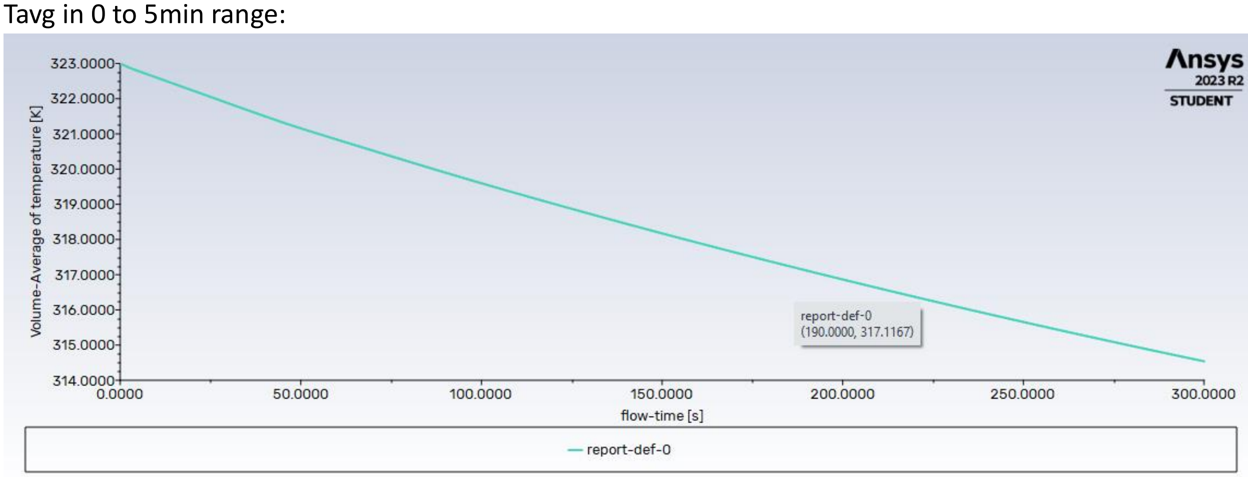
D4)

Tavg at T= 5min: 313.31 K

```
Calculation complete.

        report-def-0
 -------------------
                  Volume-Average                   [K]
-------------------------------- -------------------
                           fluid           313.31036
```

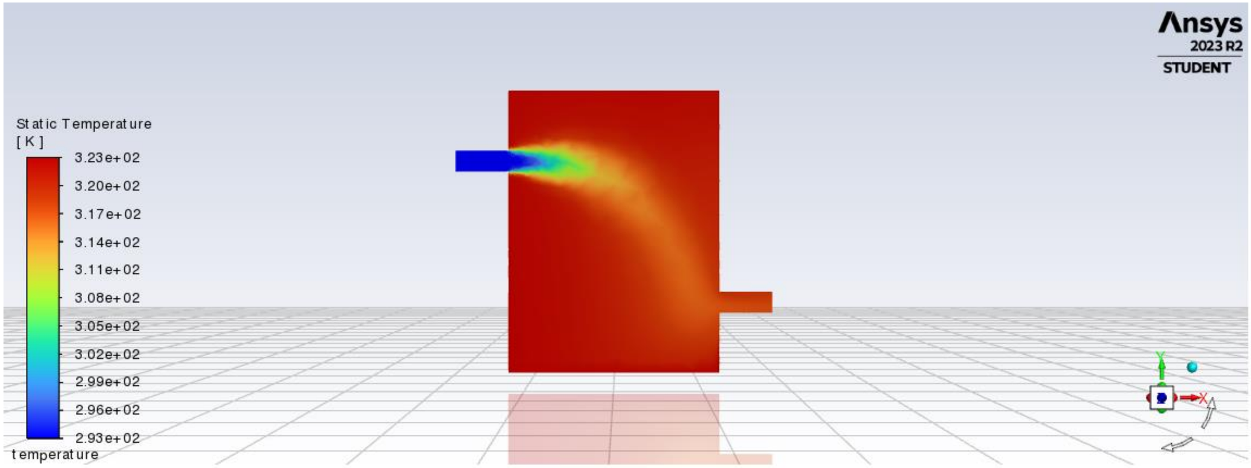
Tavg in 0 to 5min range:



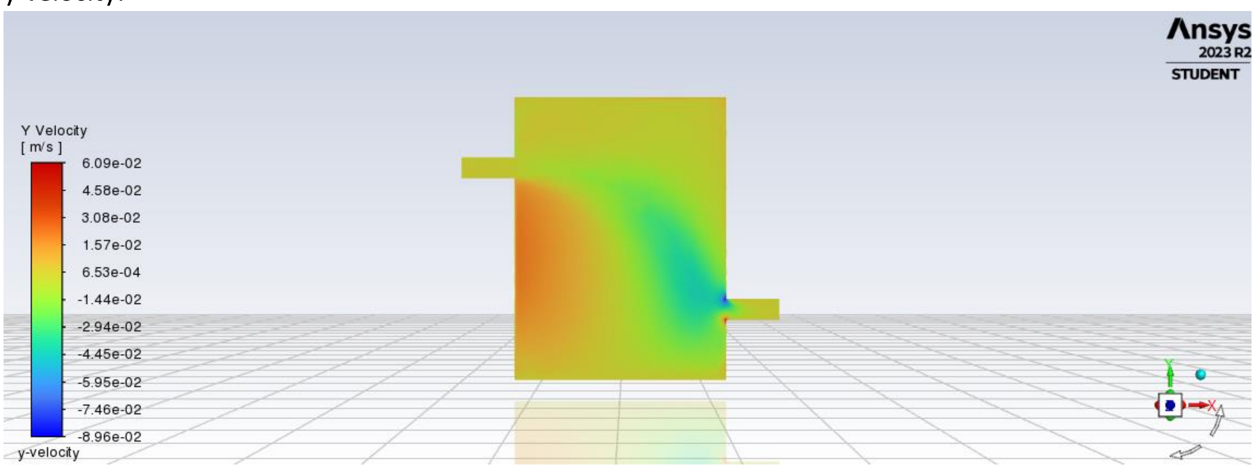
Task 1b

D5)

Temperature:



y-velocity:

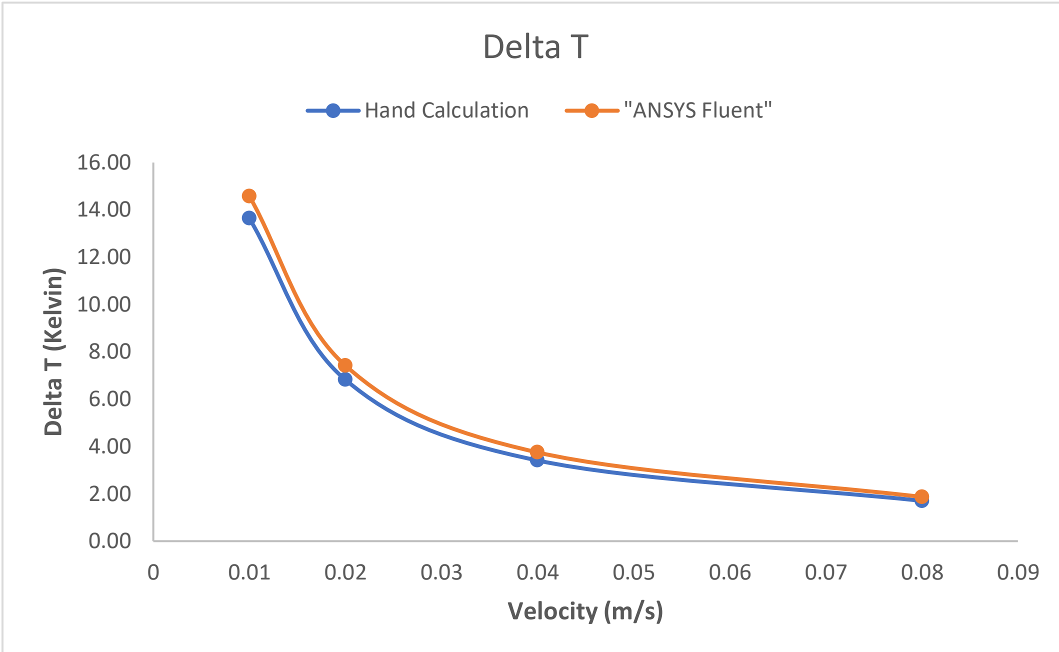


Task 2a

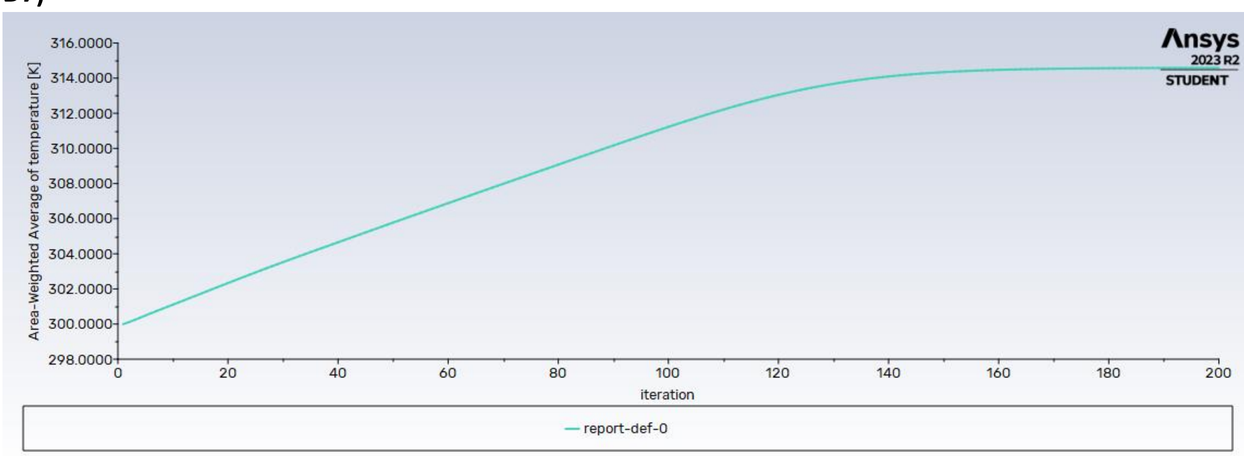
D6)

Hand Calculation	
velocity (m/s)	**Delta T (K)**
0.01	13.64
0.02	6.82
0.04	3.41
0.08	1.70

ANSYS Fluent	
velocity (m/s)	**Delta T (K)**
0.01	14.58
0.02	7.42
0.04	3.75
0.08	1.87

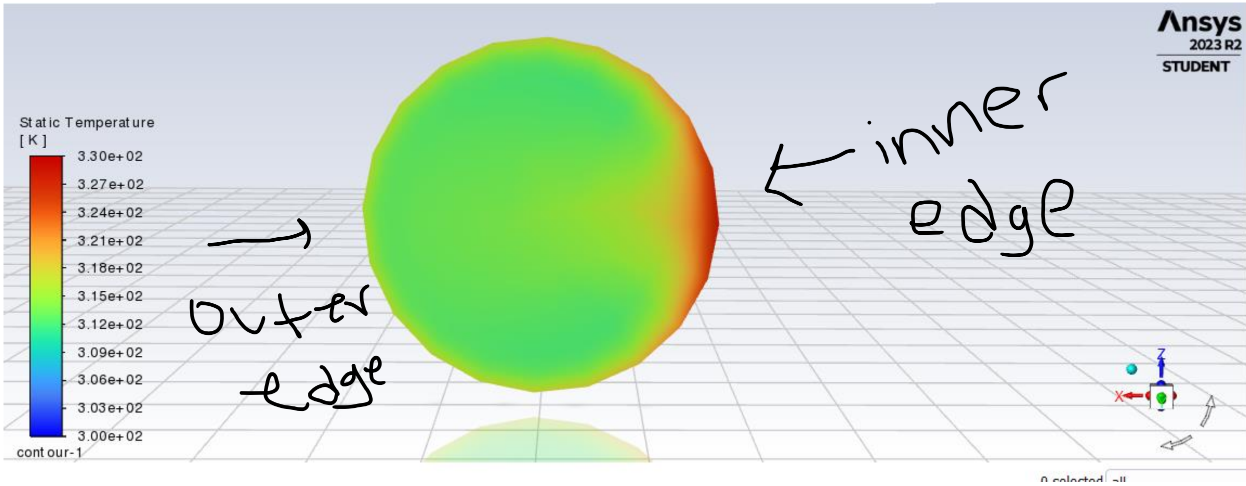

Delta T
Hand Calculation
"ANSYS Fluent"
Delta T (Kelvin)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Velocity (m/s)

D7)

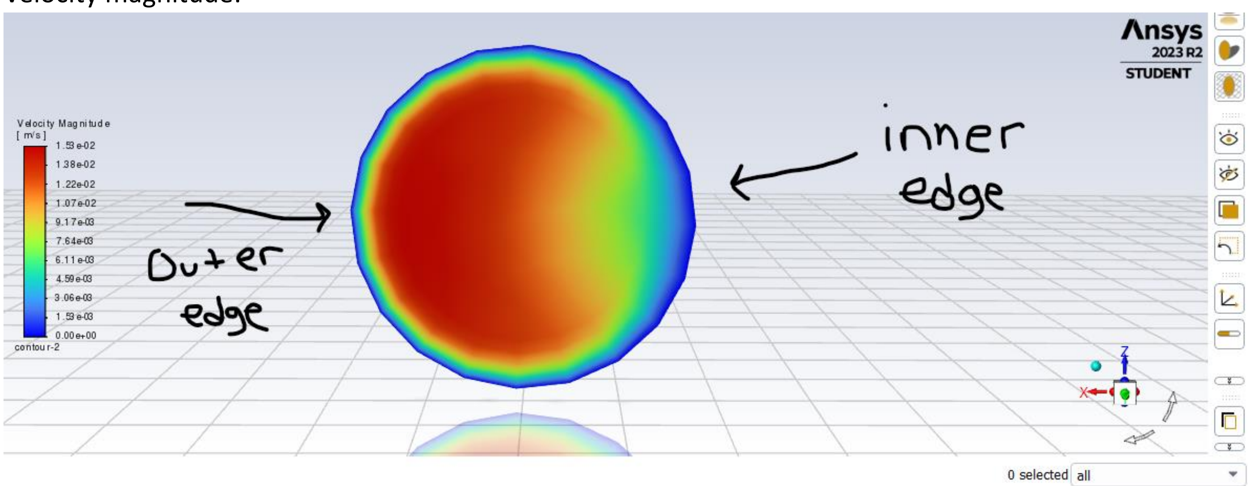

Ansys
2023 R2
STUDENT
Area-Weighted Average of temperature [K]
316.0000
314.0000
312.0000
310.0000
308.0000
306.0000
304.0000
302.0000
300.0000
298.0000
0
20
40
60
80
100
120
140
160
180
200
iteration
report-def-0

D8)

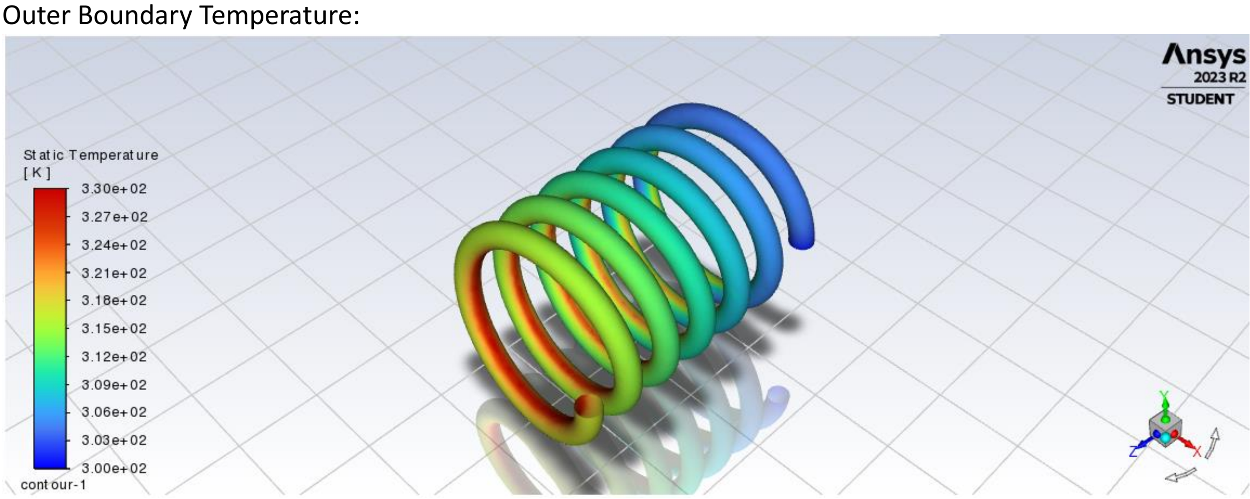
Temperature:



Velocity magnitude:

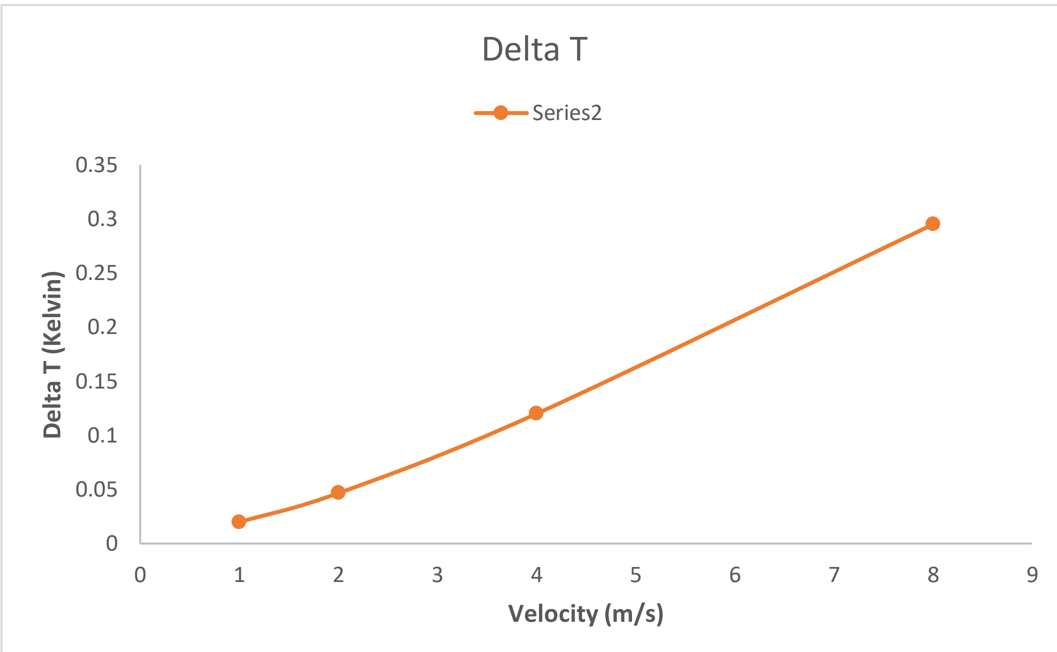


Outer Boundary Temperature:



D9)

velocity (m/s)	Delta T (K)
1	0.0198
2	0.0466
4	0.12
8	0.295



D10)

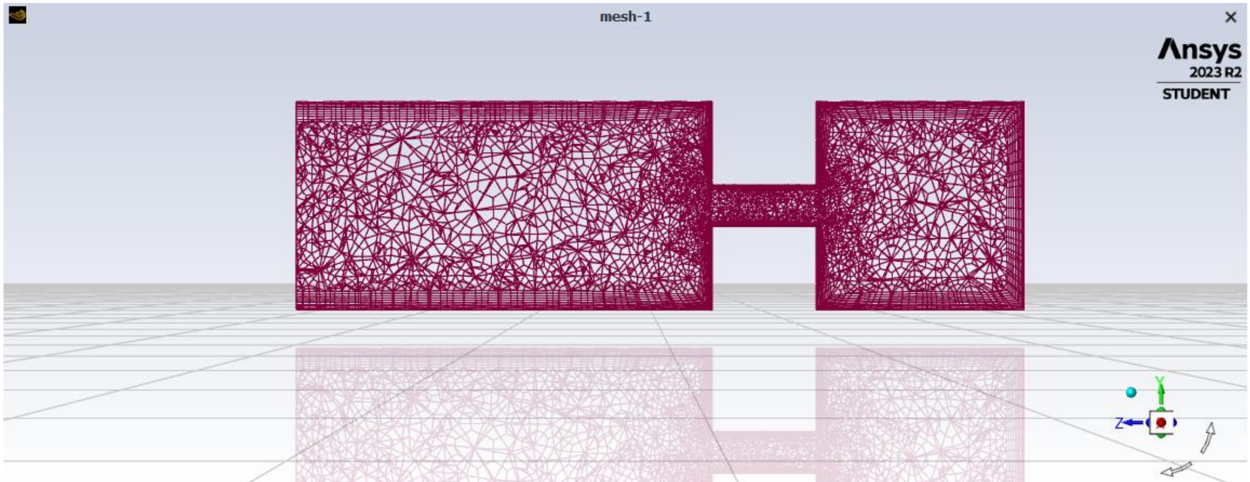
The reason why delta T increases as velocity increases is because viscous is now accounted for. There will be kinetic energy lost in the process. Since viscous term is always dissipated it will be negative which will increase in thermodynamic energy when increasing velocity. This is why temperature will increase.

D11)

Time step size: 0.00025 seconds

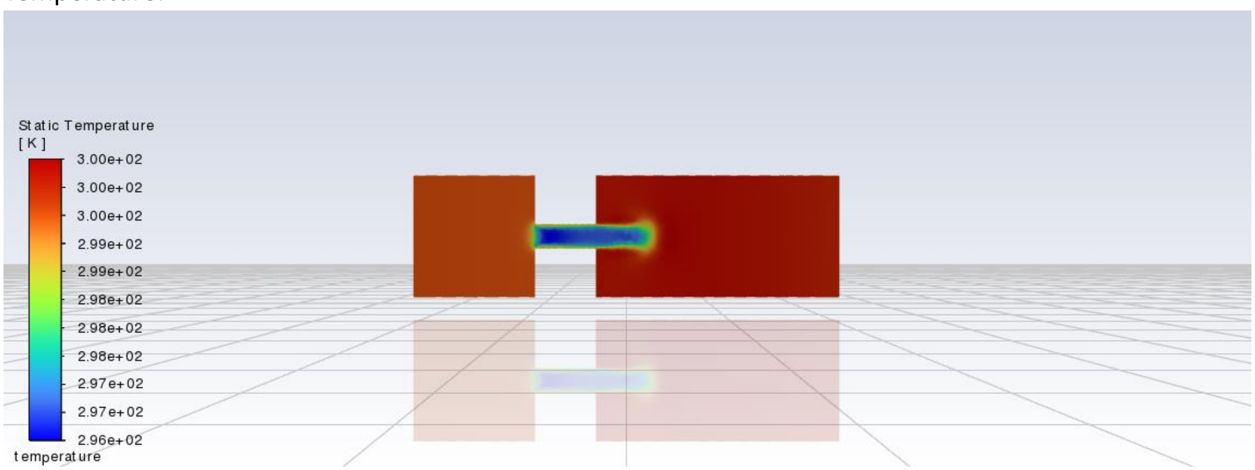
Maximum number of iterations: 20

The reason these values were chosen were because the simulation is only for 0.005 seconds. This would require the time step size to be very small and be able to run 20 number of time steps to compete the 0.005 seconds.

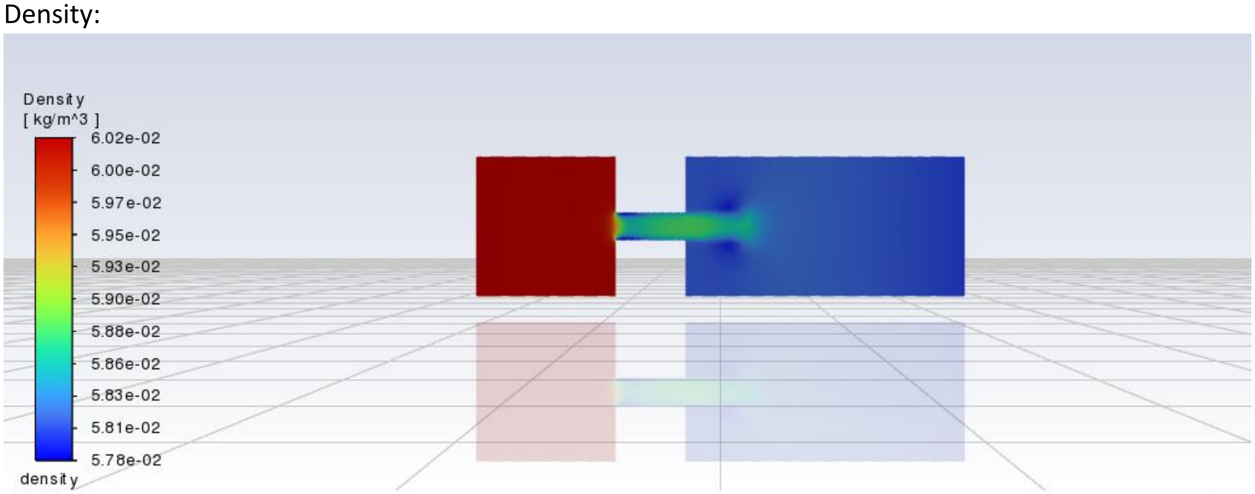


D12)

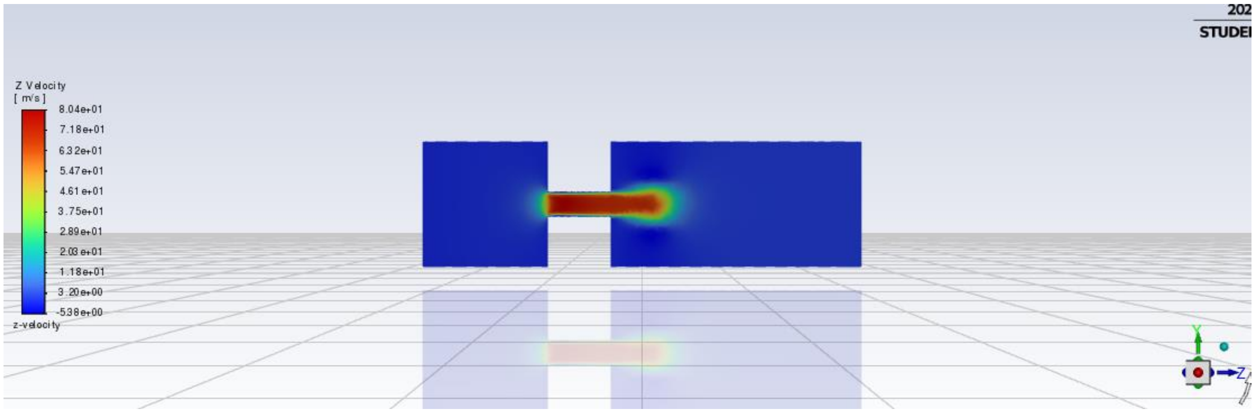
Temperature:



Density:

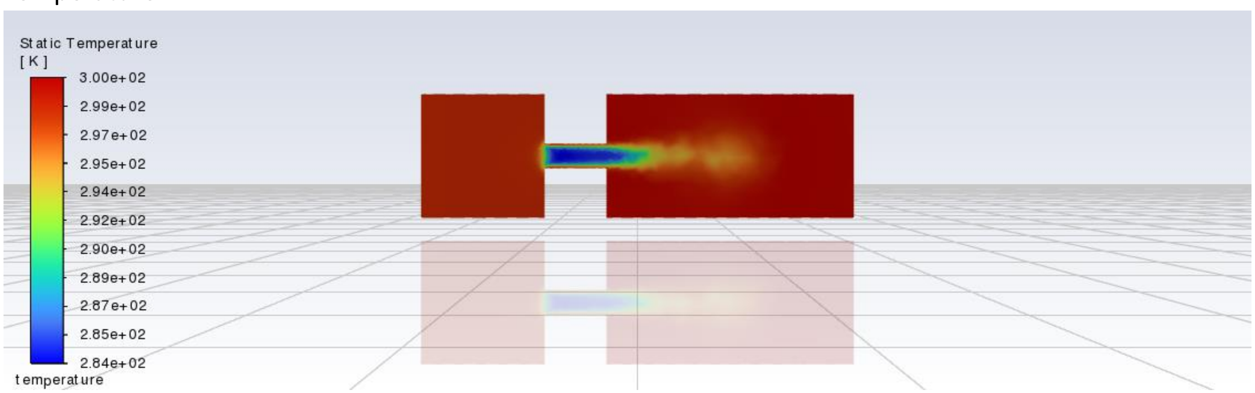


z-velocity:

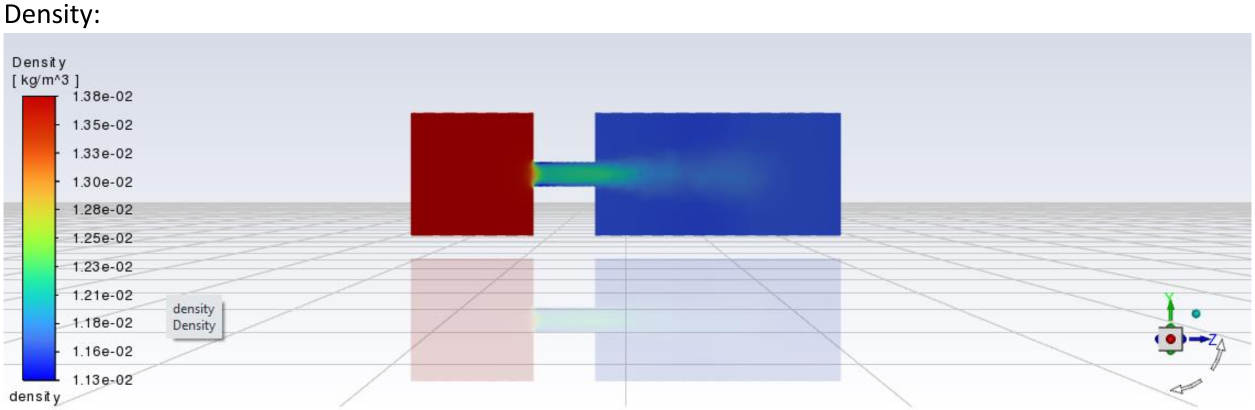


D13)

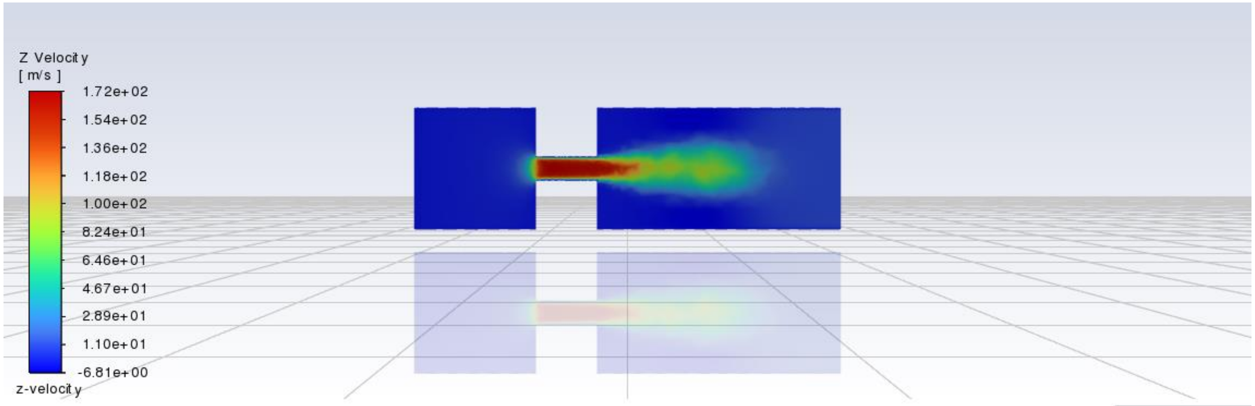
Temperature:



Density:

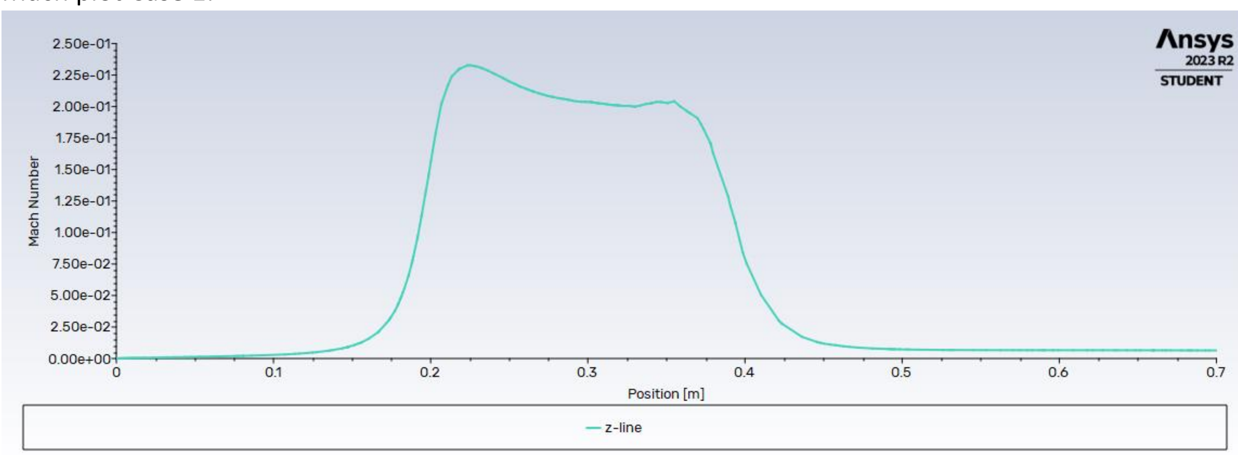


z-velocity:

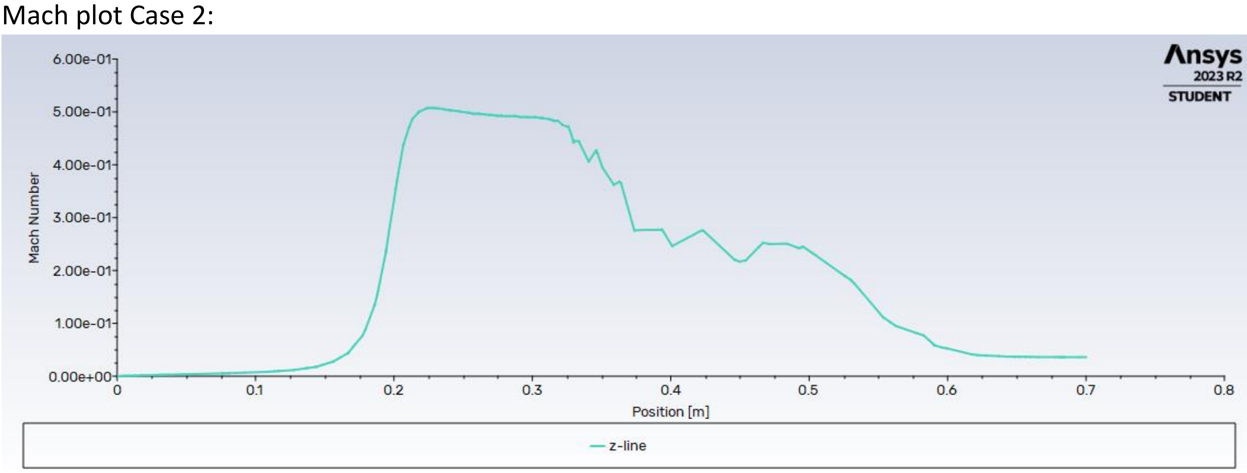


D14)

Mach plot Case 1:



Mach plot Case 2:



None of the cases reaches the supersonic regime as they are all under the value of 1.

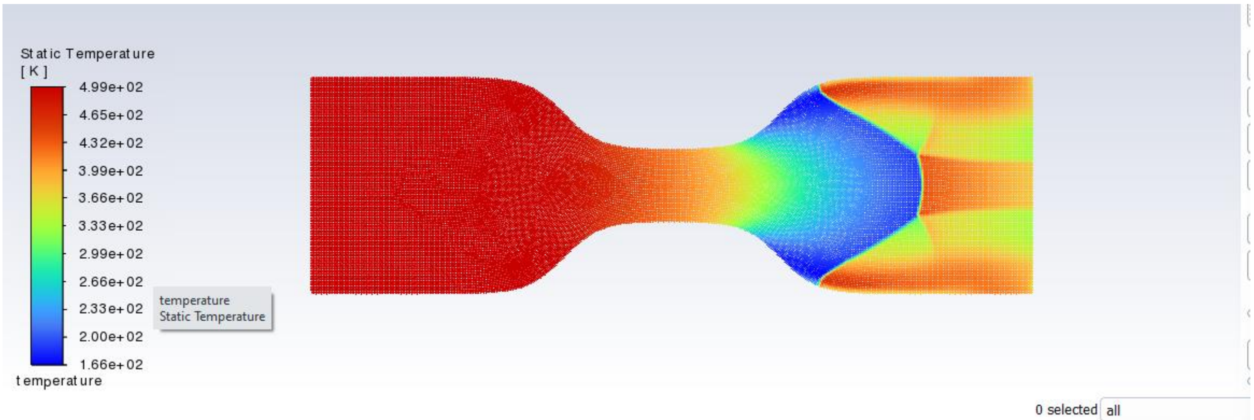
D15)

Case 2 produces the higher velocity of the air jet. Case 2 also produces the lower temperature of the air jet. The reason for this is because in the momentum equation, the ratio of the pressure difference per baseline pressure is a ratio resulting in a larger temperature difference.

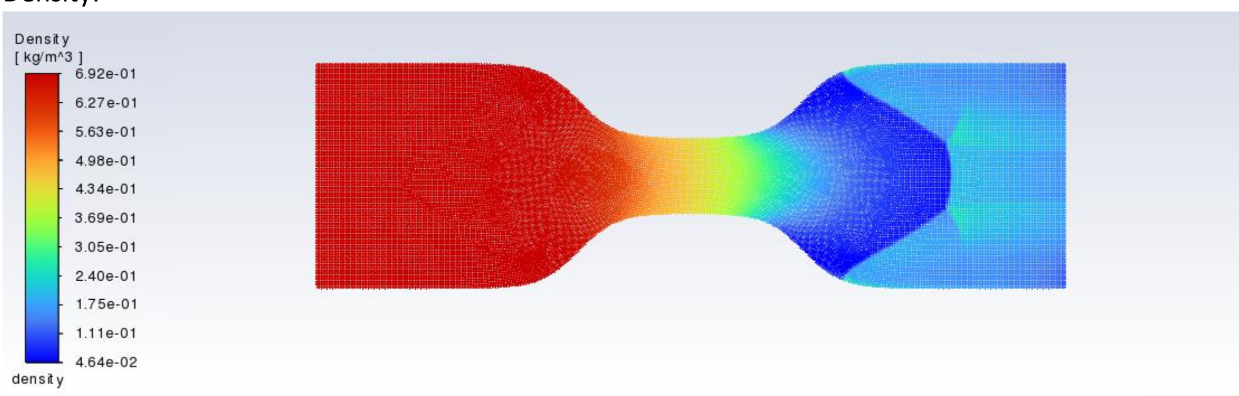
Task 4a

D16)

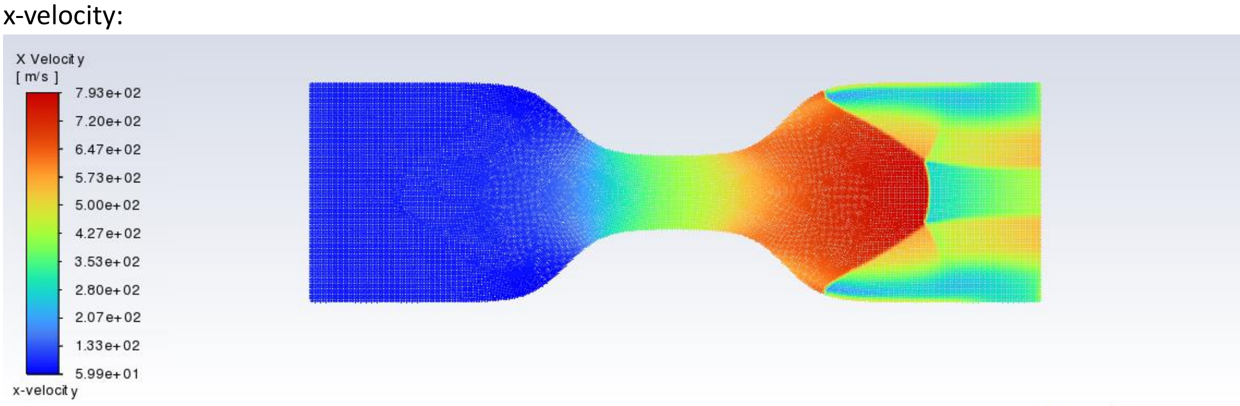
Temperature:



Density:

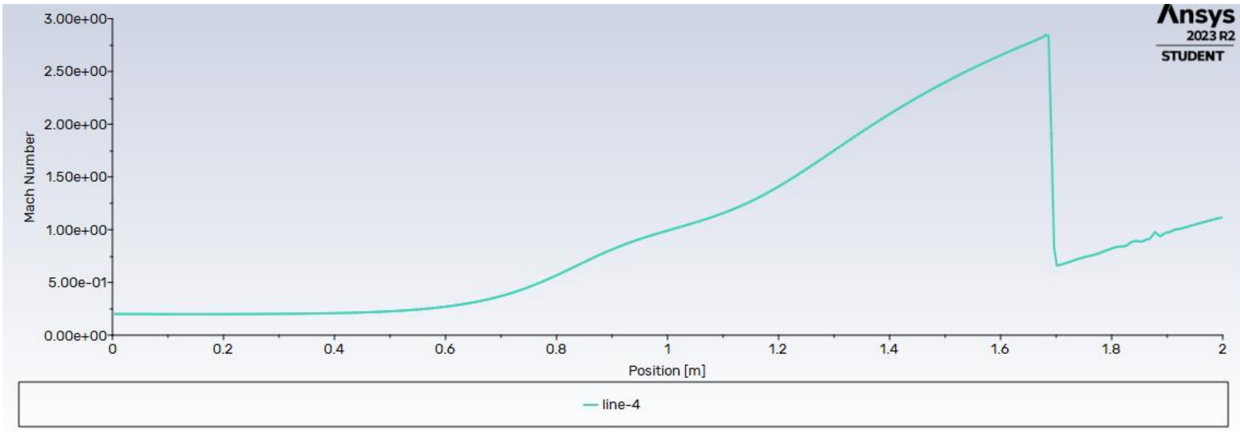


x-velocity:



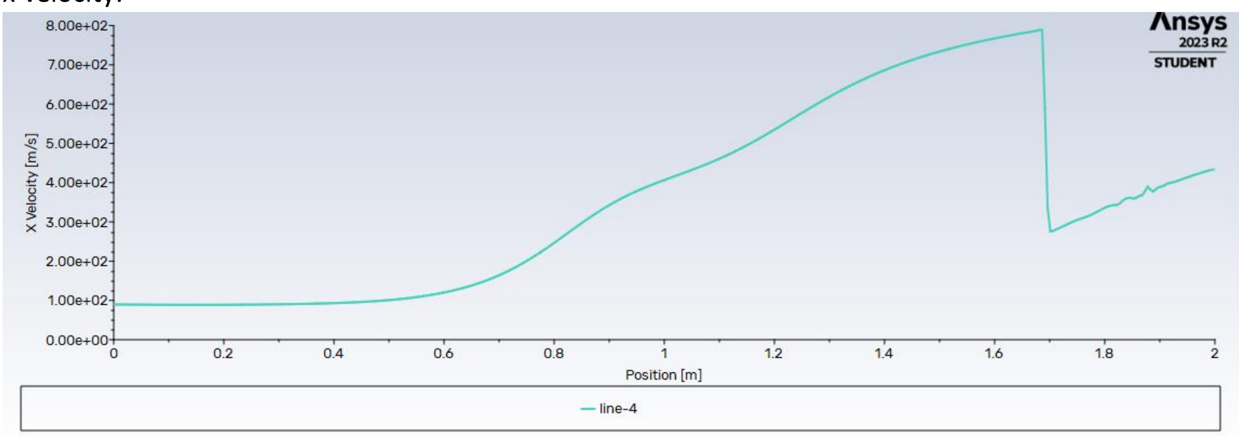
D17)

Mach:



This plot shows that in task 4a, it the mach values are in the supersonic region which is values between 1.3 - 5.

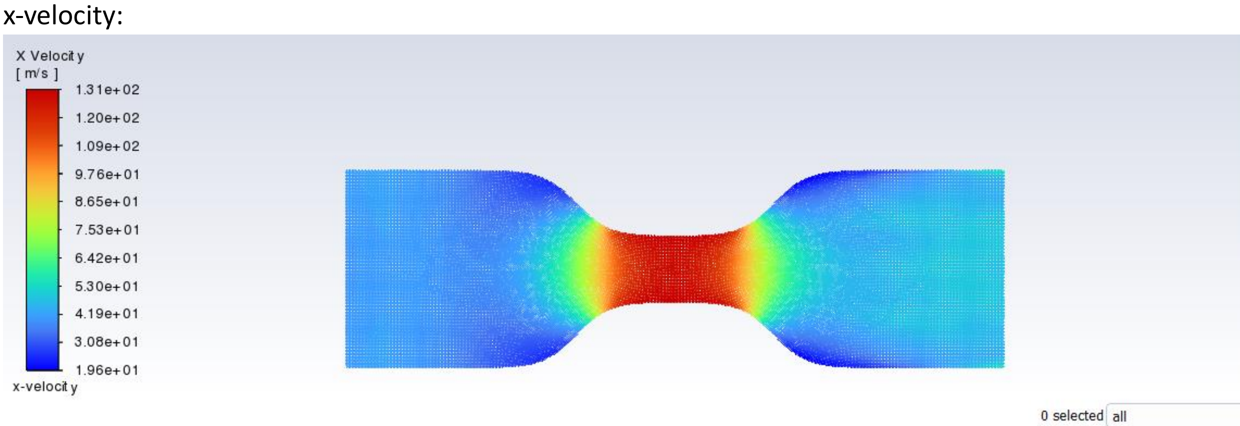
x-velocity:



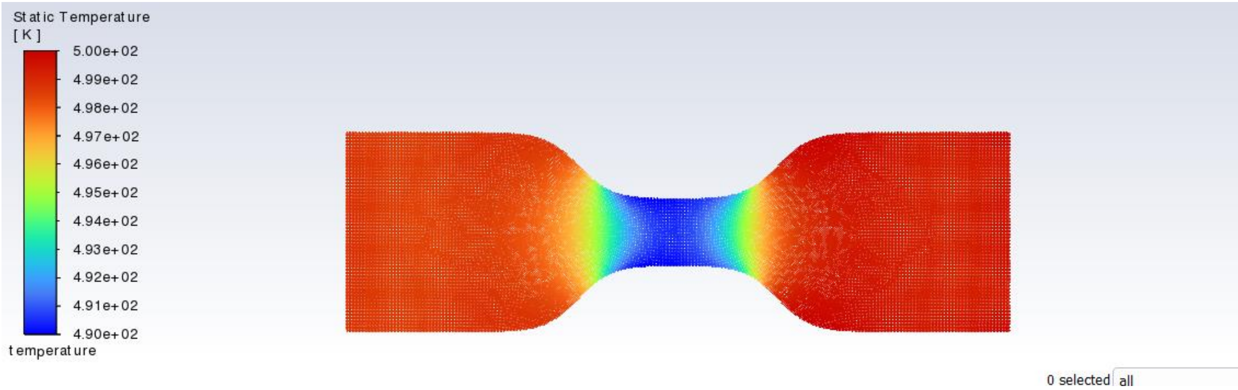
Task 4b

D18)

x-velocity:

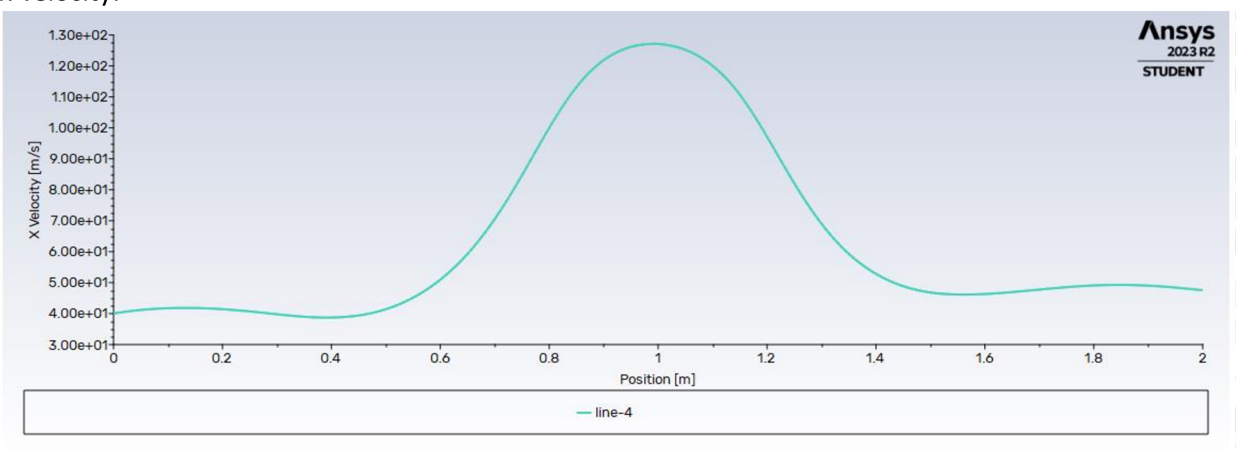


temperature:

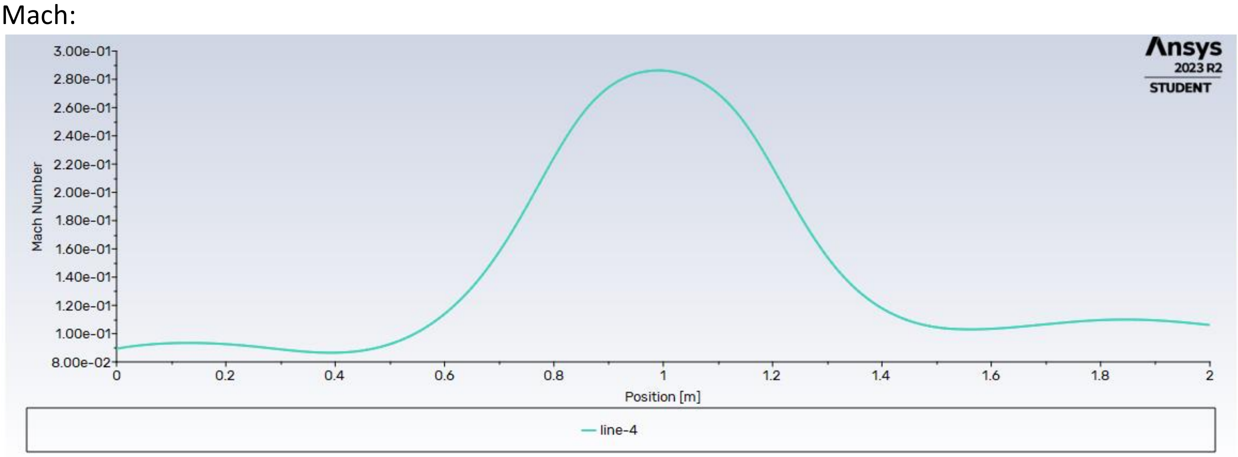


D19)

x-velocity:



Mach:

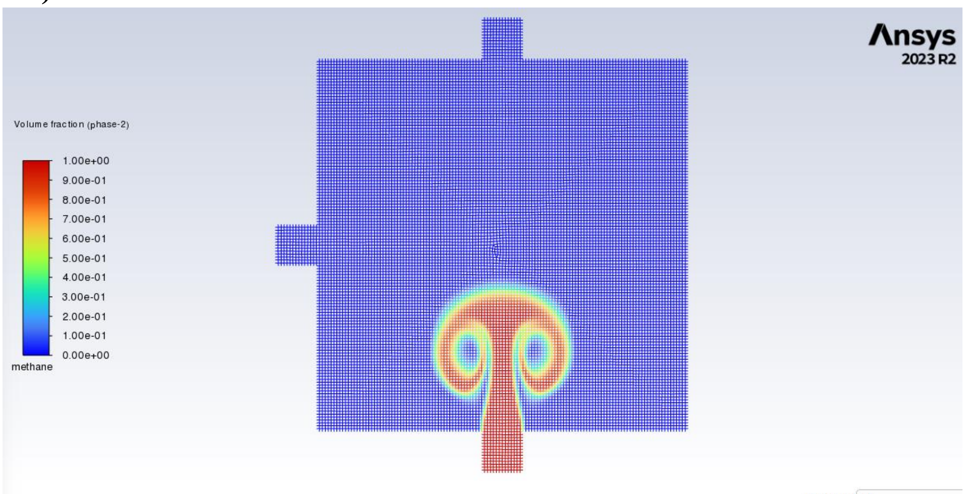


This plot shows that in task 4b, it the mach values are in the subsonic region which would be a value less than 0.3.

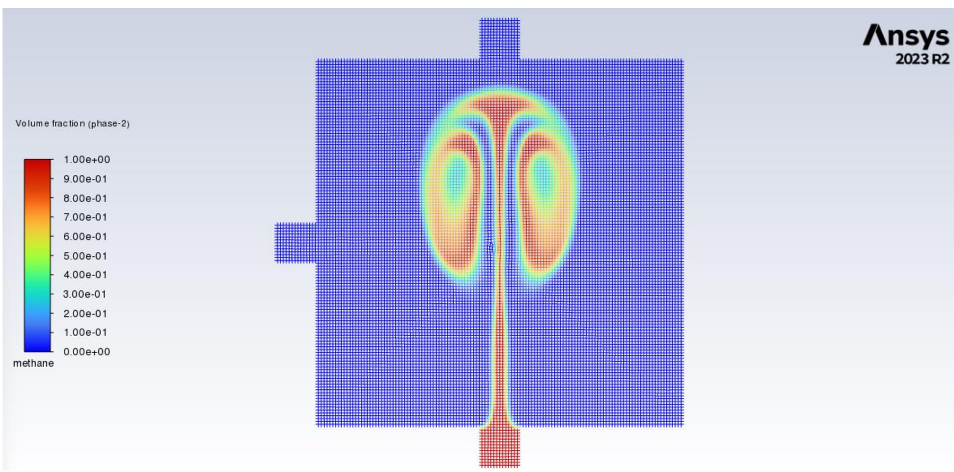
No Collaboration.

Task 1

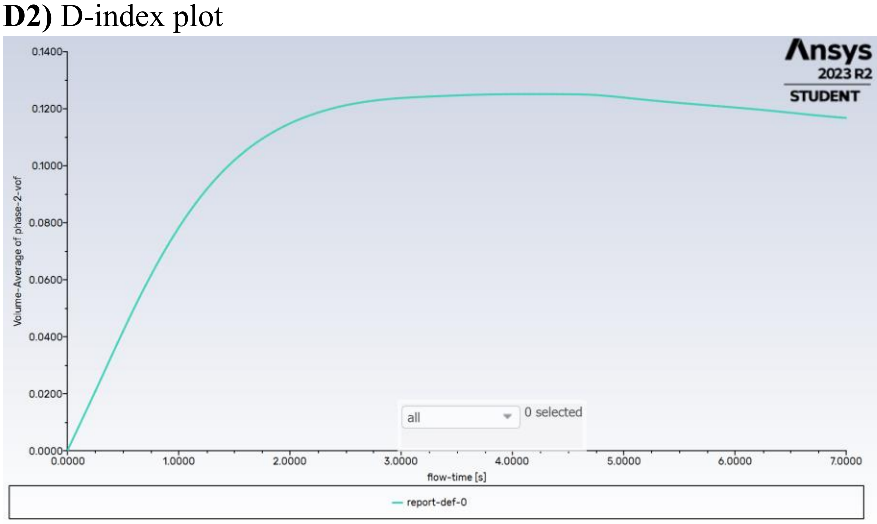
D1) Volume fraction of methane at t = 1s



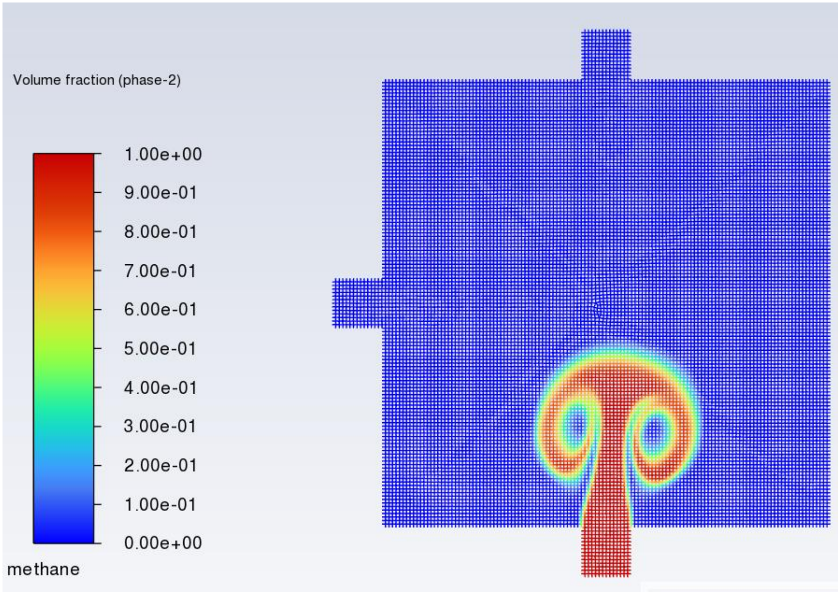
Volume fraction of methane at t = 2.5s



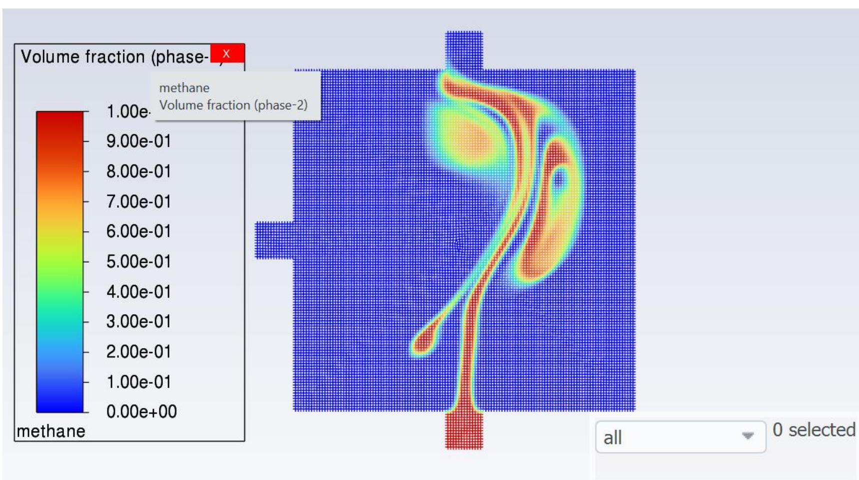
D2) D-index plot



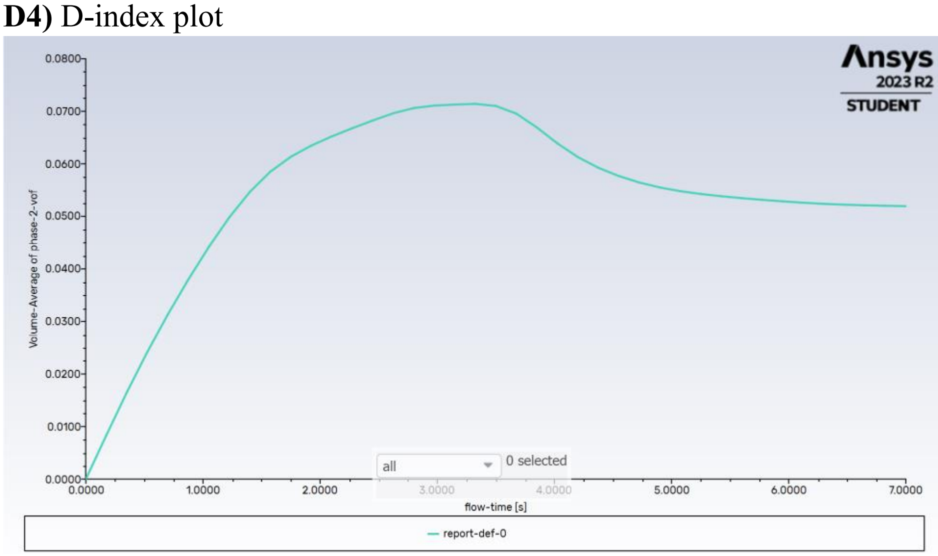
D3) Volume fraction of methane at t = 1s



Volume fraction of methane at t = 2.5s

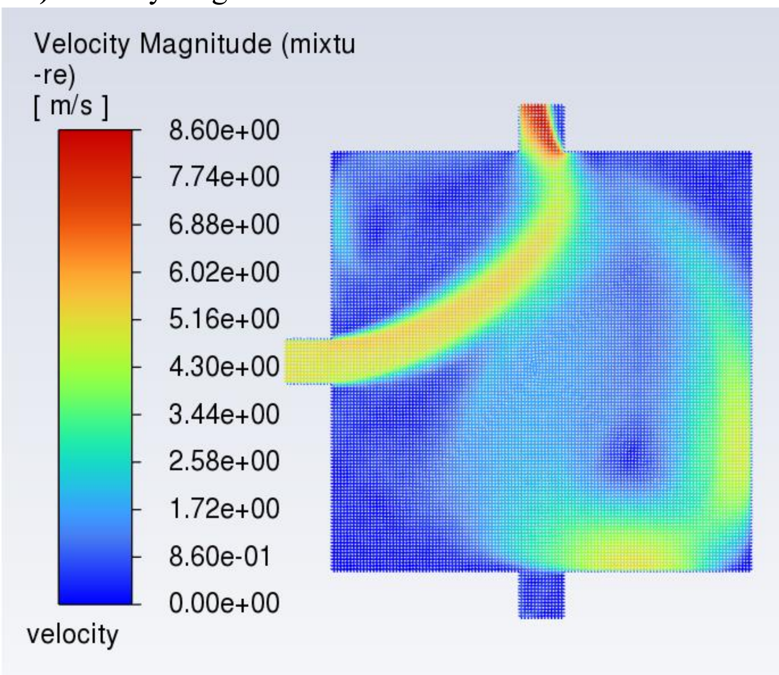


D4) D-index plot



The injection of the fresh air does help in reducing the D-index value or the volume average of methane. As you can see there is more decrease of the D-index value in the 2nd scenario. The reason for this is because the fresh air helps the methane go out of the top opening faster.

D5) Velocity magnitude at t = 7s

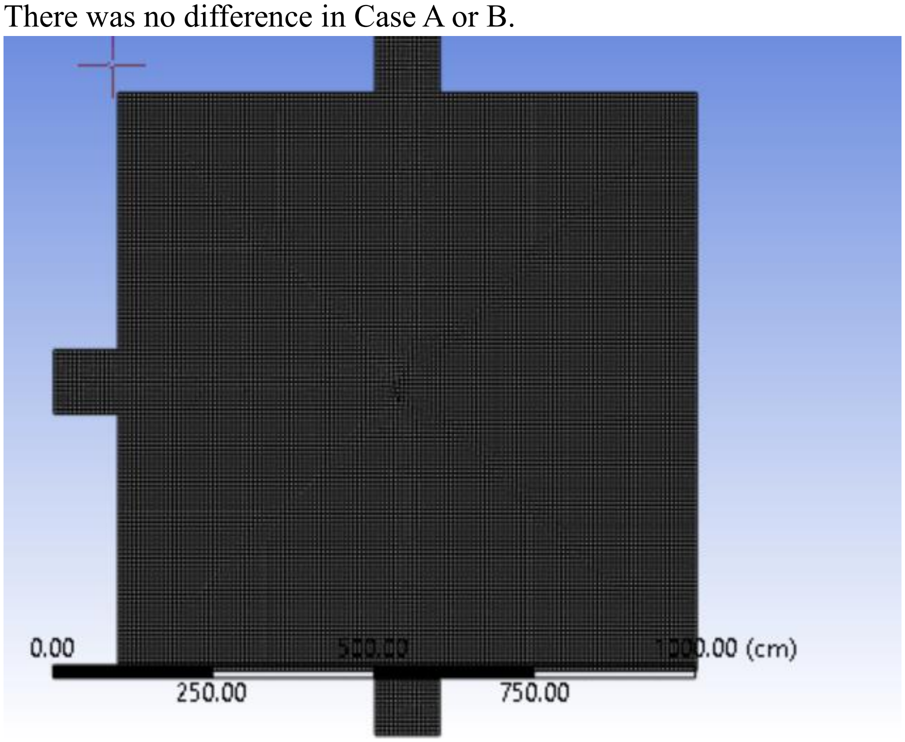


D6) Mesh Resolution: Element size is 7cm.

Time step size: .05

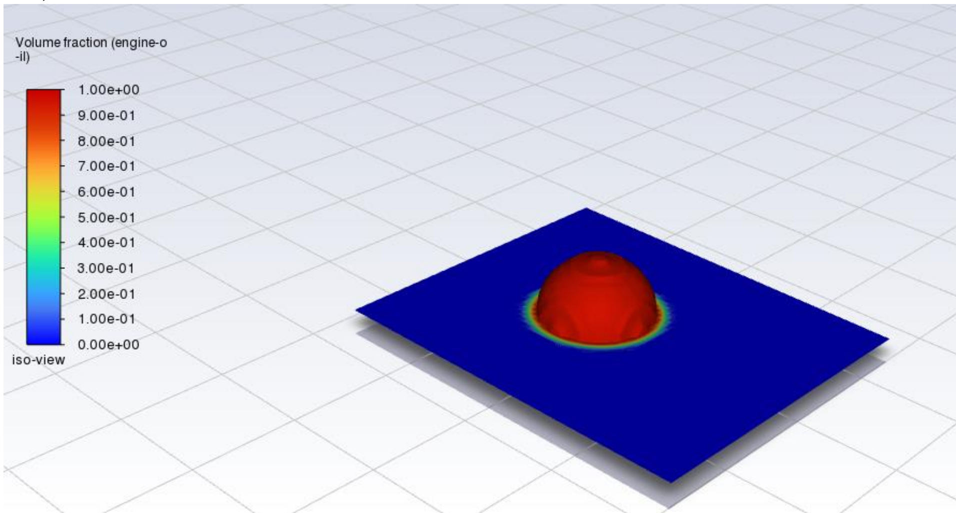
Number of steps: 50

There was no difference in Case A or B.

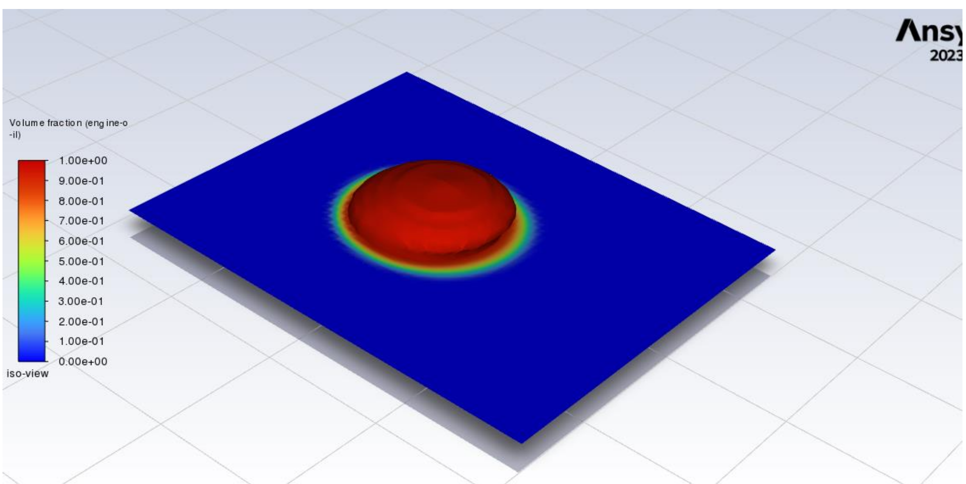


Task 2

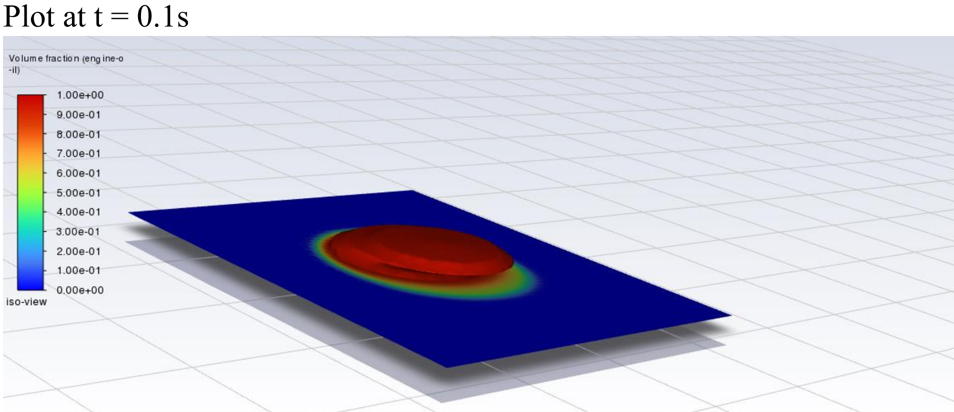
D7) Plot at t = 0s



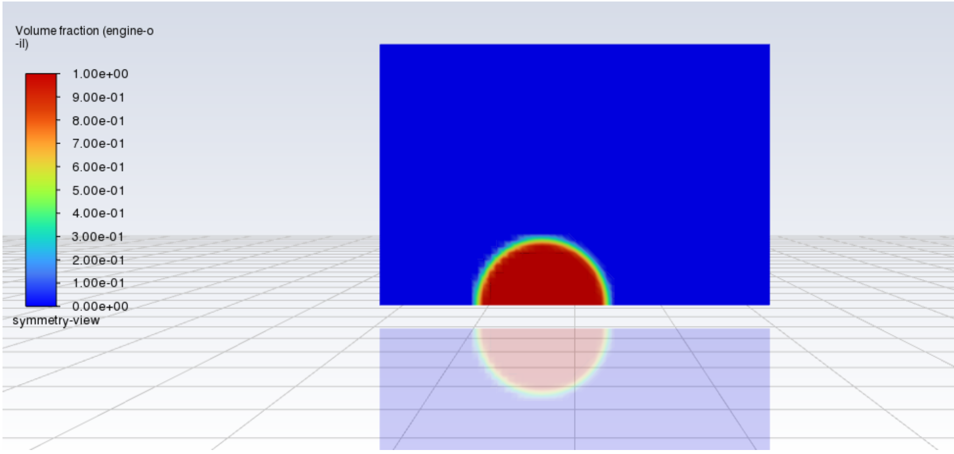
Plot at t = 0.05s



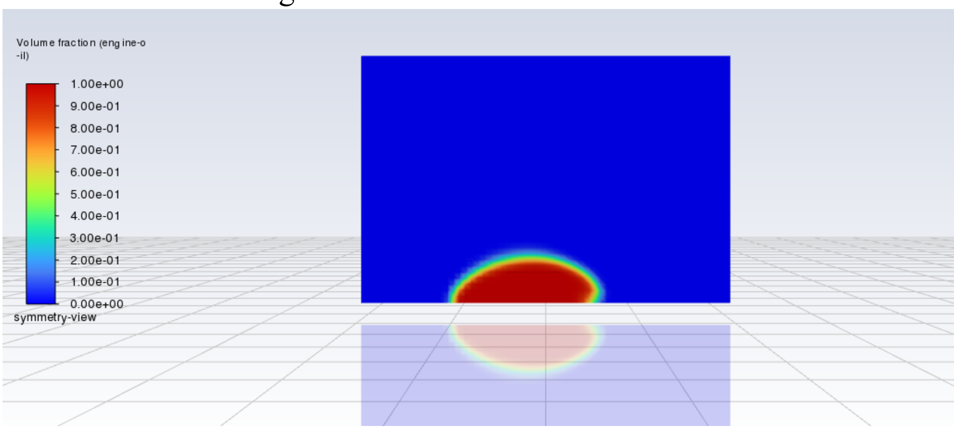
Plot at t = 0.1s



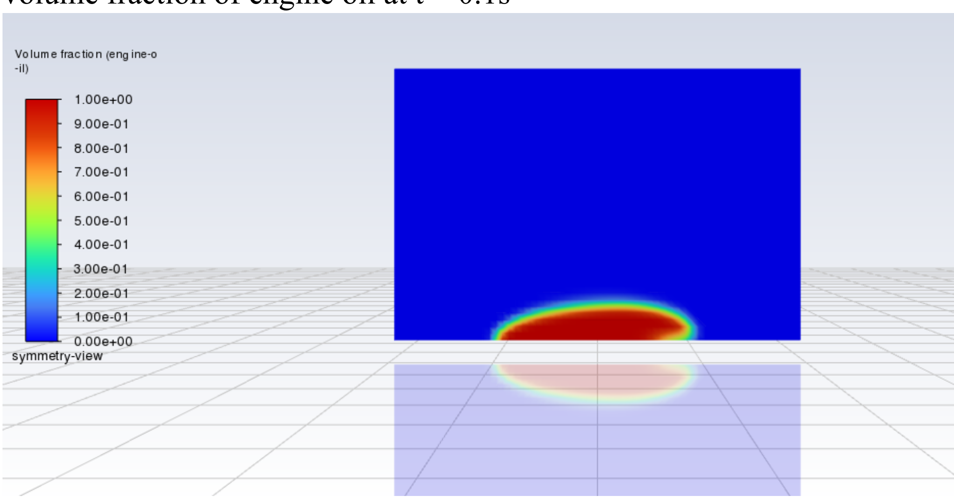
D8) volume fraction of engine oil at t = 0



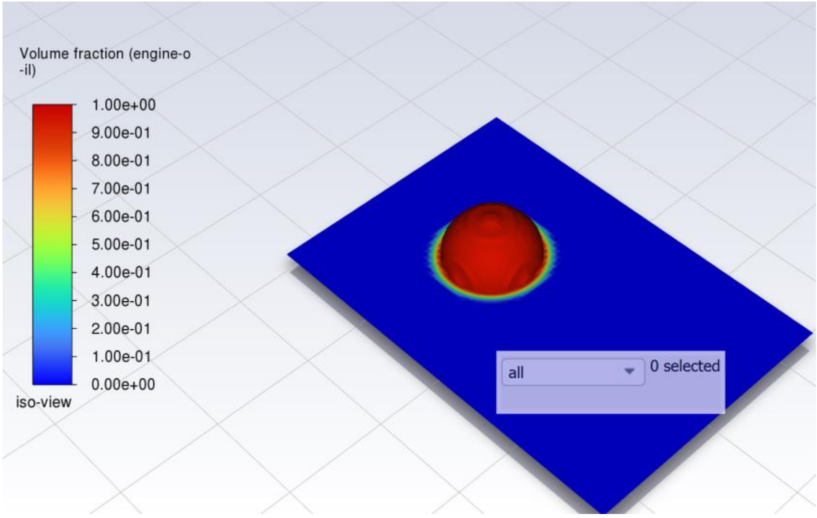
volume fraction of engine oil at t = 0.05s



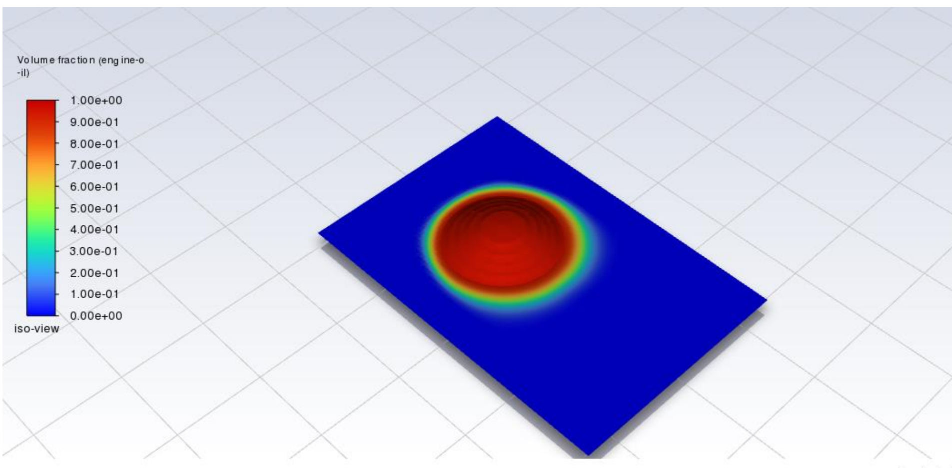
volume fraction of engine oil at t = 0.1s



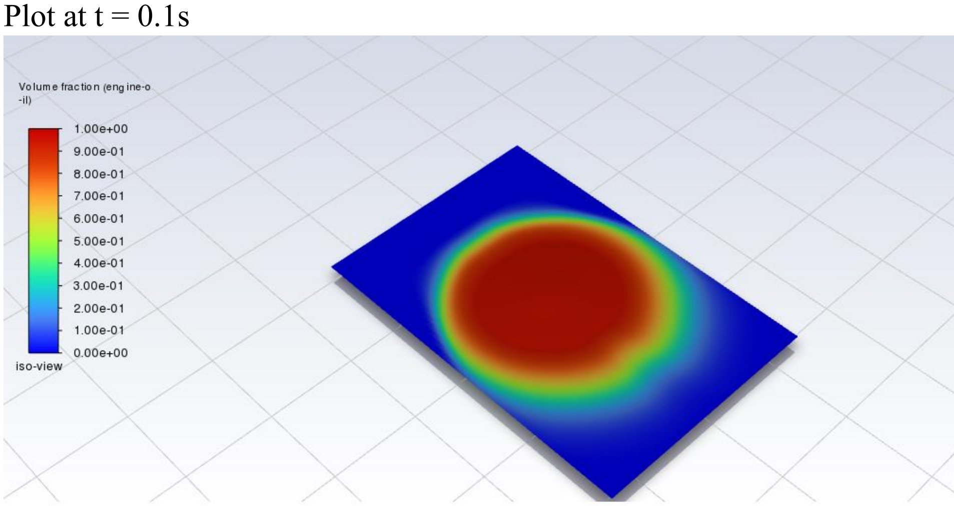
D9) Plot at t = 0s



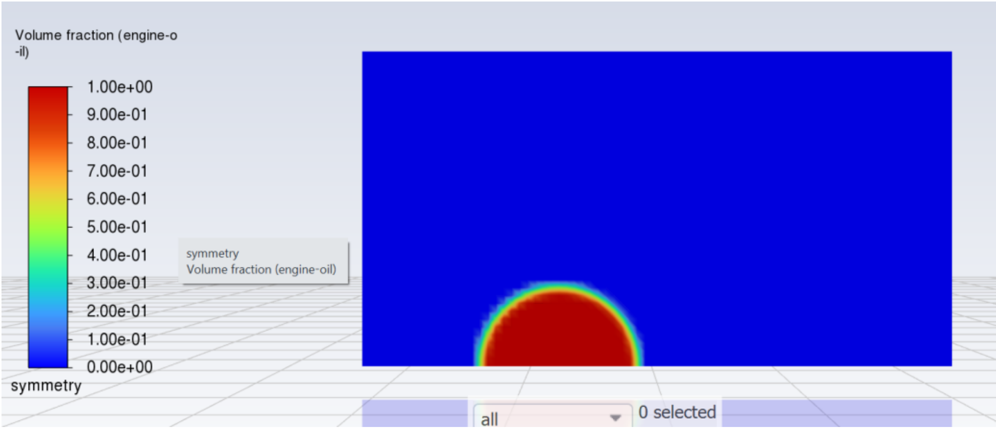
Plot at t = 0.05s



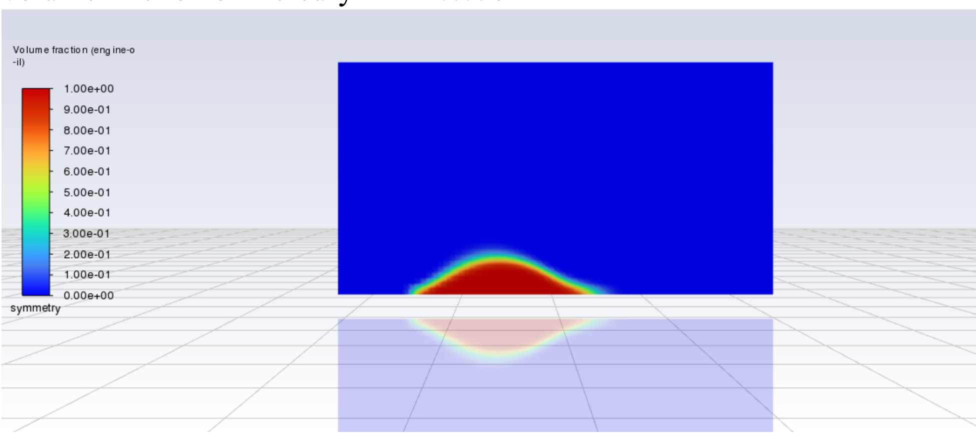
Plot at t = 0.1s



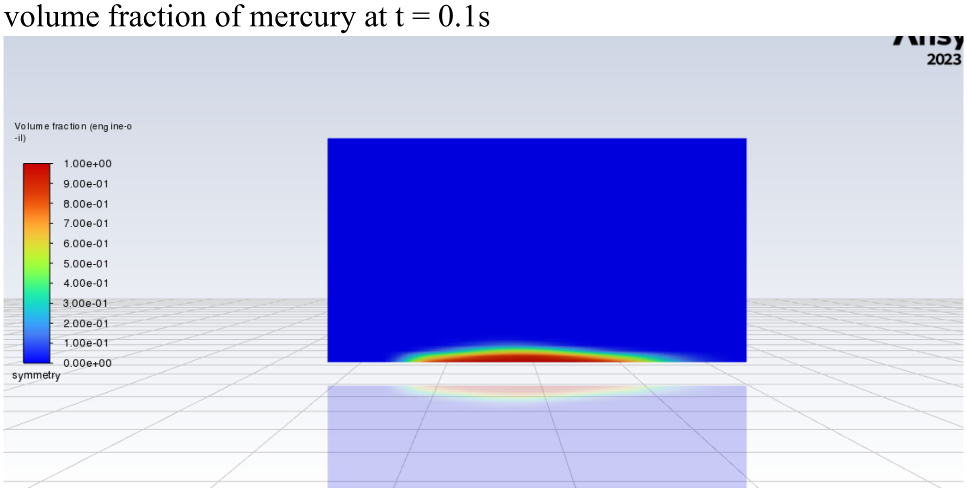
D10) volume fraction of mercury at t = 0s



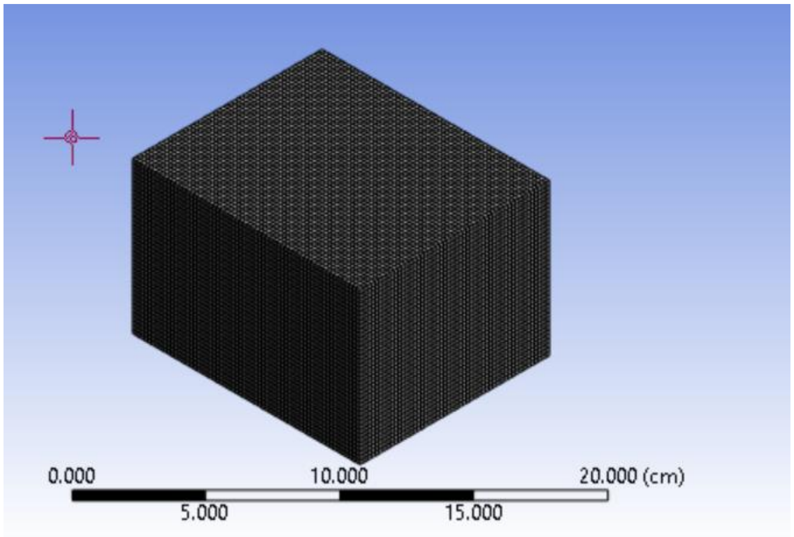
volume fraction of mercury at t = 0.05s



volume fraction of mercury at t = 0.1s

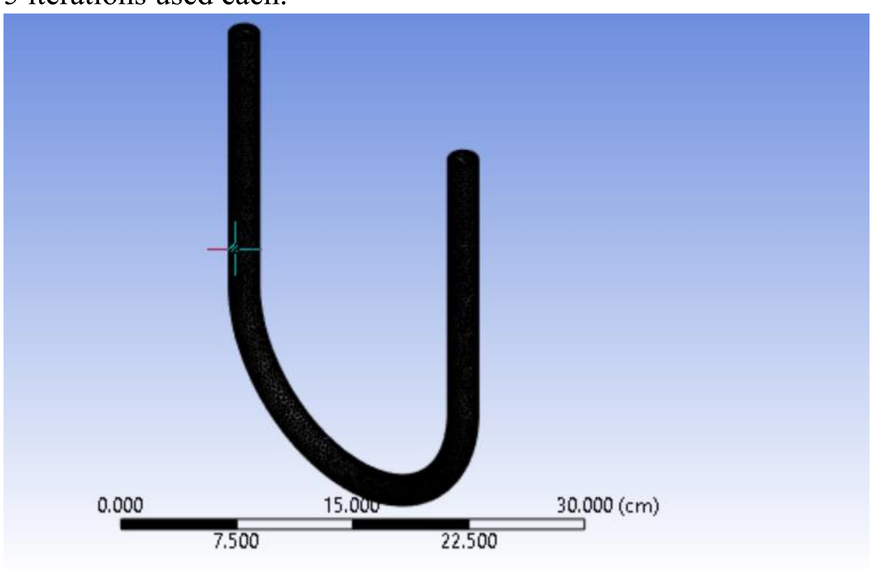


D11) Computational domain: Plate size: 10cm x 15cm
Overall volume analyzed: 10cm x 15cm x 8cm
Boundary conditions: **Pressure-outlet** on all sides and top side. **Plate** on bottom side of the cube.
Mesh resolution: Element size is 0.2cm
Used automatic inflation set at programmed controlled.

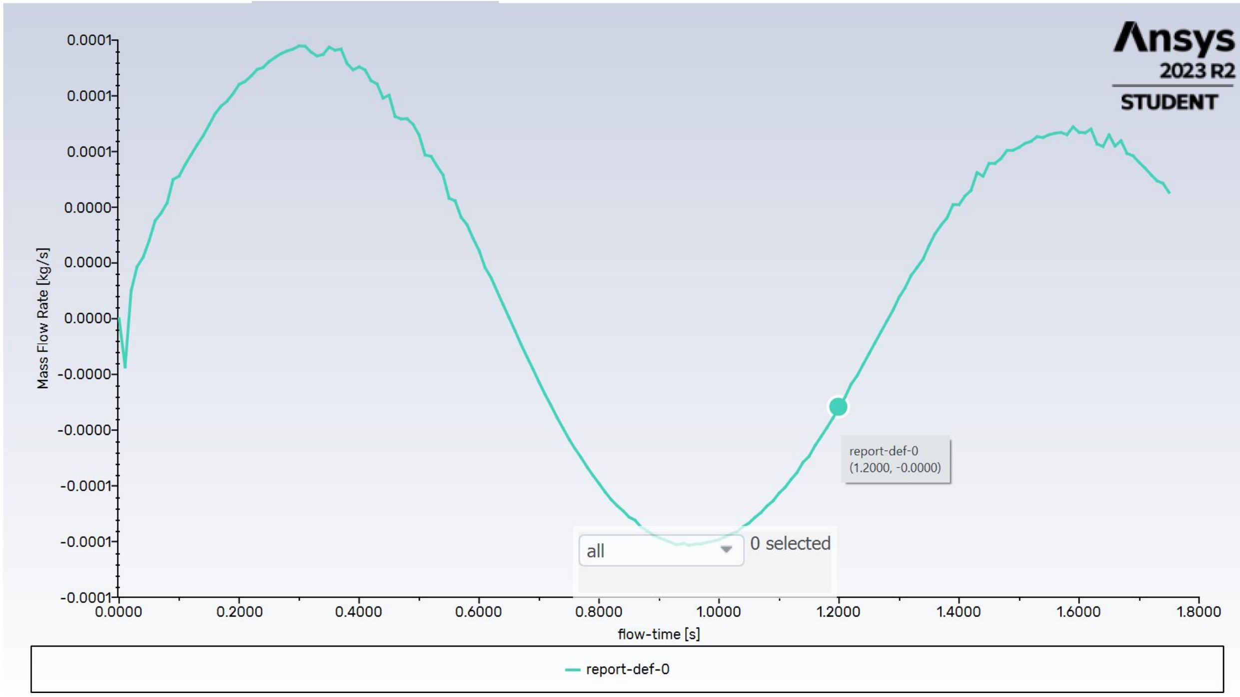


Task 3

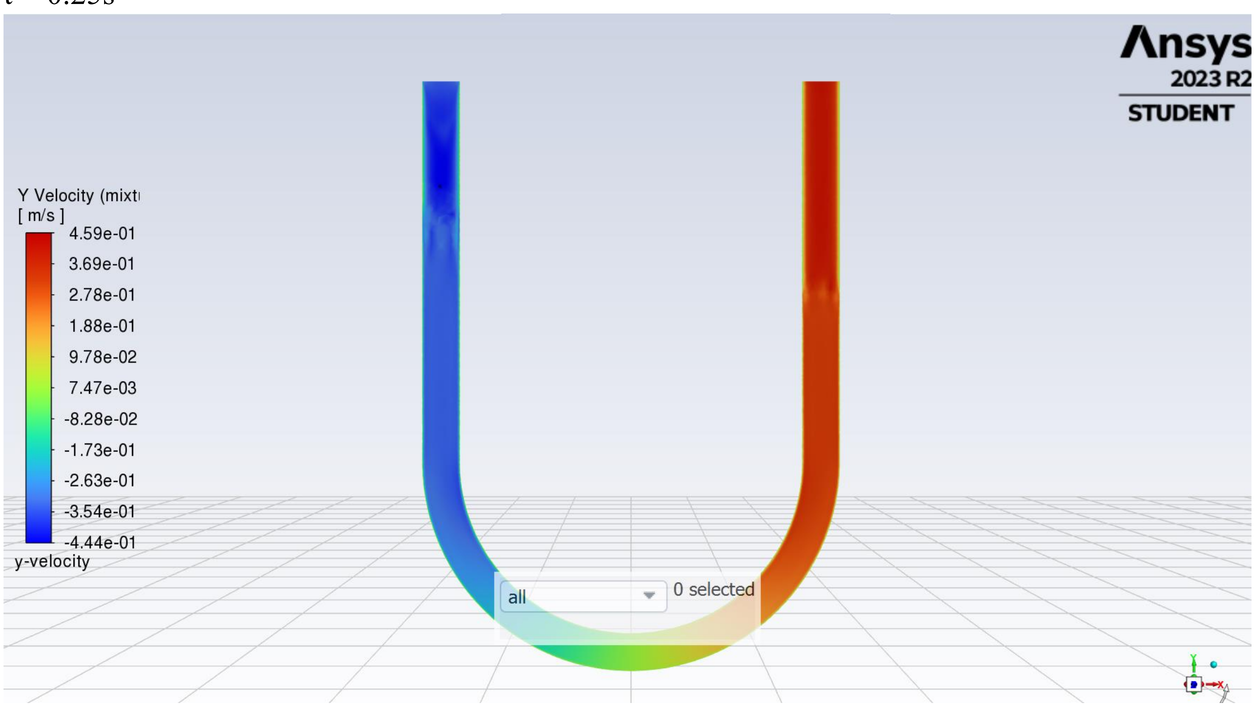
D12) Boundary conditions: The two openings hand **Pressure- outlet** boundary conditions.
Mesh resolution: Element size is 0.3cm. Used automatic inflation set at programmed controlled.
Time step size: .01 seconds
Number of time steps: 175
5 iterations used each.



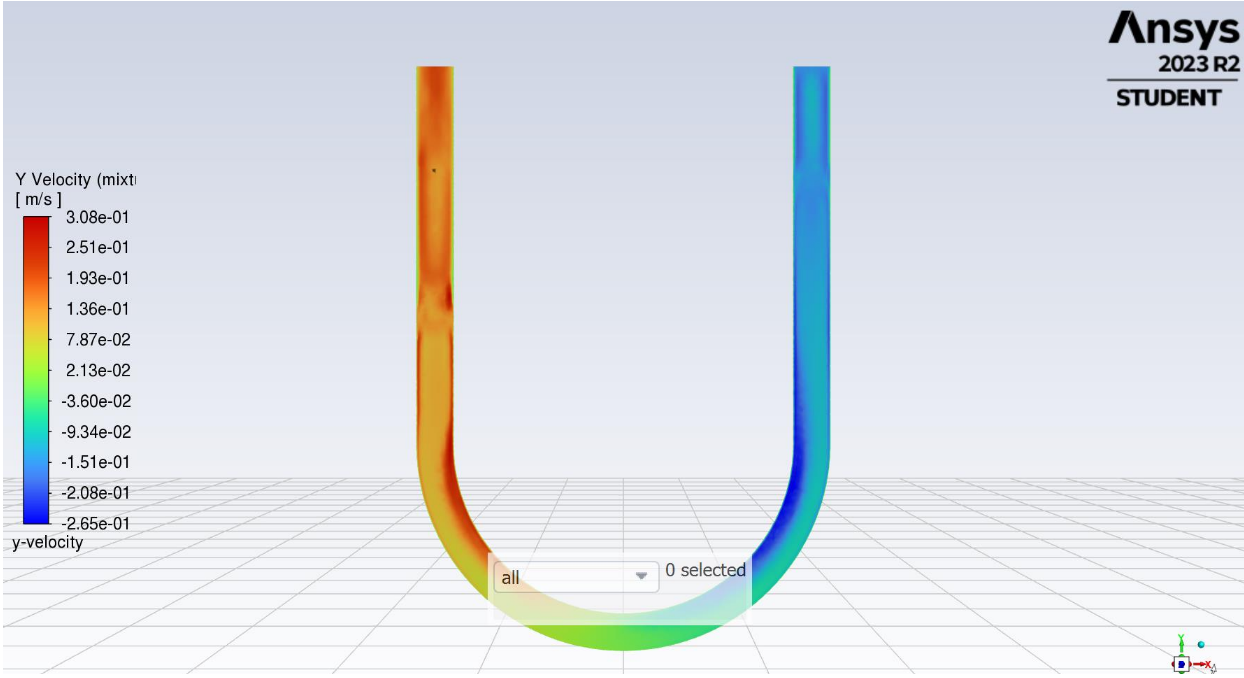
D13) τ = 1.2s → Rounded to first digit: **τ = 1.0s**
Plot of mass flow rate of air at opening A



D14) y-velocity contour plot
t = 0.25s

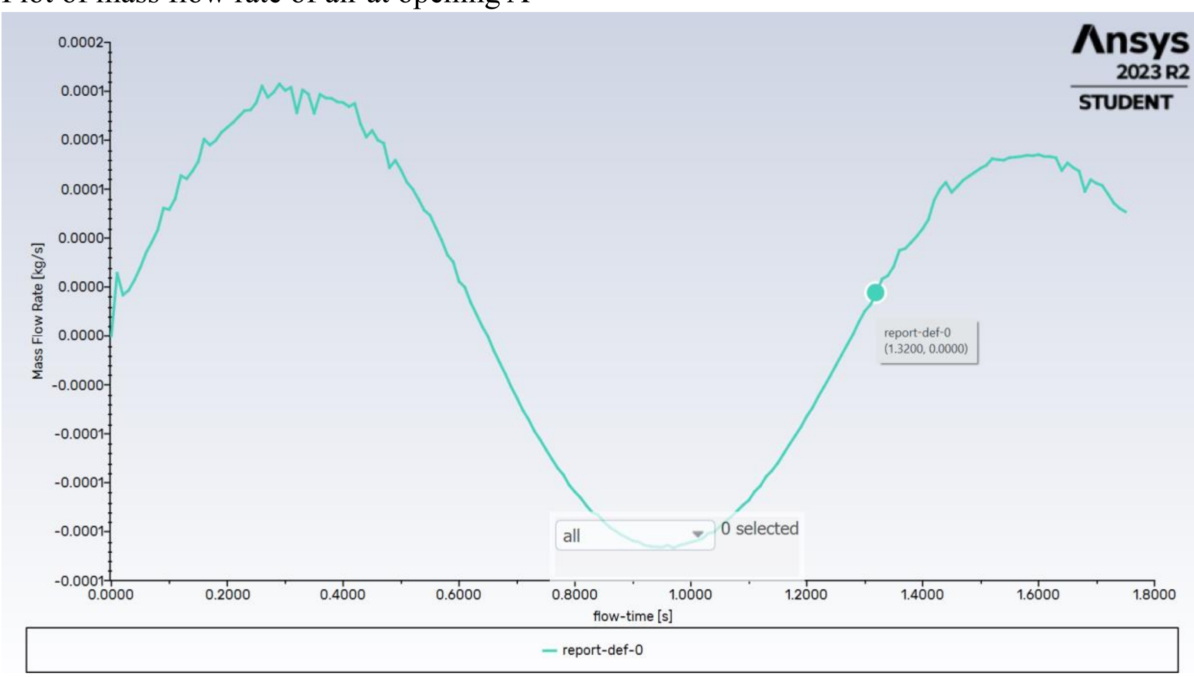


t = 0.75s



D15) τ = 1.32s → Rounded to first digit: **τ = 1.0s**

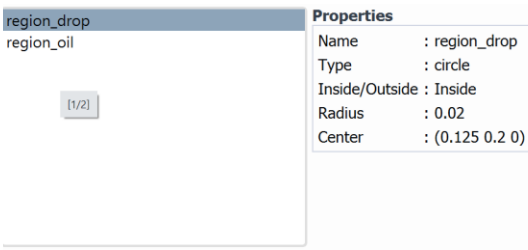
Plot of mass flow rate of air at opening A

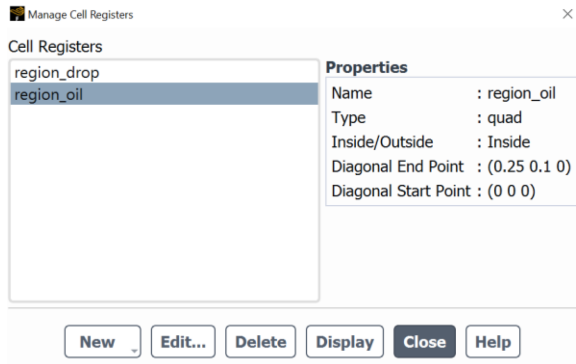


The time periods of both cases stayed the same. The reason for this is due to only the density changing. Gravity will stay the same and the rate of the mass flow rate should therefore be the same.

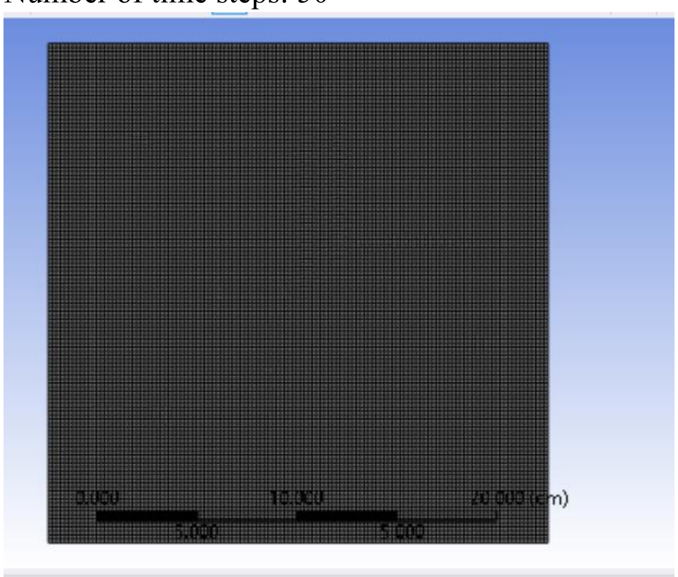
Task 4
D16)

Mesh resolution: Element size is 0.2cm.



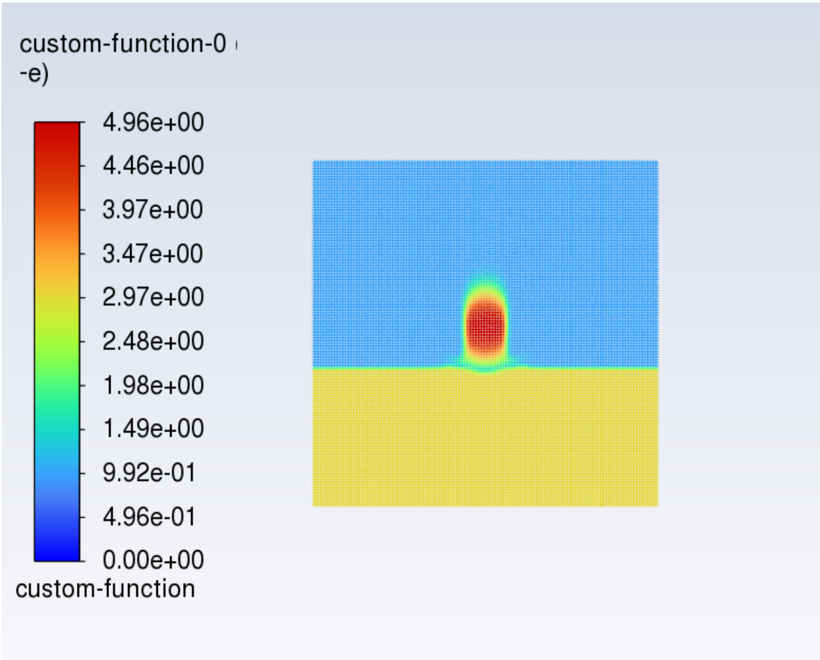


Time step size: .004 seconds
Number of time steps: 50

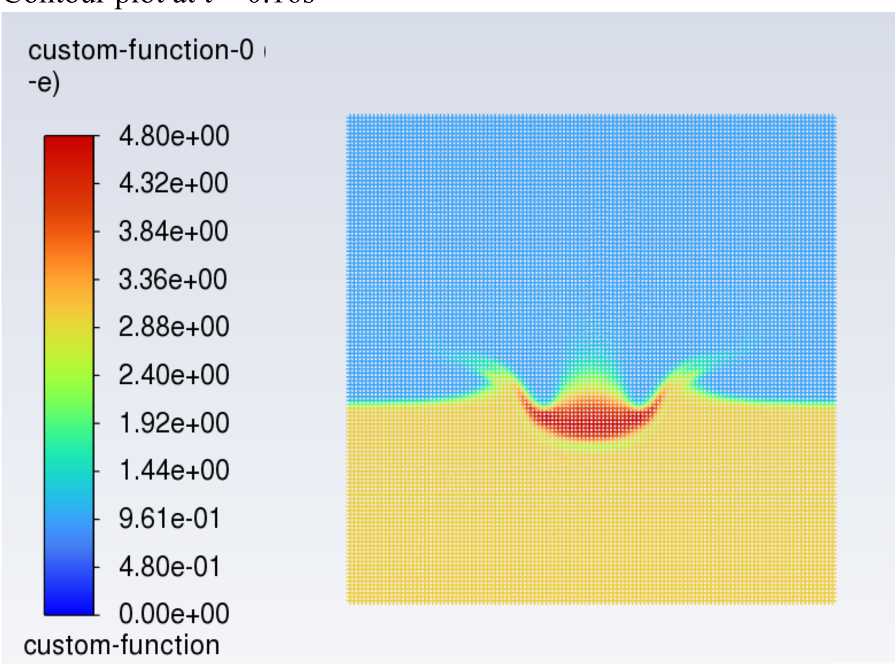


D17) This plots consists custom fraction at 1.00 shows air, 3.00 shows engine oil, and 5.00 shows water.

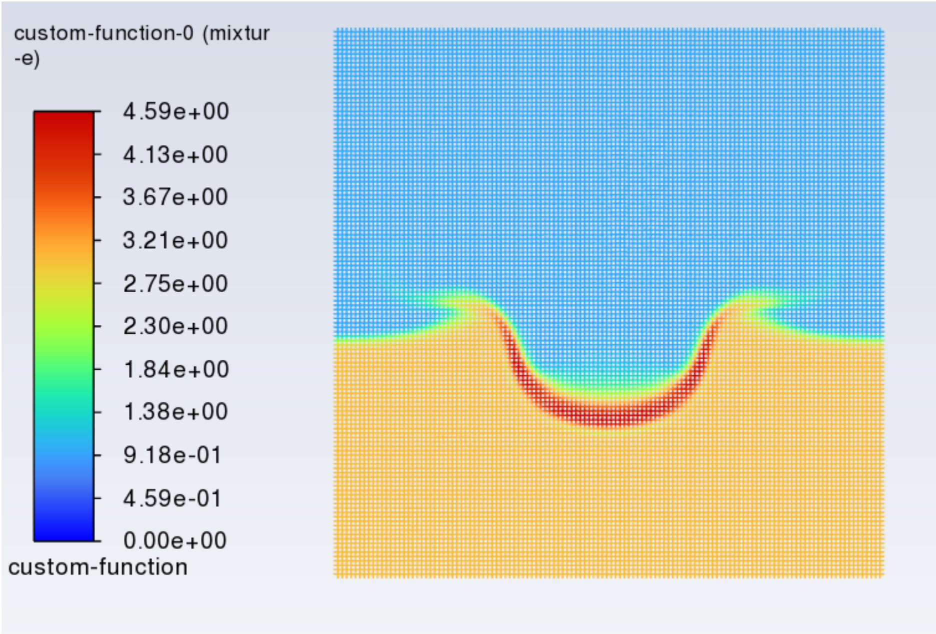
Contour plot at t = 0.12s



Contour plot at t = 0.16s



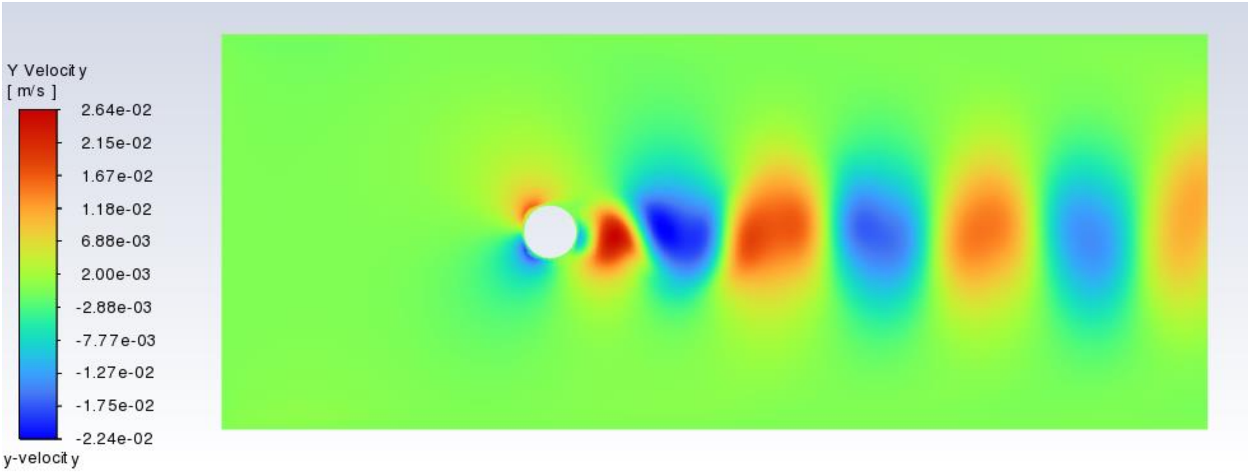
Contour plot at t = 0.2s



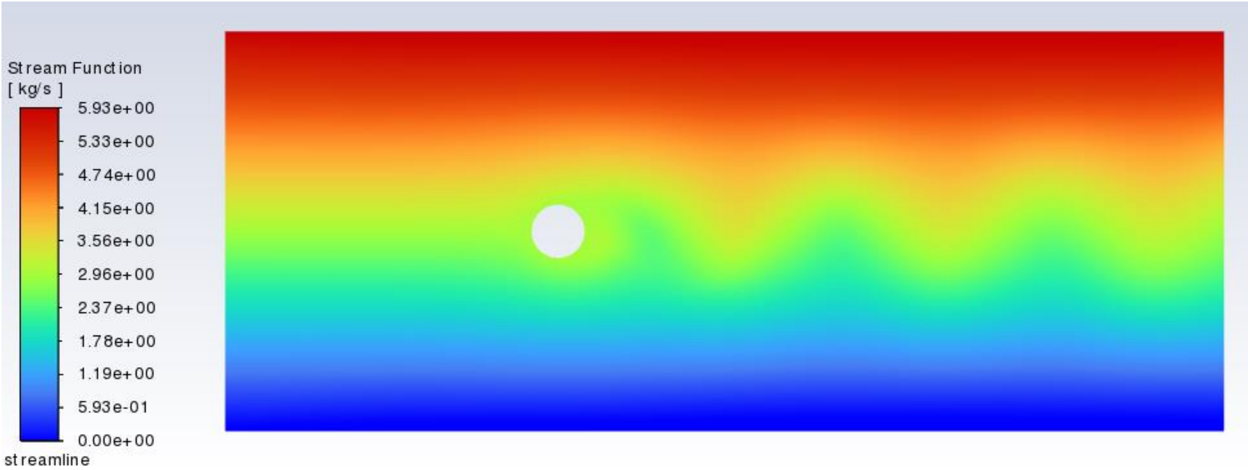
No collaboration
Task 1:
D1) Element size: 0.004 m
Time Step size: 0.05s
Number of time steps: 1200
Max Iteration/Time step: 15
Reynolds number was estimated through the following equation:

Re = $\frac{\rho \; x \; V \; x \; D}{viscosity} = \frac{790\frac{kg}{m^3} \; x \; 0.025\frac{m}{s} \; x \; 0.04m}{0.0012\frac{kg}{m\,s}}$ = 658.33 **Re = 658.33**

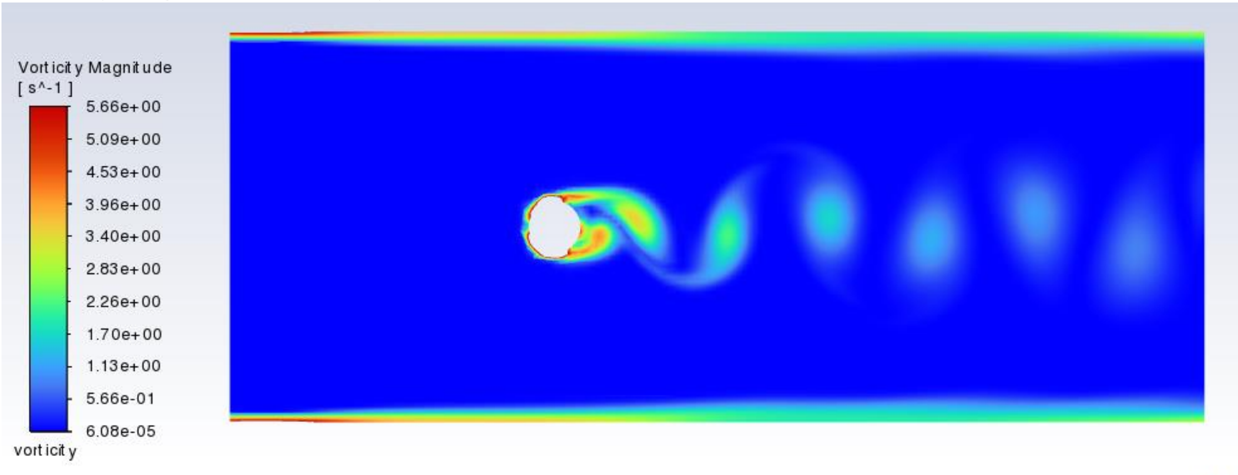
D2) y-velocity contour plot



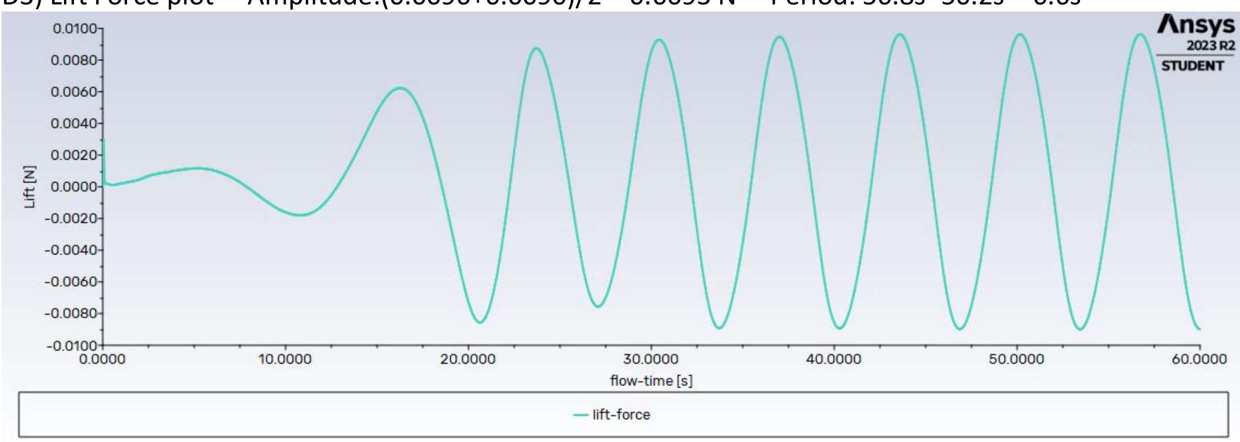
Stream function contour plot



Vorticity magnitude contour plot



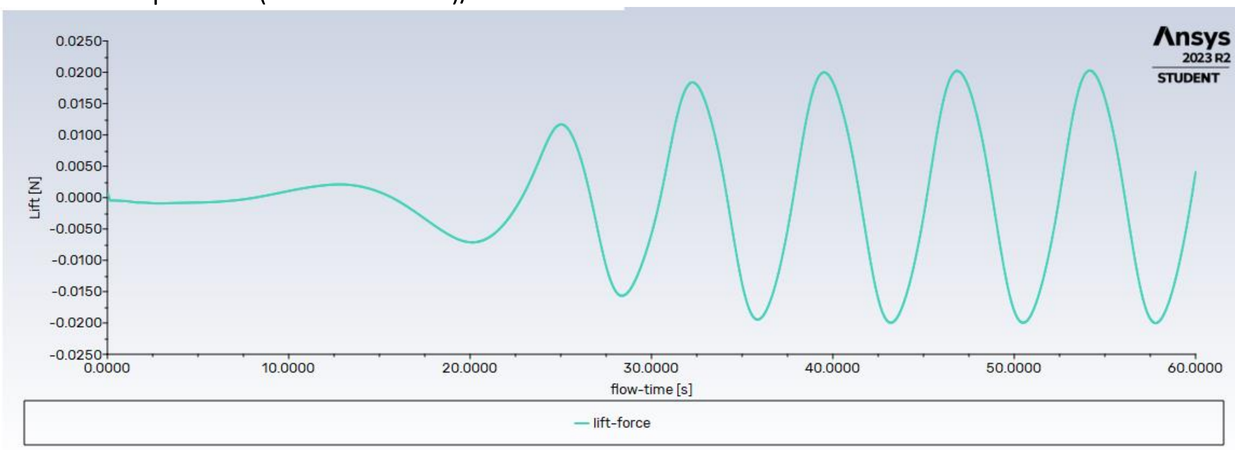
D3) Lift Force plot   Amplitude:(0.0096+0.0090)/2 = 0.0093 N   Period: 56.8s- 50.2s = 6.6s



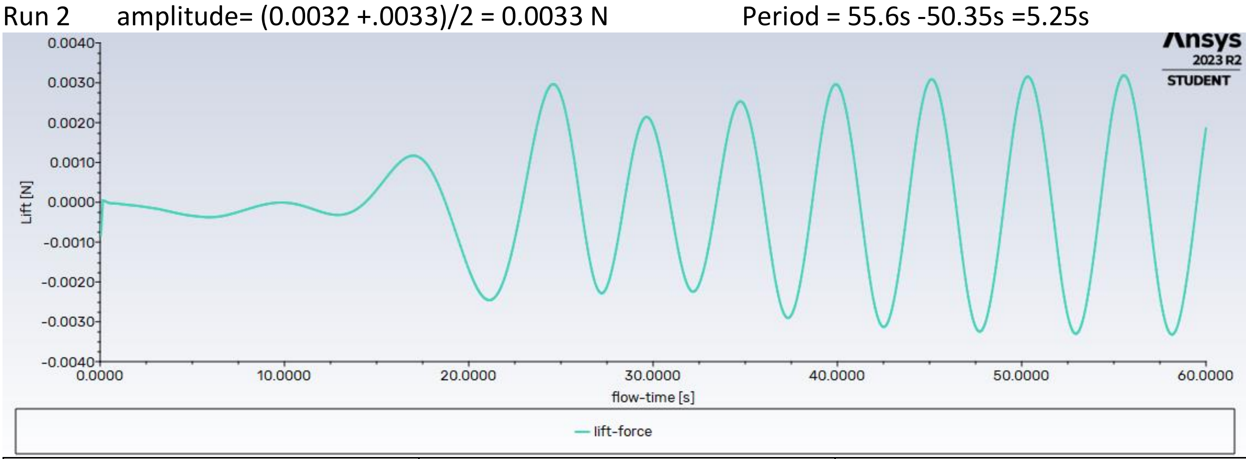
The lift force oscillates consistently after 20 seconds. The amplitude and period were found by looking at the last cycle and averaged the minimum and maximum. Period was found by finding the difference in time of the two peaks.

D4)

Run 1 amplitude= (0.0203 +0.0199)/2 = 0.0201N Period = 54.2s -46.9s = 7.3s



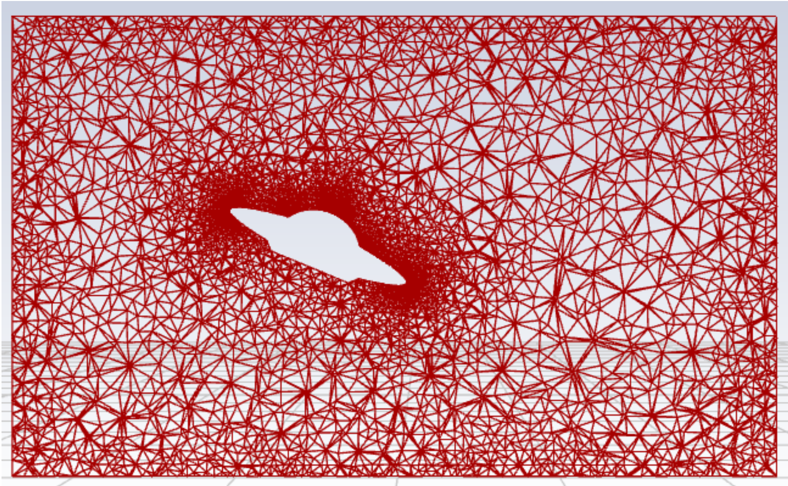
Run 2 amplitude= (0.0032 +.0033)/2 = 0.0033 N Period = 55.6s -50.35s =5.25s



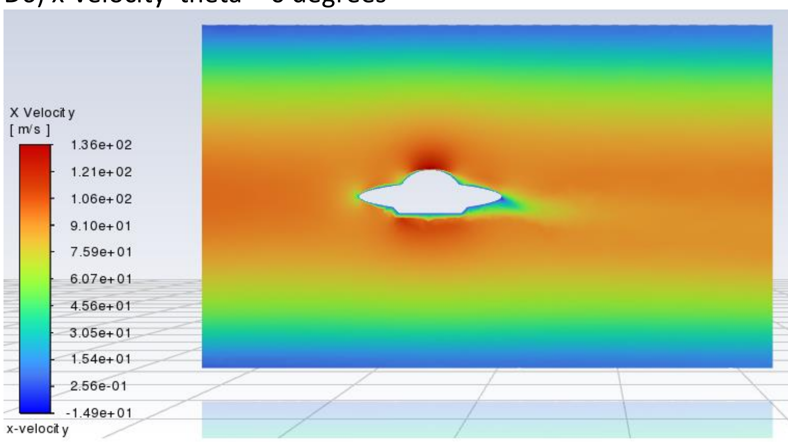
Shape	**Amplitude (N)**	**Period (s)**
Circular Cylinder	0.0093	6.6
Elliptical Cylinder, Run 1	0.0201	7.3
Elliptical Cylinder, Run 2	0.0033	5.25

Task 2

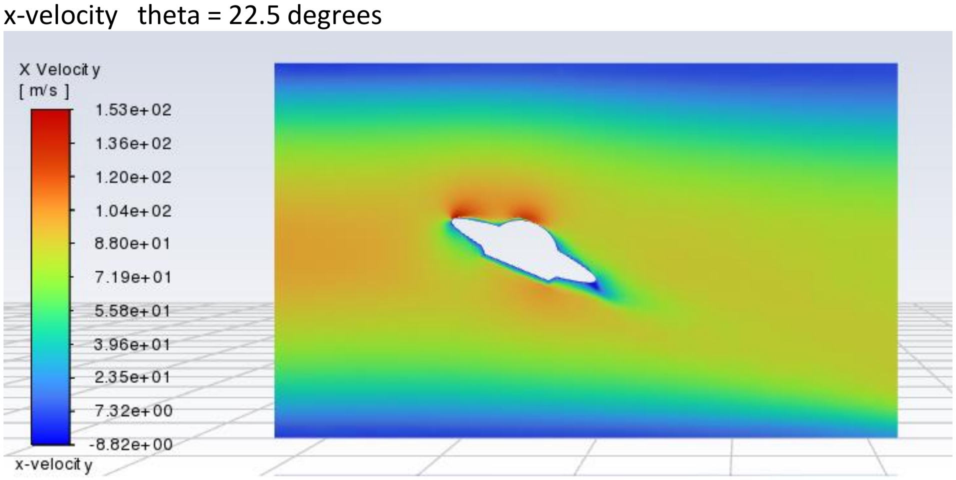
D5) Mesh along plane of symmetry along 22.5 degrees



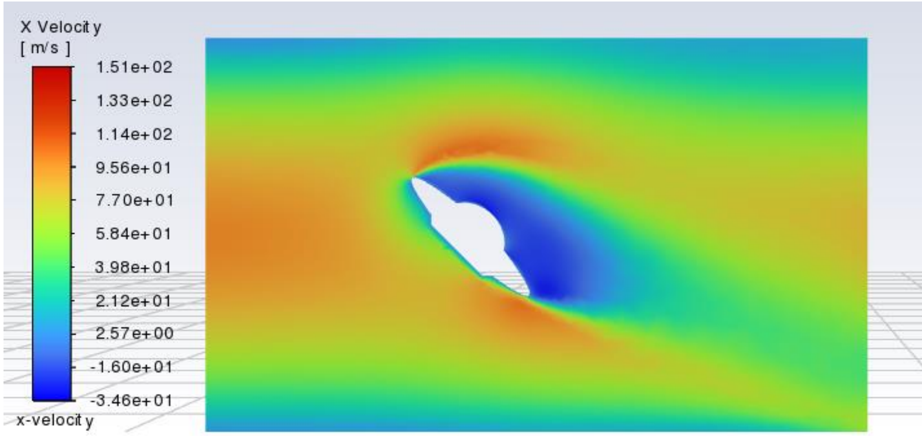
D6) x-velocity theta = 0 degrees



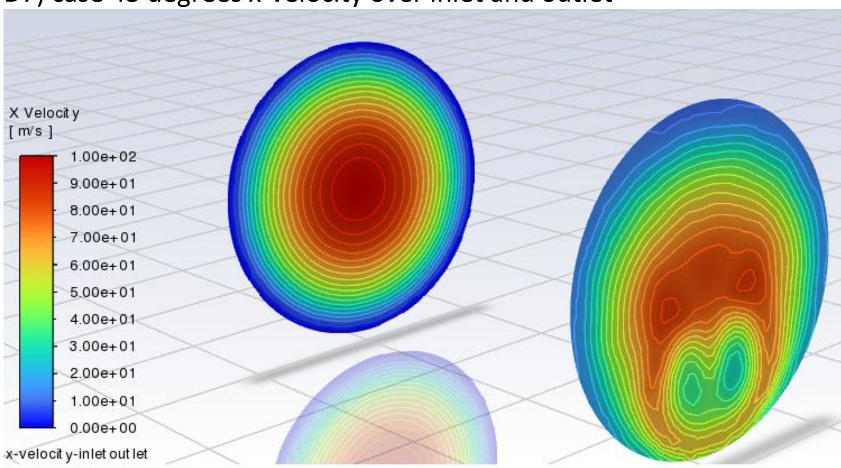
x-velocity theta = 22.5 degrees



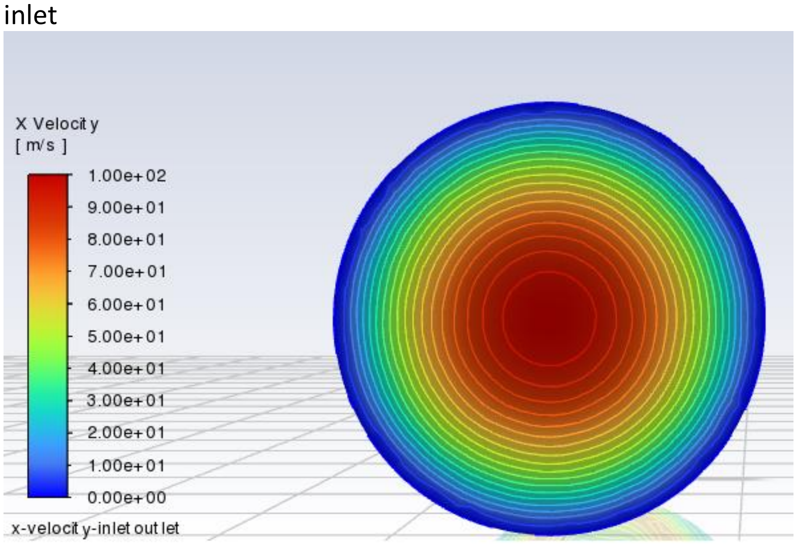
x-velocity theta = 45 degrees



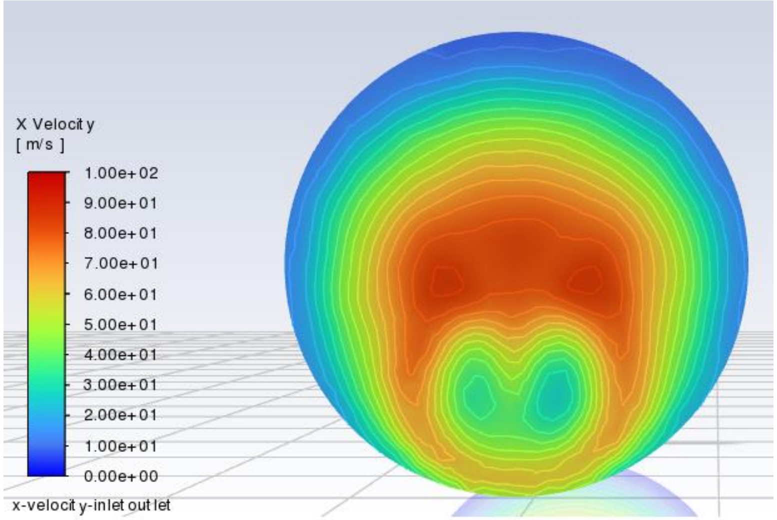
D7) case 45 degrees x-velocity over inlet and outlet



inlet



Outlet



D8)

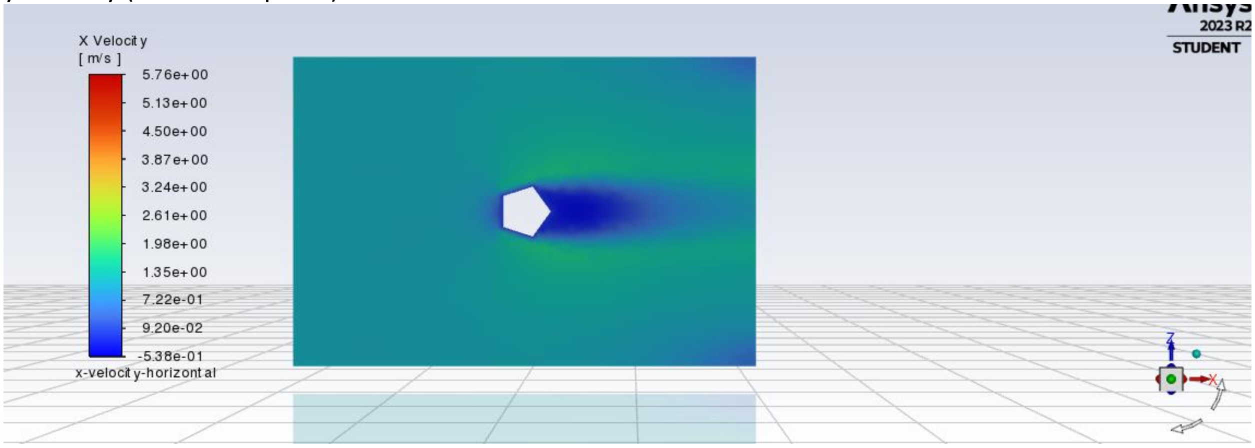
Angle (Degrees)	Lift force (N)	Drag force (N)
0	5.3	4.5
22.5	58.4	18.5
45	46.03	63.5

Task 3

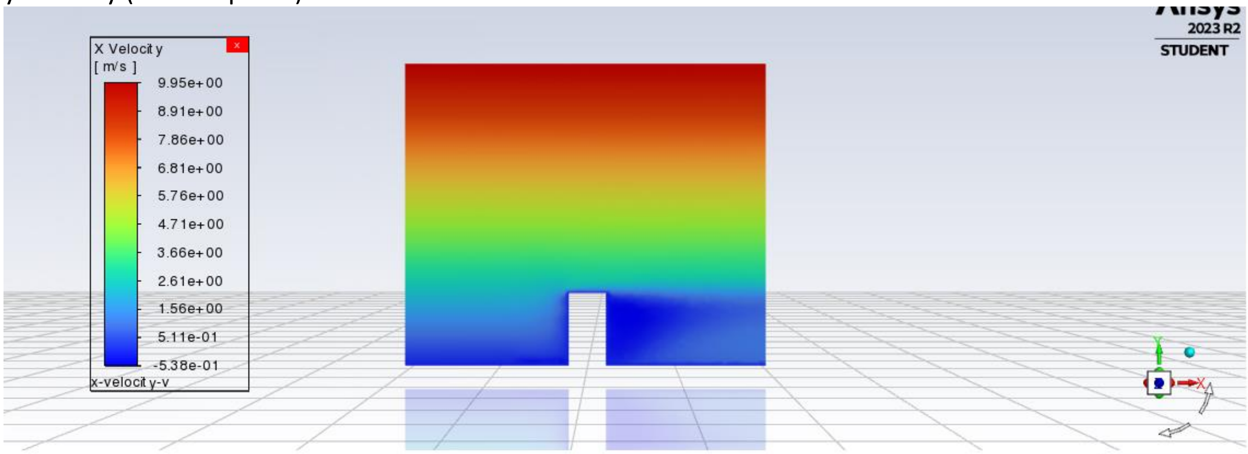
My plots for velocity are in the x direction instead of y direction due to my geometry orientation difference but should still be the same. It will just be showing in the x direction.

D9) Run 1

y-velocity (Horizontal plane)

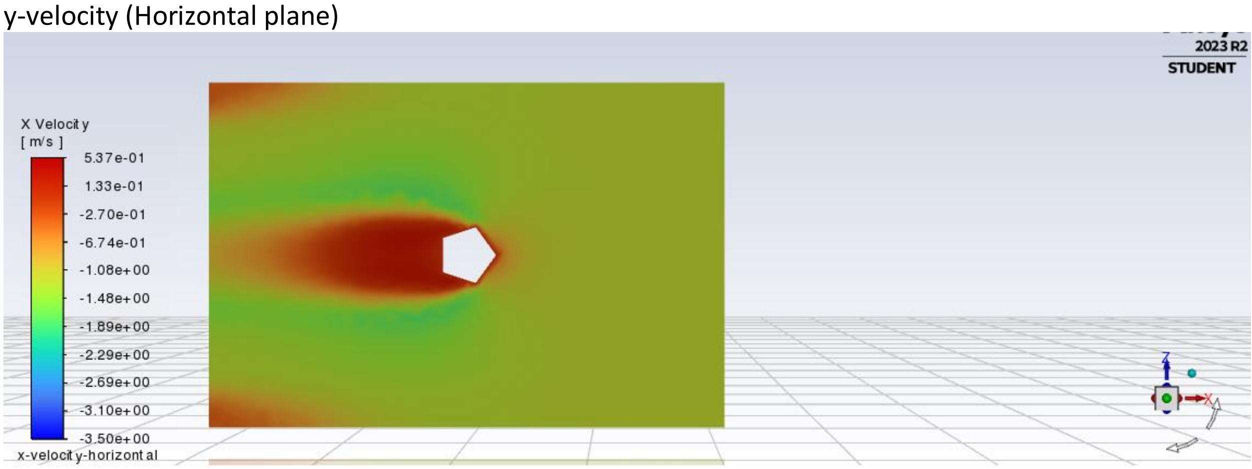


y-velocity (vertical plane)

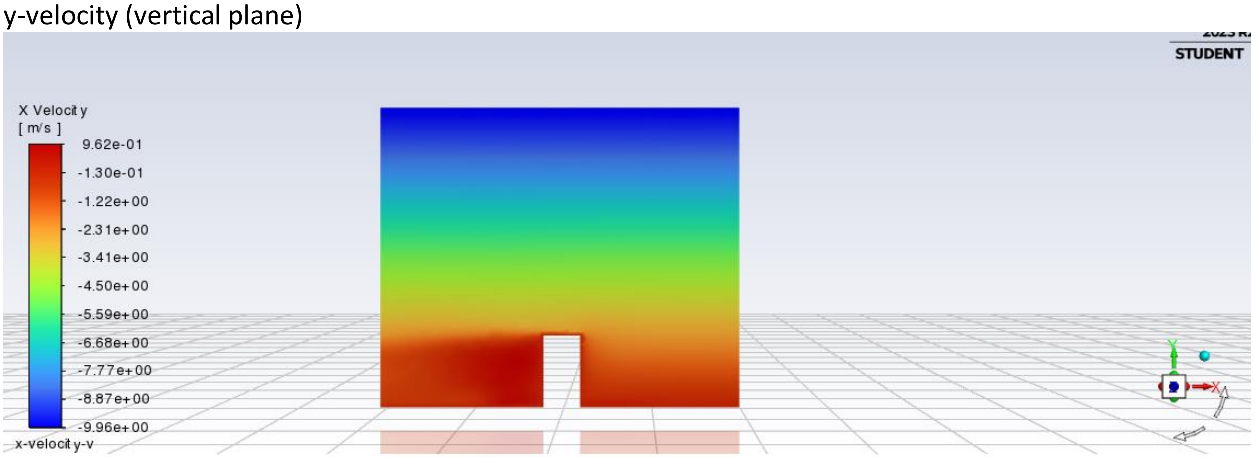


Run2

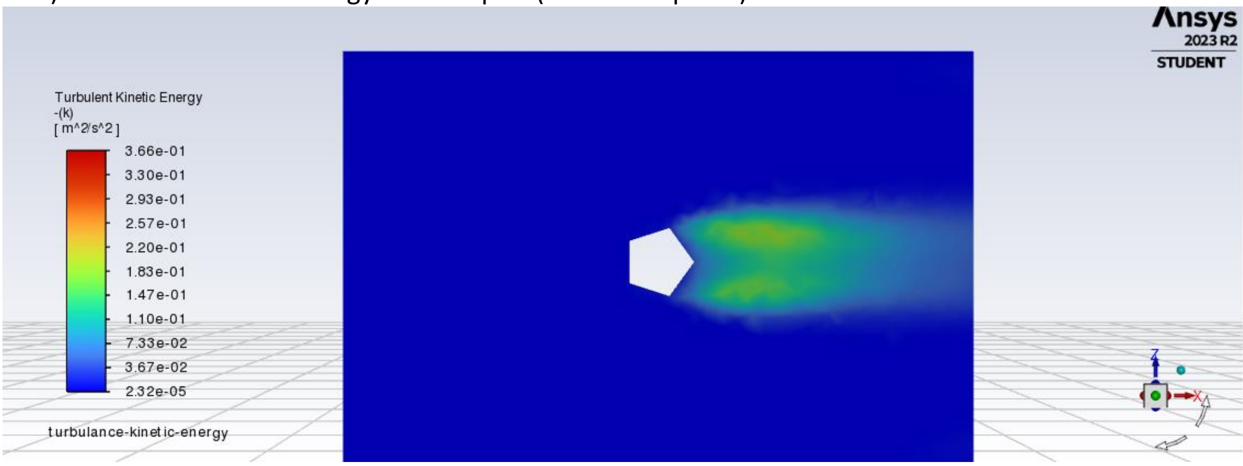
y-velocity (Horizontal plane)



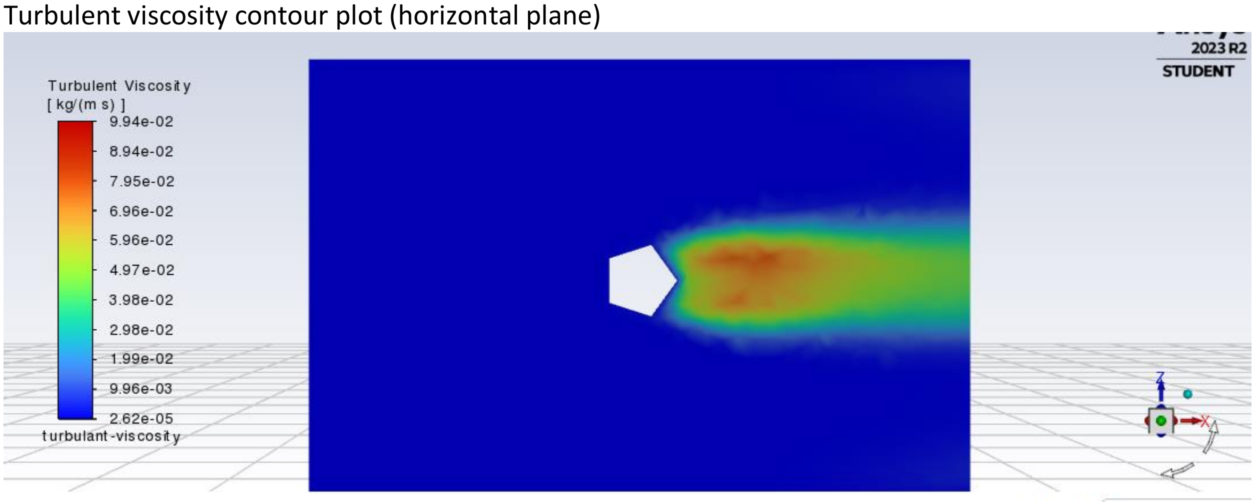
y-velocity (vertical plane)



D10) Turbulence kinetic energy contour plot (horizontal plane)



Turbulent viscosity contour plot (horizontal plane)



$\mu_{T,\max} = 0.0994$ kg/m s

$\mu_{T,max}/\mu = 0.0994/0.000017894 = 5554.93$

The max turbulent viscosity is far much greater than the molecular viscosity of air. The ratio is 5554.93.

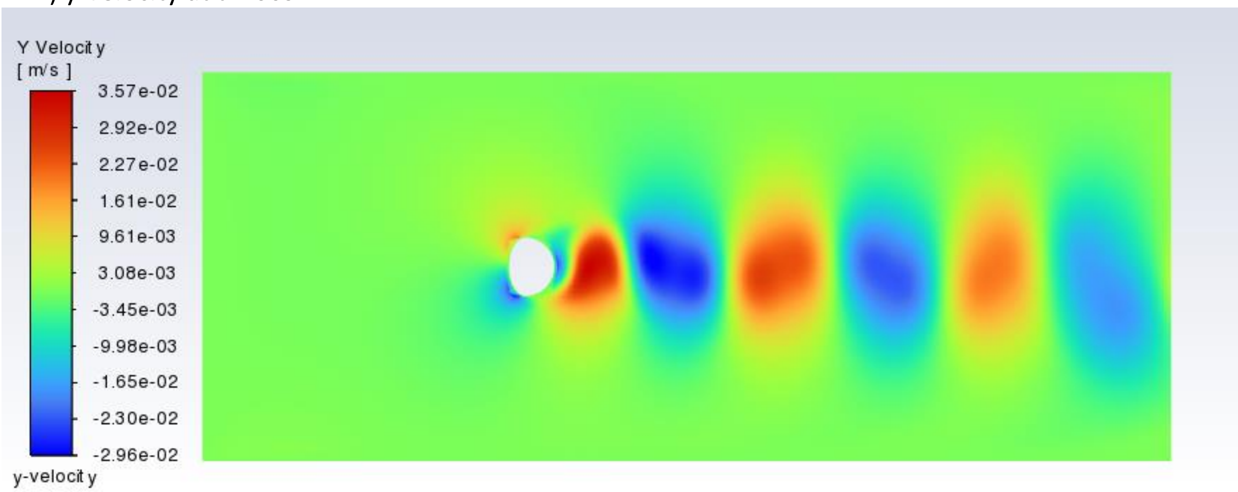
D11)

	Total drag (N)	Pressure term of drag (N)	Viscous term of drag (N)
Run 1	23.95	23.82	0.125
Run 2	-32.197	-32.138	-0.059

Task 4

The geometry cross section shape was modified to an oval shape where a hemisphere with a radius of 2.25cm is on the right a side and ellipse is on the left side with the long side being on the y axis with its length at 4.5cm and the short side's length is at 2.5cm. Area came out to be 12.4cm^2 which is comparable to the task one area at 12.6cm^2.

D12) y-velocity at t = 60s



D13) amplitude: 0.0195N