MAE 560: Applied Computational Fluid Dynamics

Project 3

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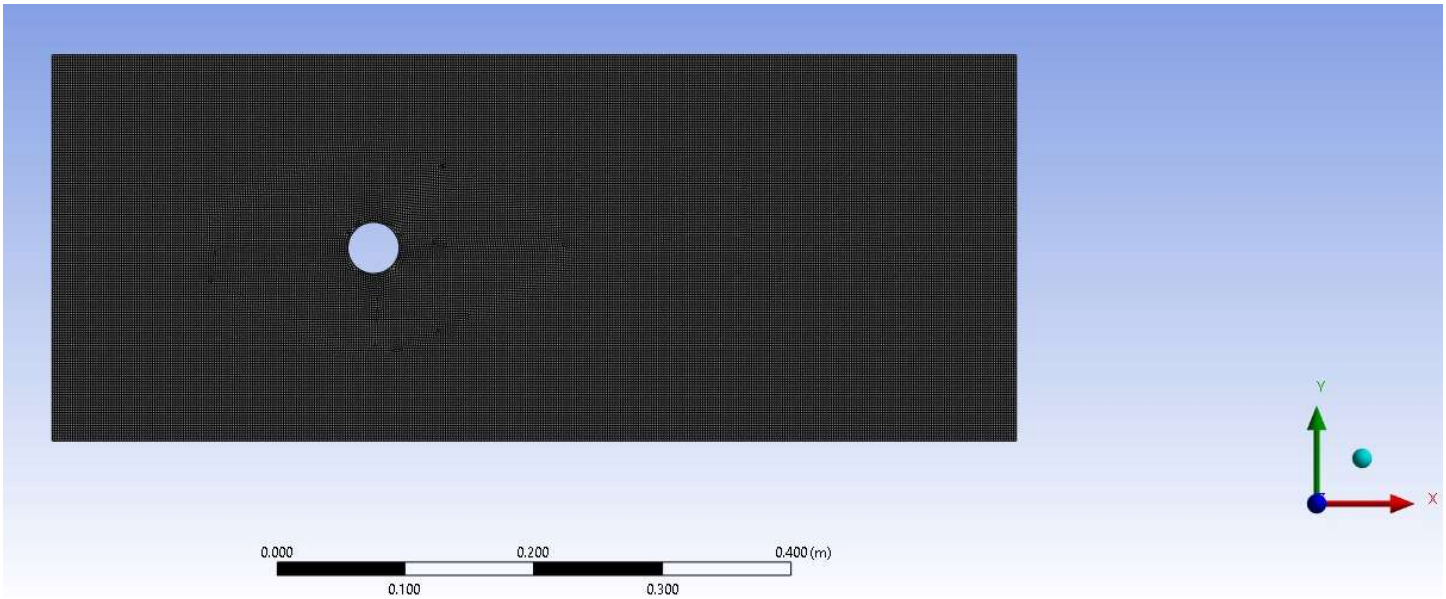
(NO COLLABORATION)

Task 1

(D1)



Mesh Resolution = 0.01

Time Step size used for simulation = 1000

Time Step size = 0.06

Iteration = 10

Element Size	Time Step Size (s)	Number of Time Steps	Max Iterations
0.001	0.06	1000	10

To calculate Estimated Reynolds no.

μ= 0.0012 kg/Ms

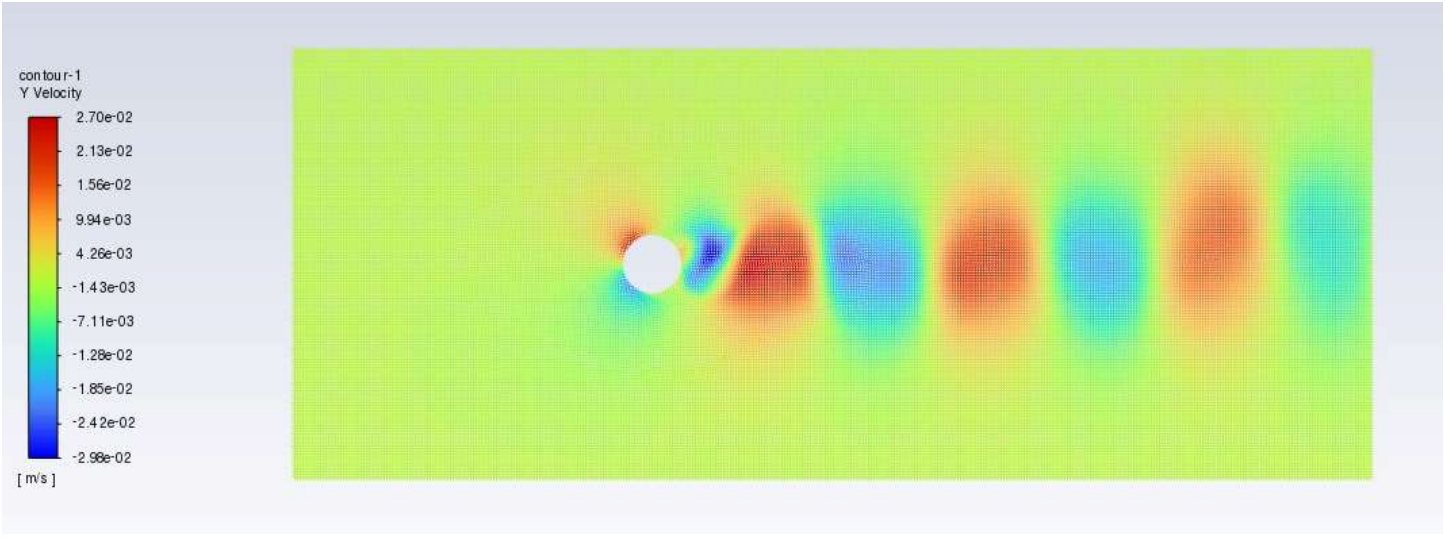
ρ= 790 kg/m³

D= 0.04m

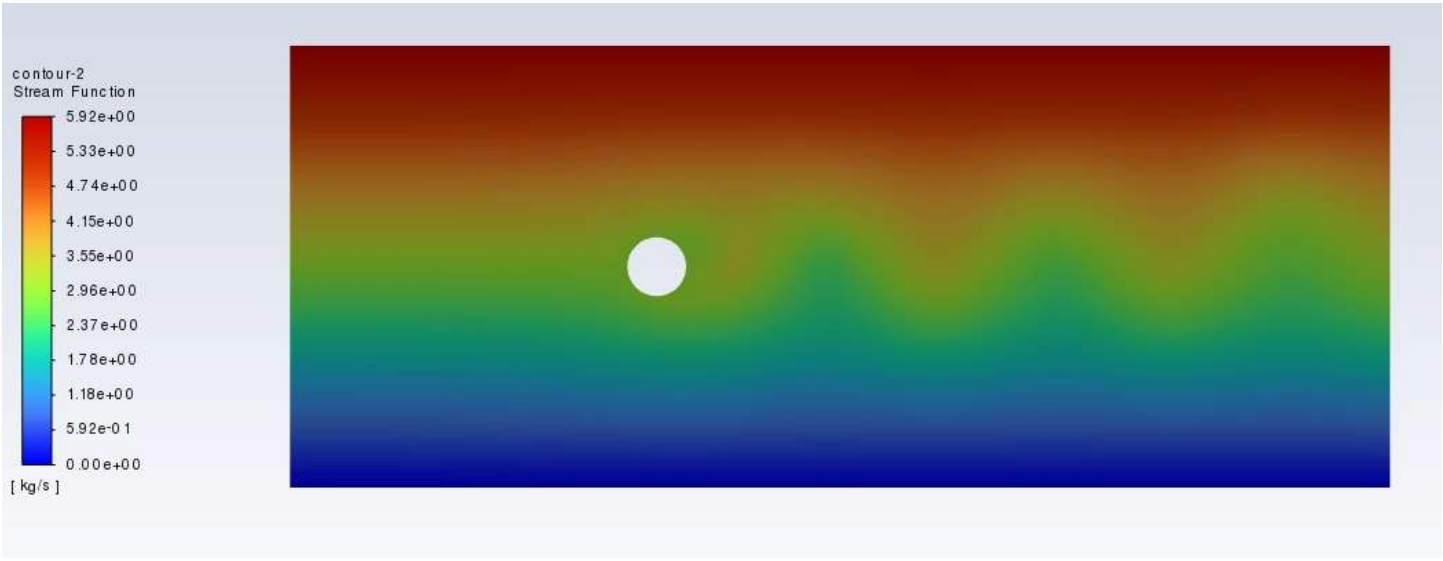
v= 0.025 m/s

Re= ρvD/ μ; (790 × 0.025) × 0.04/0.0012 = **658.36**

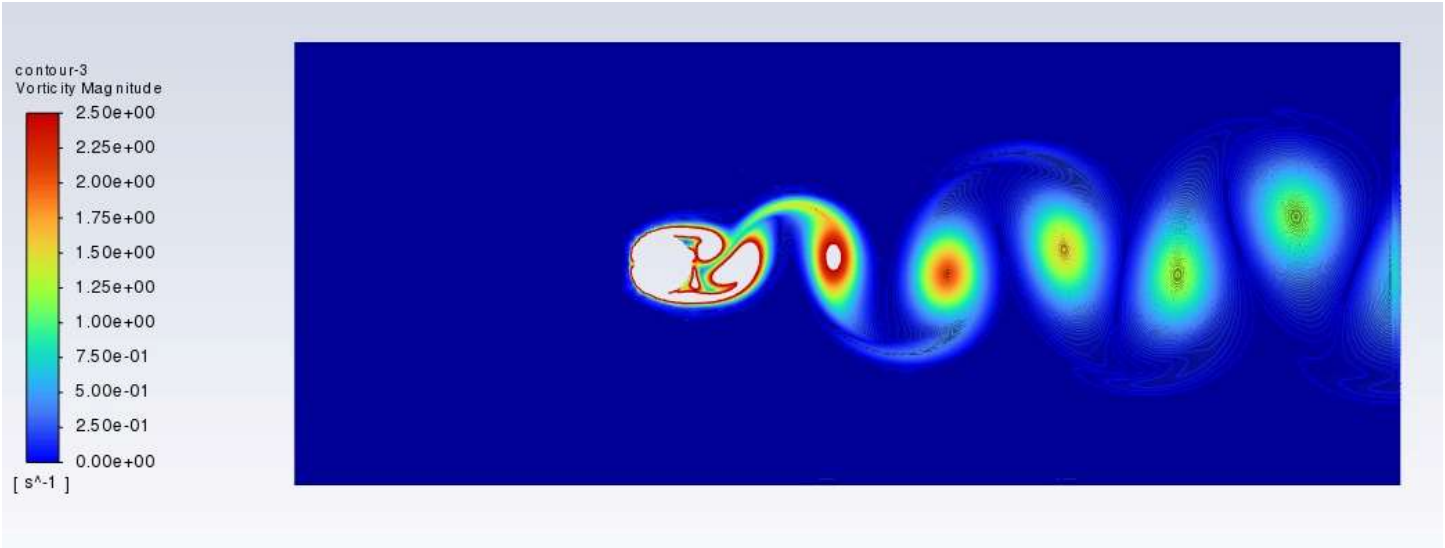
(D2)



Contour plots of y-velocity at t= 1min

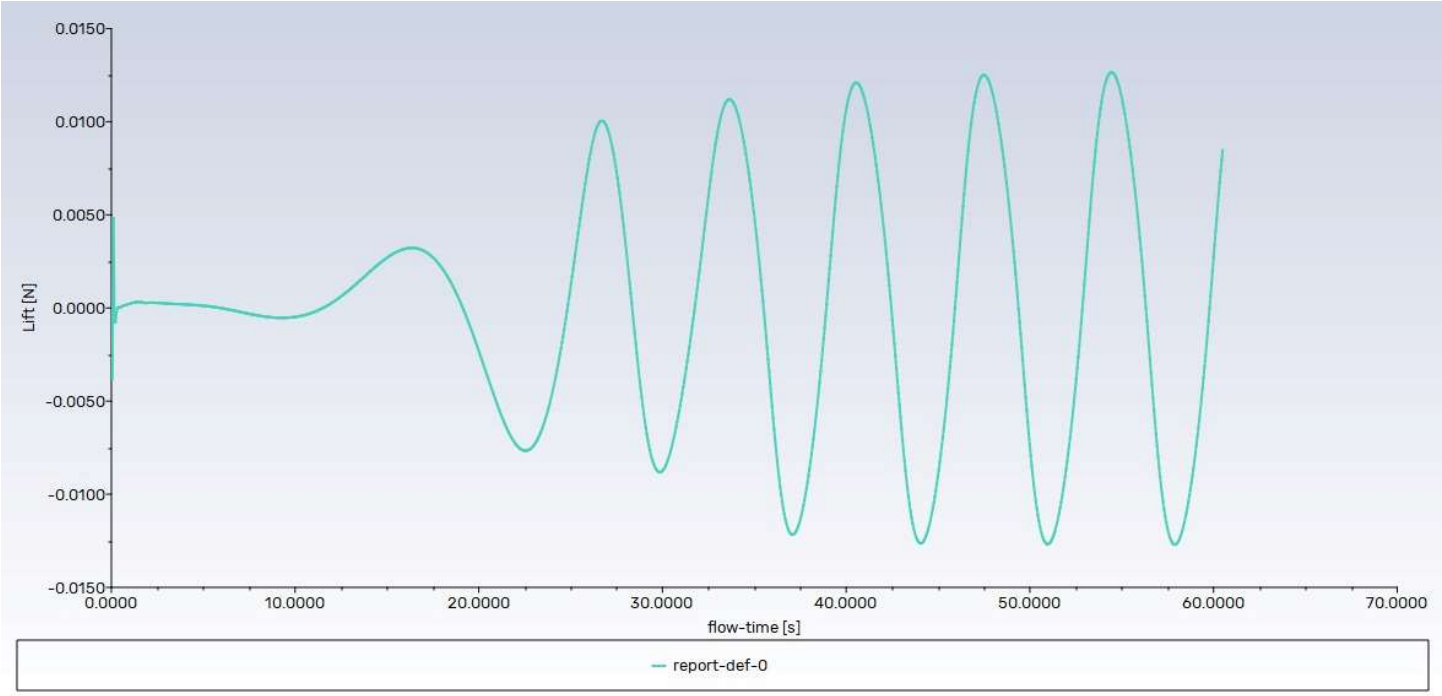


Contour plots of stream function t= 1min



Contour plots of vorticity magnitude t= 1min

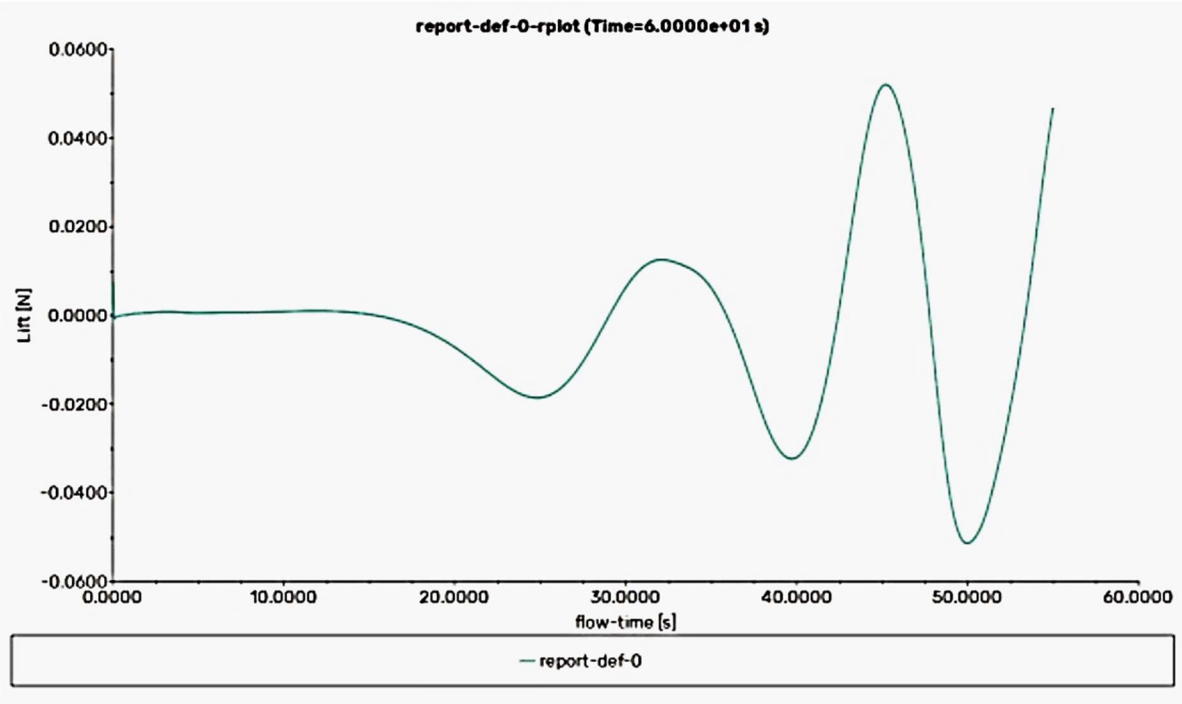
(D3)



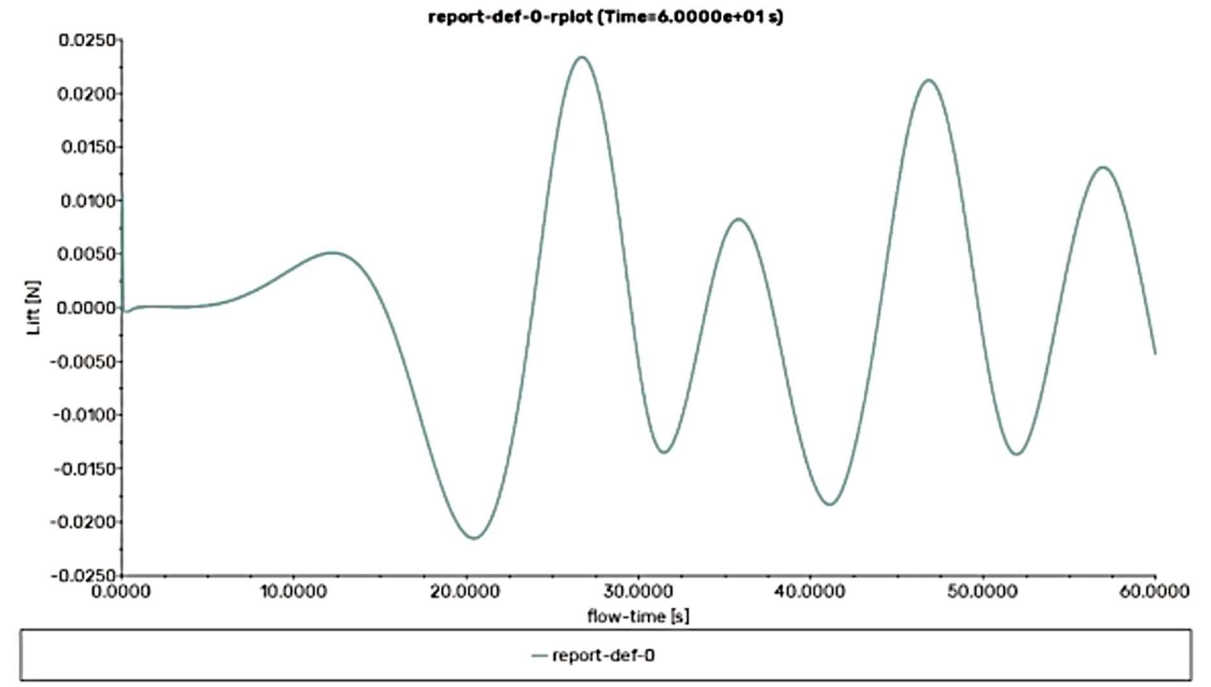
A plot of lift force as function of time t=0 to t=1 min

(D4)

Run 1



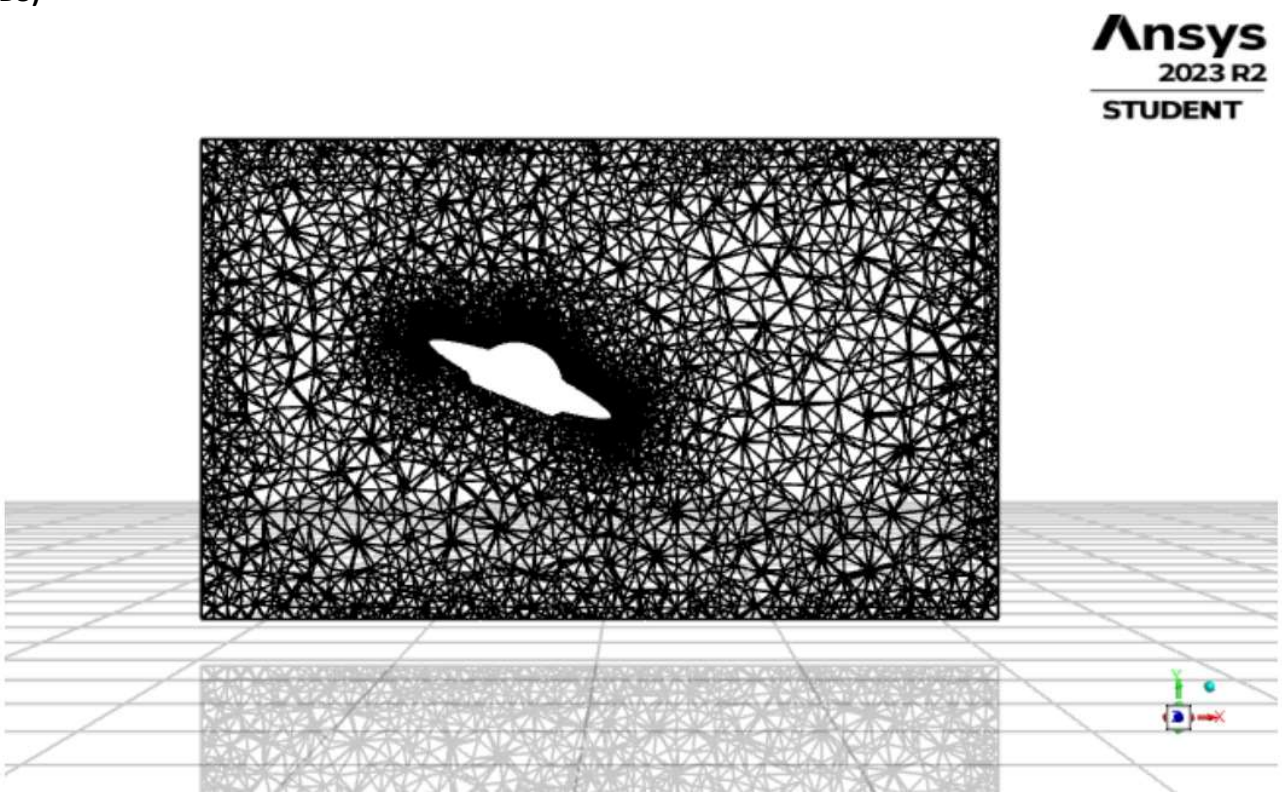
Run 2



	Amplitude (in Newton)	Period (in second)
Circular Cylinder	0.0126	7.4s
Elliptical Cylinder, Run 1	0.0579	9s
Elliptical Cylinder, Run 2	0.0149	12.4s

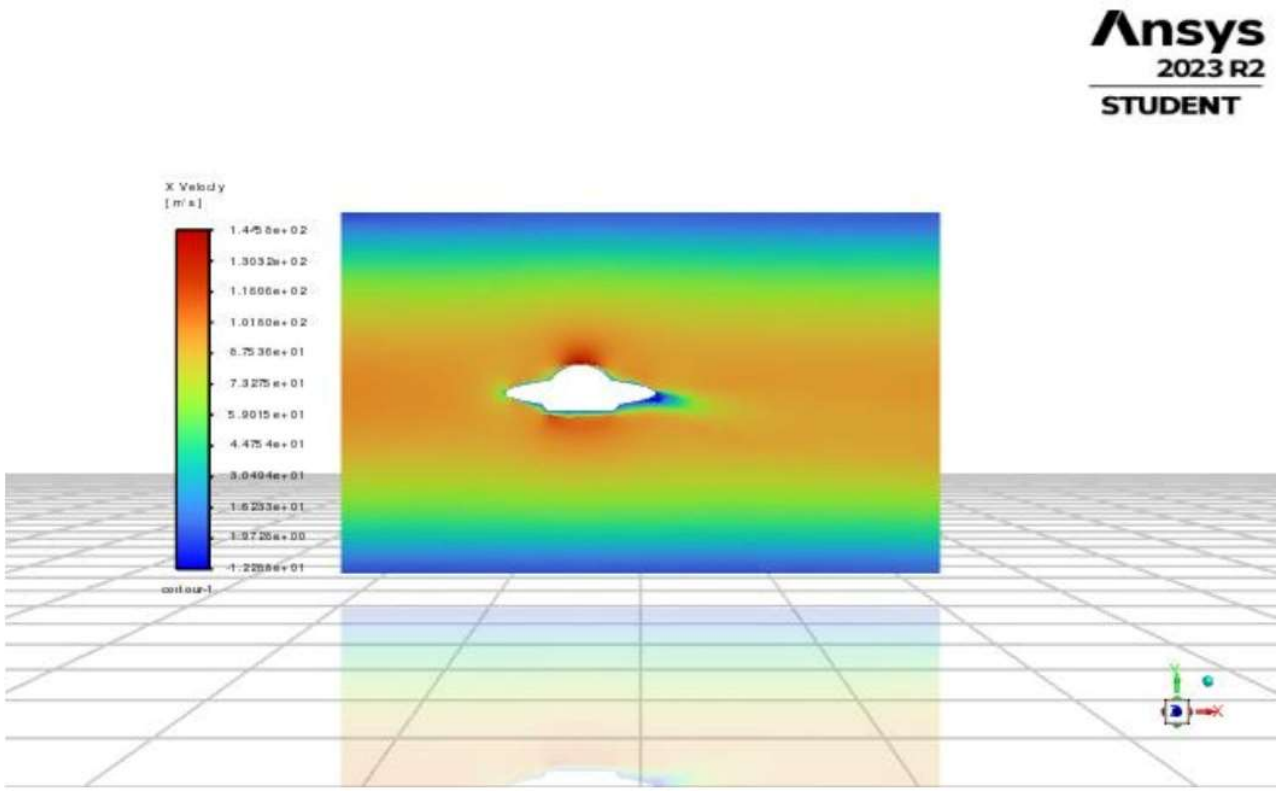
Task 2

(D5)

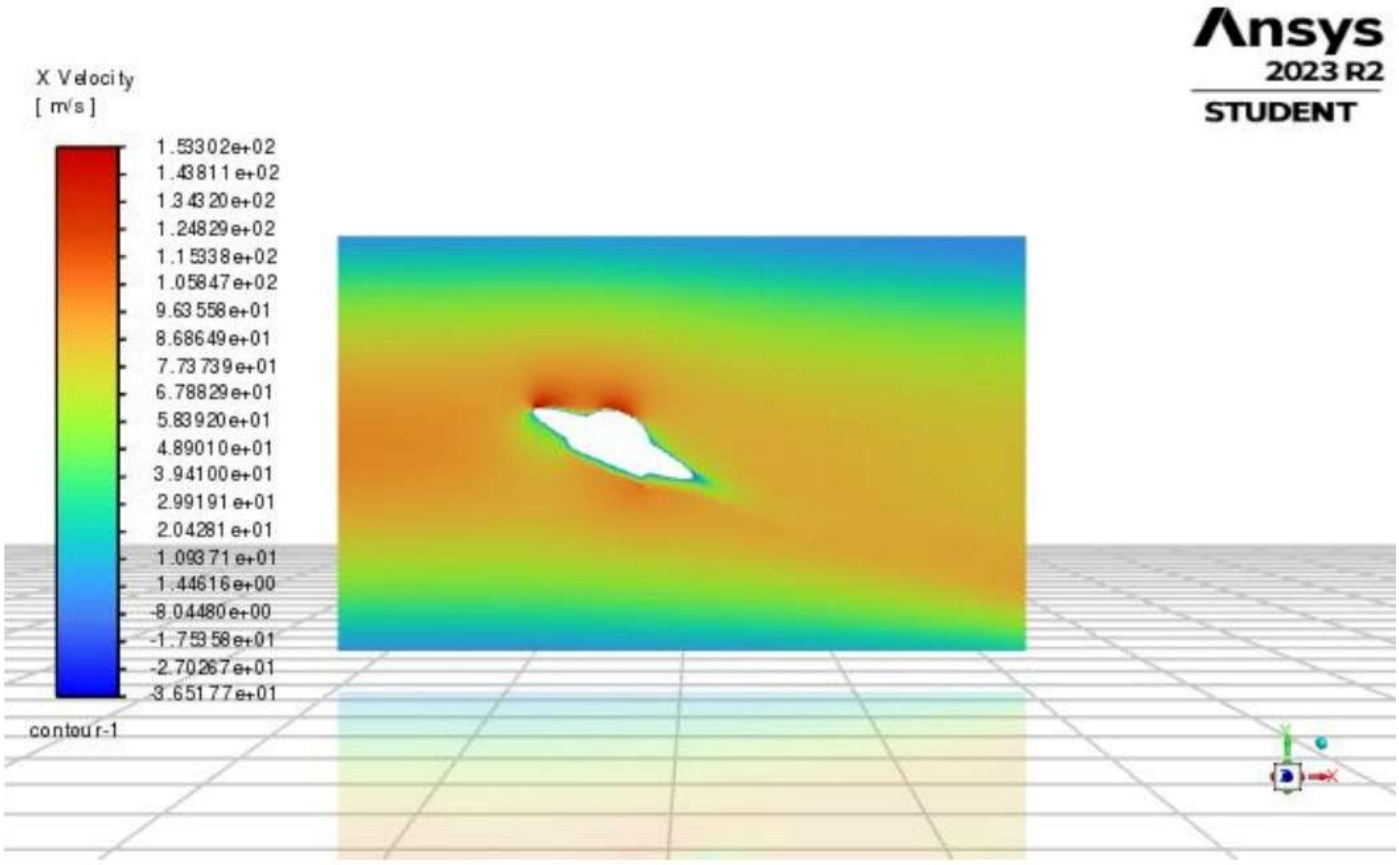


A plot of the mesh along the plane of symmetry for the case.

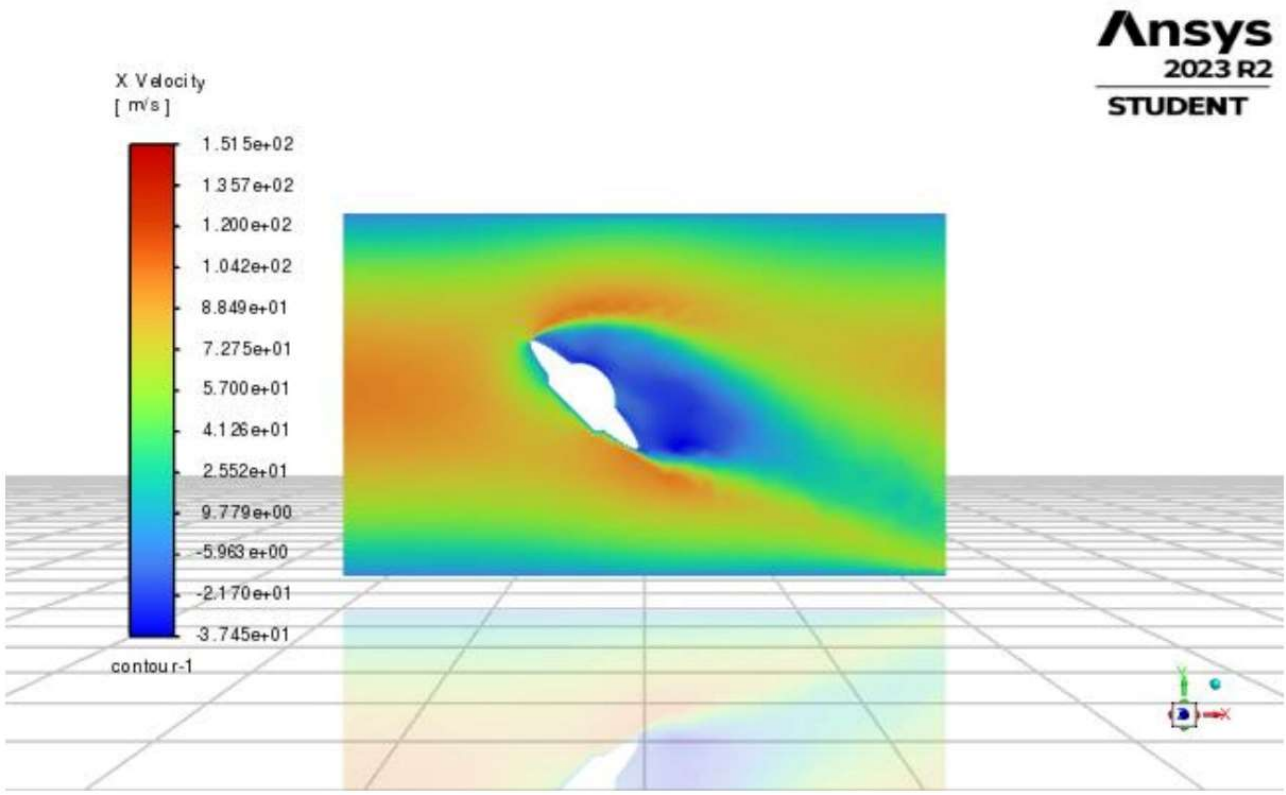
(D6)



Contour plots of x-velocity on the plane of symmetry with θ = 0°

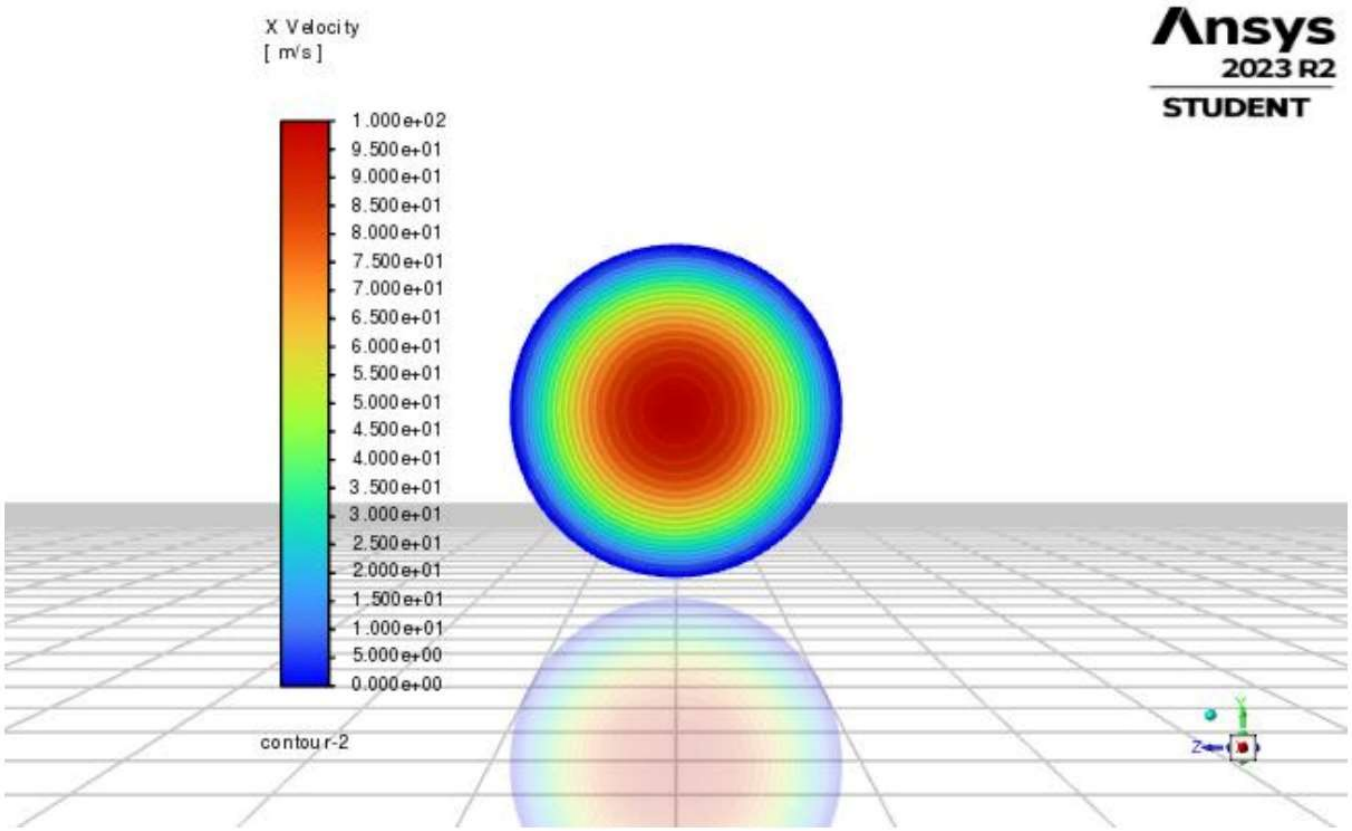


Contour plots of x-velocity on the plane of symmetry with θ = 22.5°

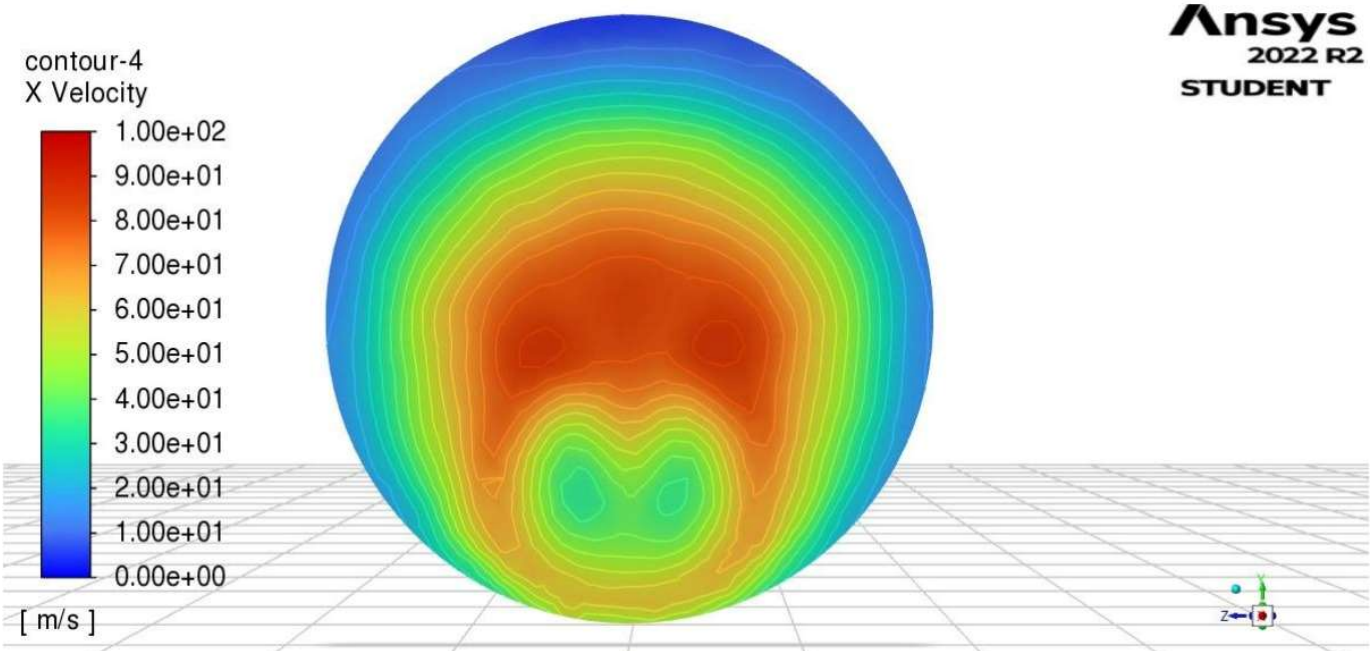


Contour plots of x-velocity on the plane of symmetry with θ = 45°

(D7)



Contour Plots of X- Velocity over the inlet, at θ = 45°



Contour Plots of X- Velocity over the outlet, at θ = 45°

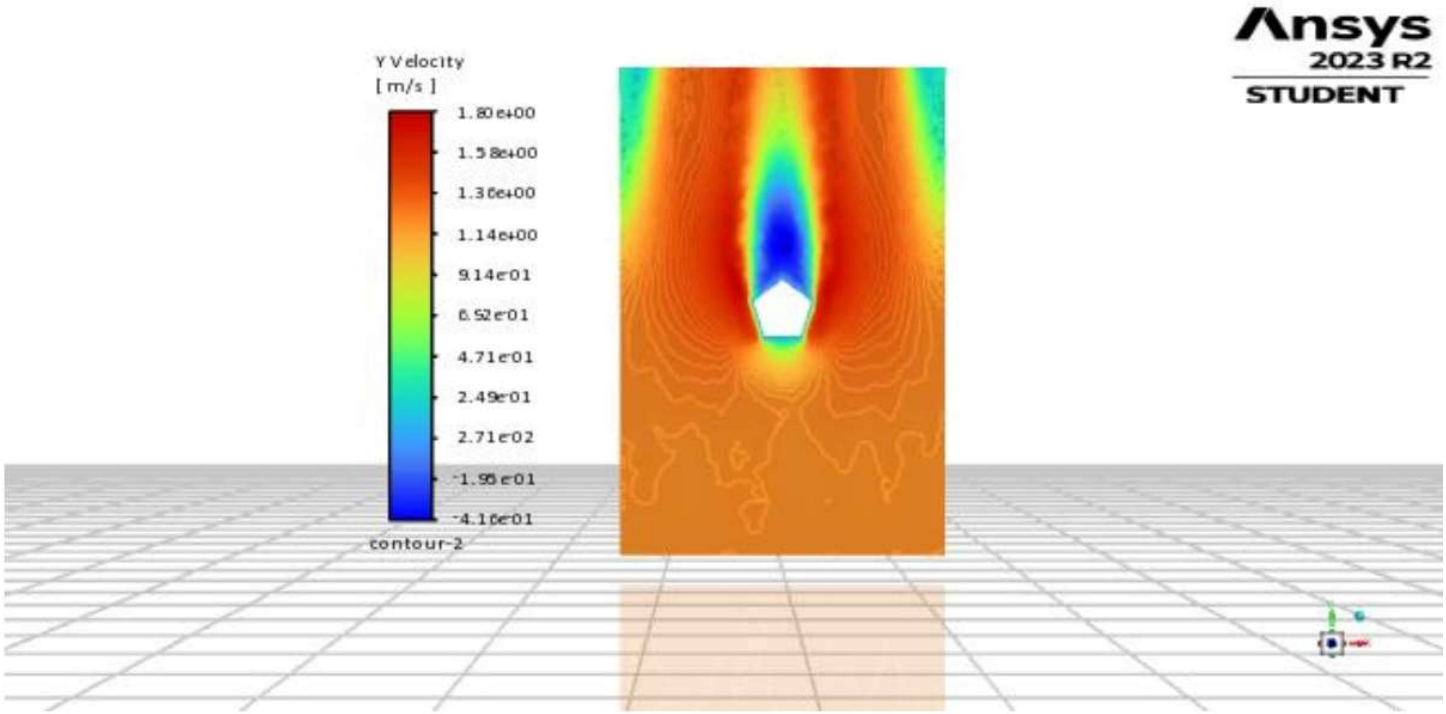
(D8)

	Lift Force (in Newton)	Drag Force (in Newton)
θ = 0°	7.40	3.489
θ = 22.5°	63.18	19.1222
θ = 45°	44.55	59.8660

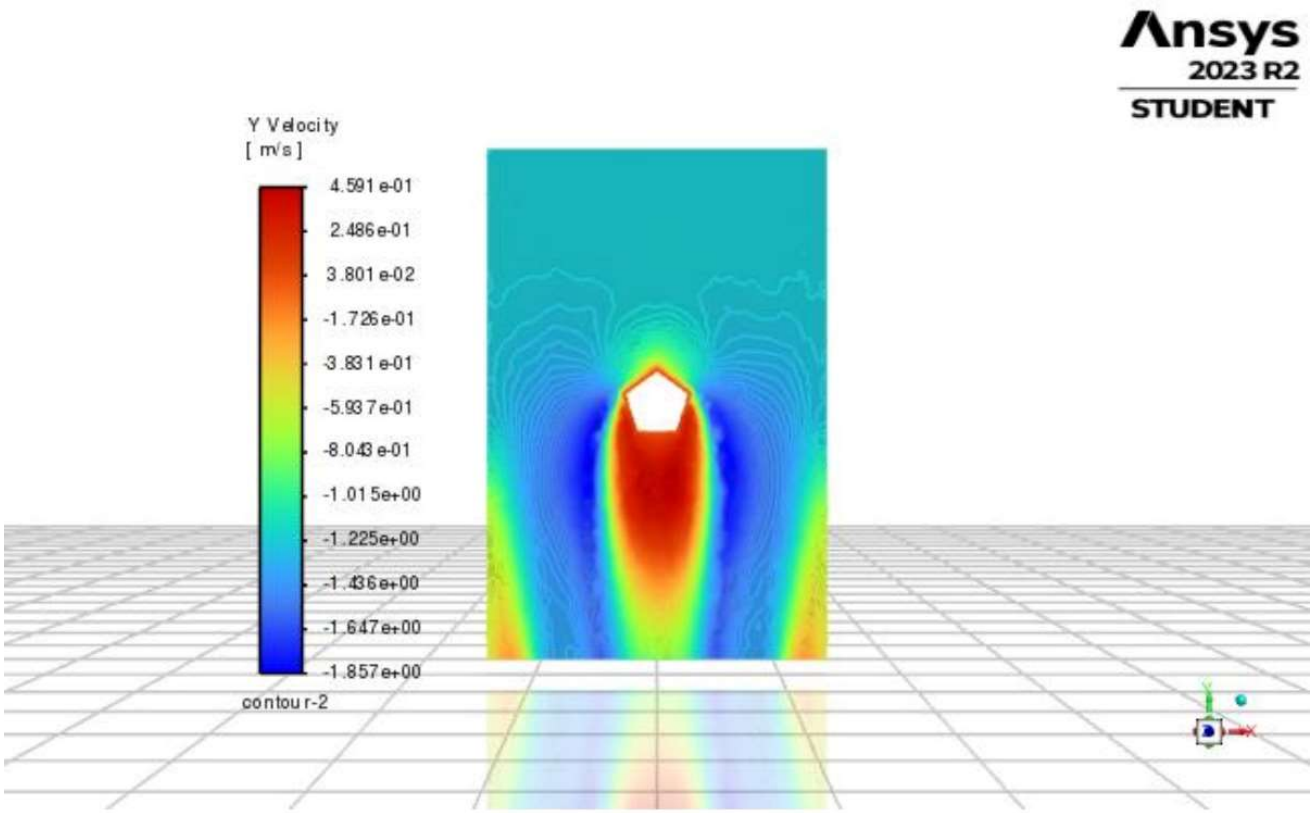
Task 3

(D9)

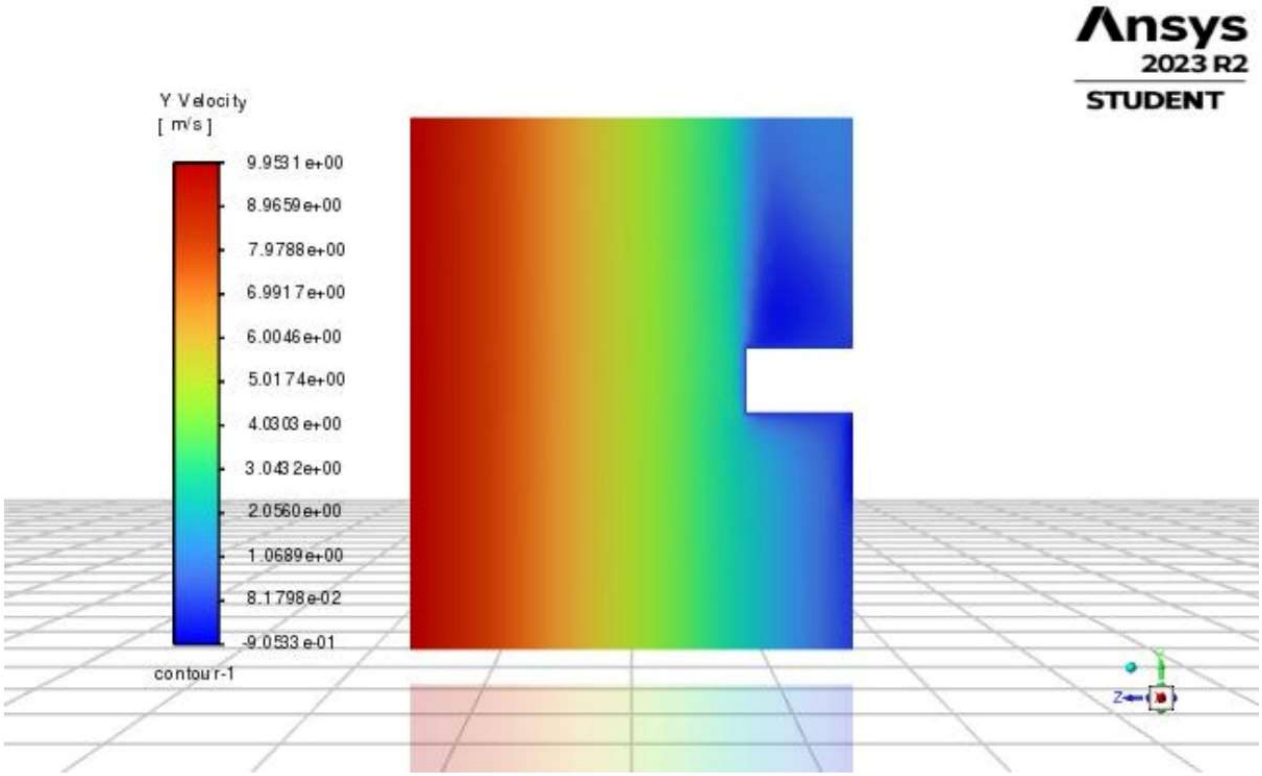
Run1 - Contour plots of y-velocity on the **horizontal** Plane -



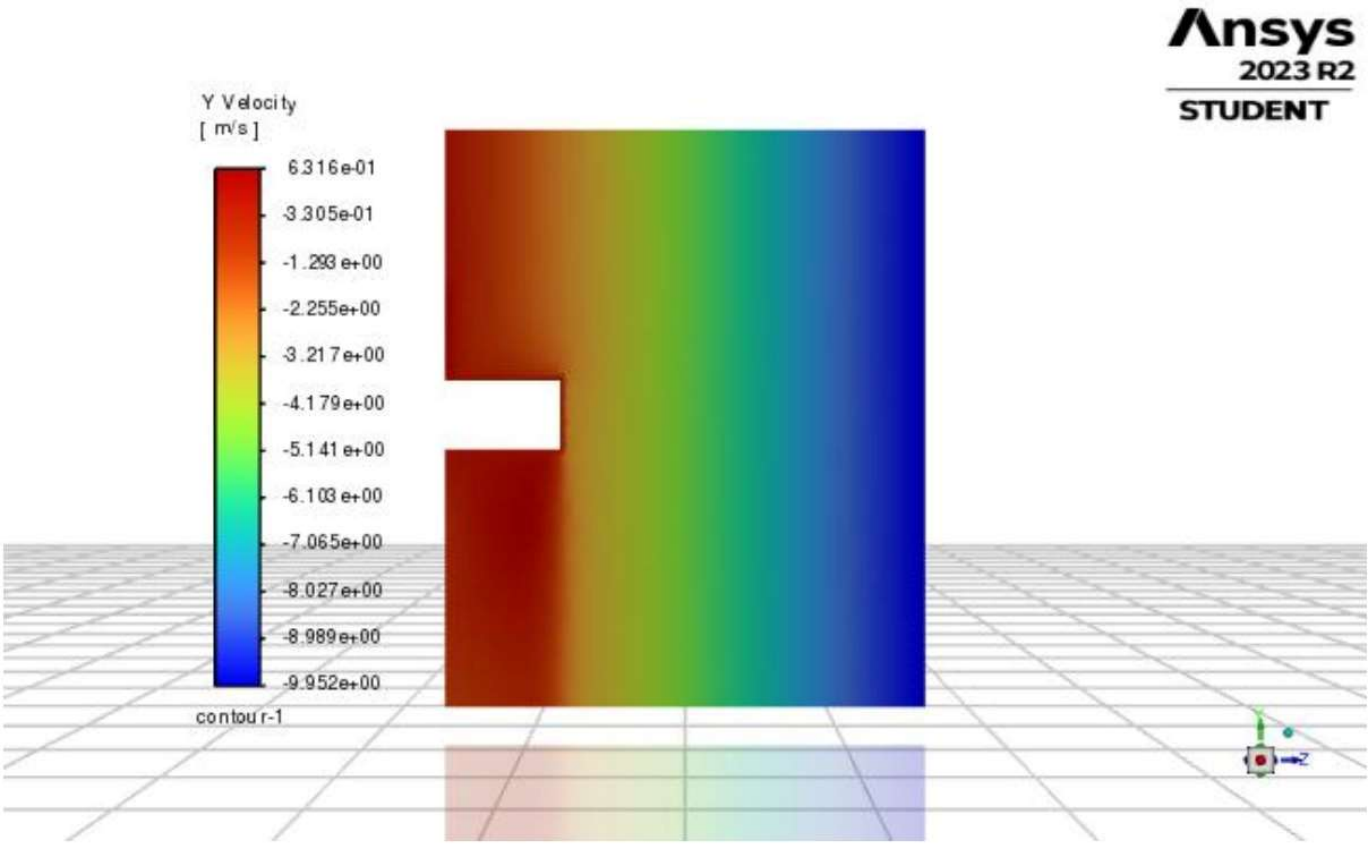
Run2 - Contour plots of y-velocity on the **horizontal** Plane **-**



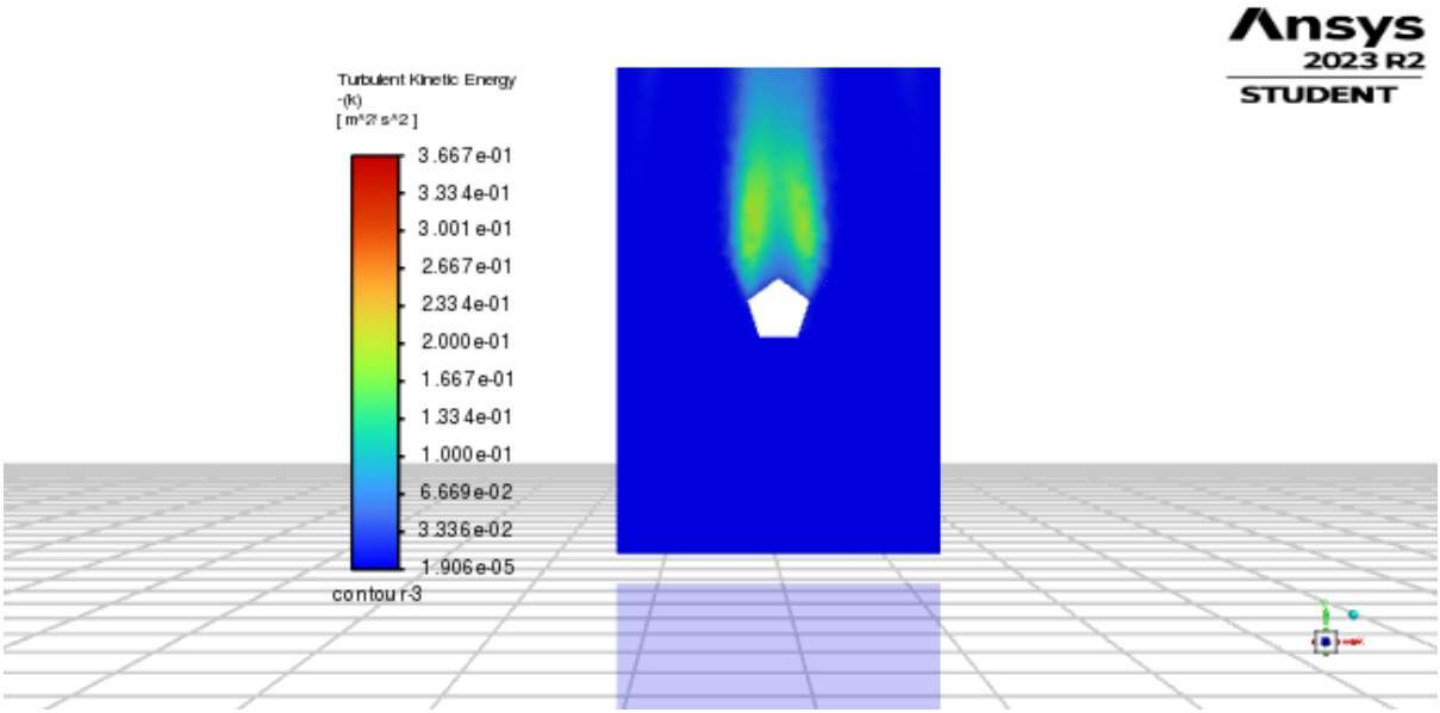
Run1 - Contour plots of y-velocity on the **vertical** Plane -



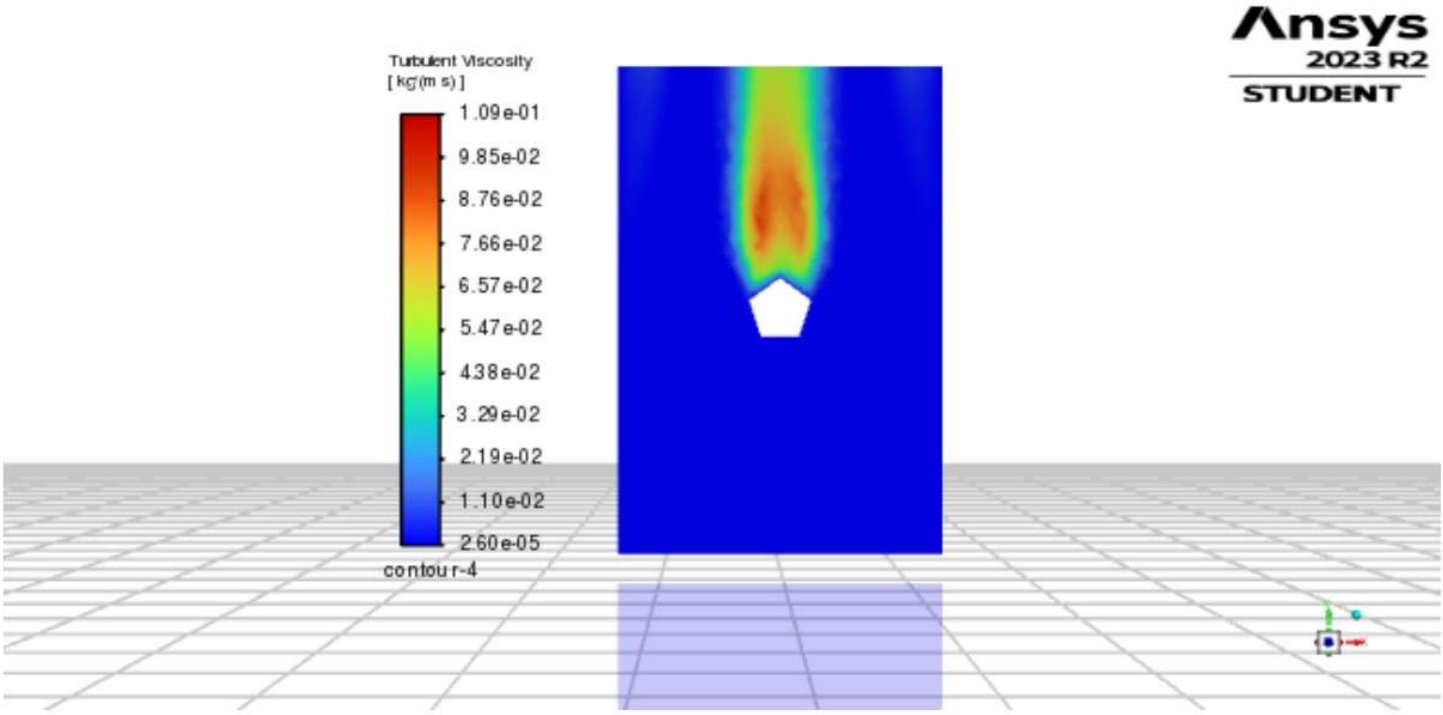
Run2 - Contour plots of y-velocity on the **vertical** Plane-



(D10)



*Run1 Contour plots of **turbulence kinetic energy***



*Run1 Contour plots of **turbulence viscosity***

- Maximum turbulent viscosity on this plane (μ_{Tmax}): 5.73×10-2
- Estimating the ratio between μ_{Tmax} & μ: μ_{Tmax}/μ = 3.21 × 103
- From the value above we can compare,

  The values of the Turbulent Viscosity = 0.057392554 and molecular Viscosity = 1.7994e-05

The turbulent viscosity (0.0573392554) surpasses the molecular viscosity of air by more than 3 orders of magnitude, signifying the dominance of turbulent effects over molecular effects in this flow at z = 3 m on the horizontal plane.

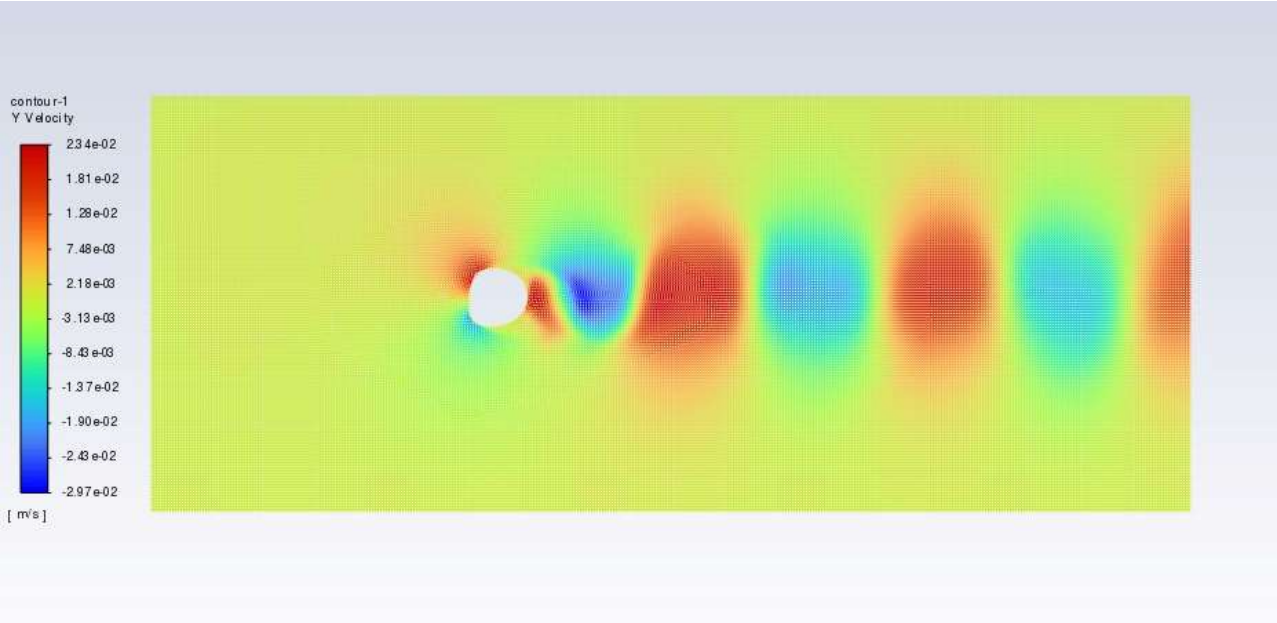
(D11)

	Total Drag (N)	Pressure Term of Drag (N)	Viscous Term of Drag (N)
Run1 (X – Direction)	**0.65422**	**0.6647**	**-0.0006998**
Run2 (X – Direction)	**-1.18552**	**-1.1510**	**-0.001904**

	Total Drag (N)	Pressure Term of Drag (N)	Viscous Term of Drag (N)
Run1 (Y – Direction)	**29.6333**	**28.982130**	**0.15598662**
Run2 (Y – Direction)	**-40.98552**	**-40.97895**	**-0.0745712**

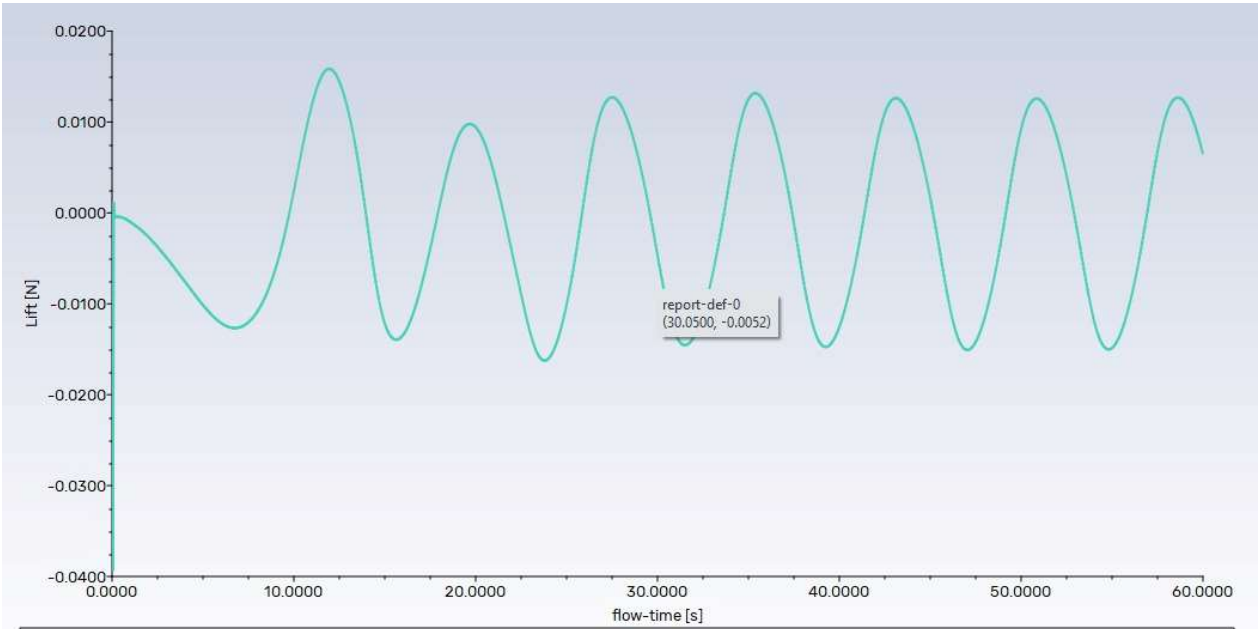
Task 4

(D12)



A contour plot of the y-velocity at t = 1min.

(D13)



A plot of lift force vs. time from the transient simulation