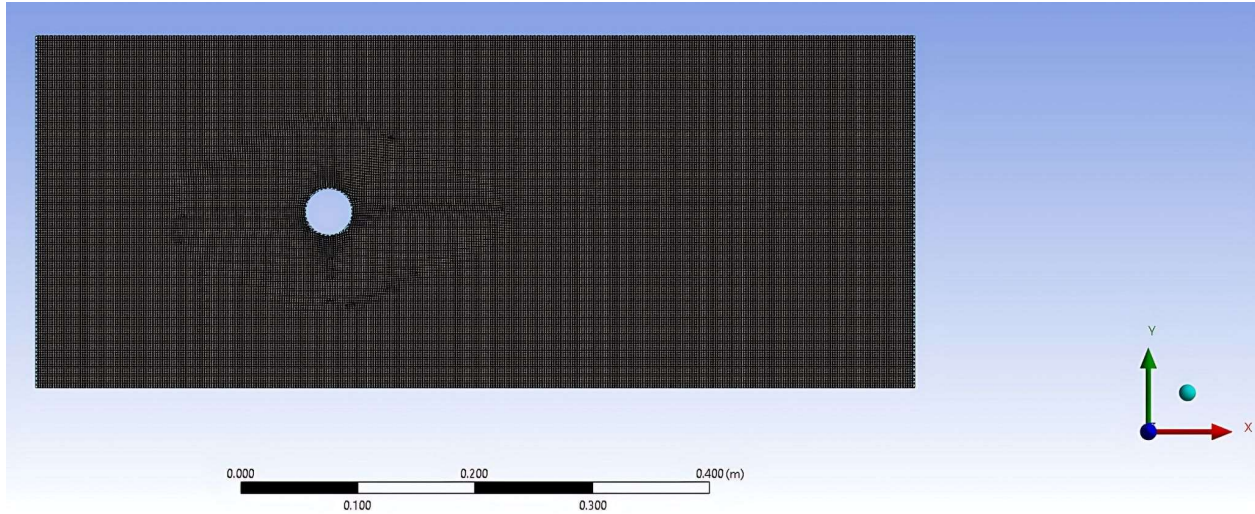# Project 3

Applied CFD

Submitted by: Shubham Jadhav

ASU ID: 1226315950

Collaboration: No collaboration

Task 1

(D1)

Element Size	Time Step Size (s)	Number of Time Steps	Max iterations
0.001	0.05	1200	10

Reynolds Number:

$Re = \rho v D / \mu$

$\mu = 0.0012$ kg/Ms
$\rho = 790$ kg/m³
$D = 0.04$m
$v = 0.025$ m/s

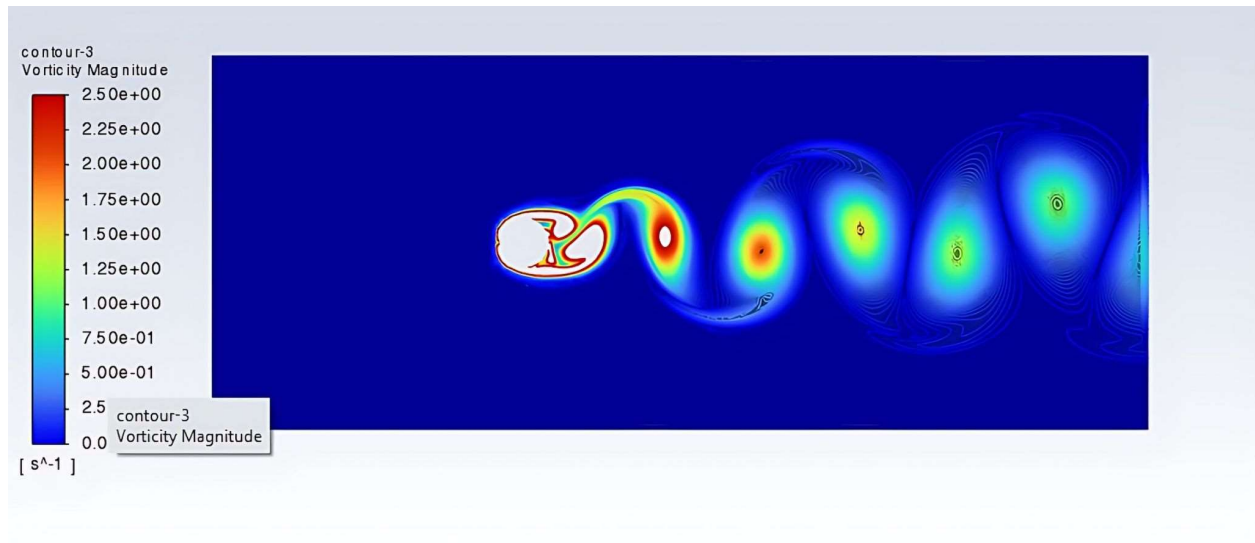**Re** = (790 x 0.025) x 0.04/0.0012 = **658.36**

(D2)
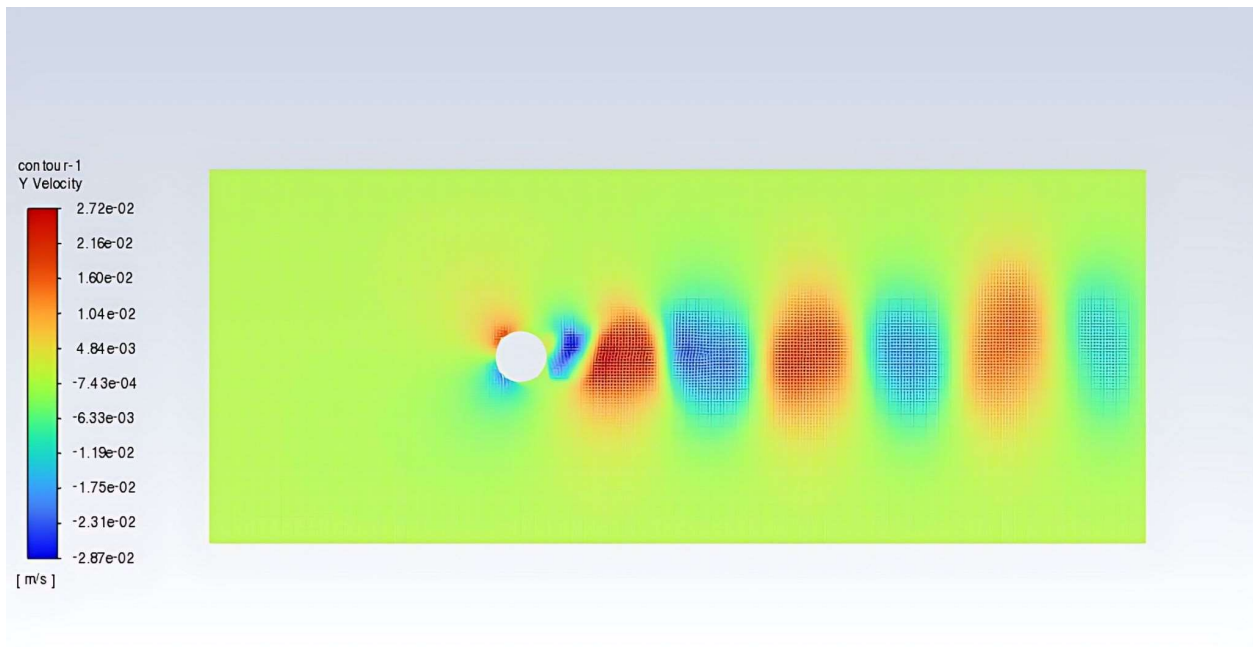
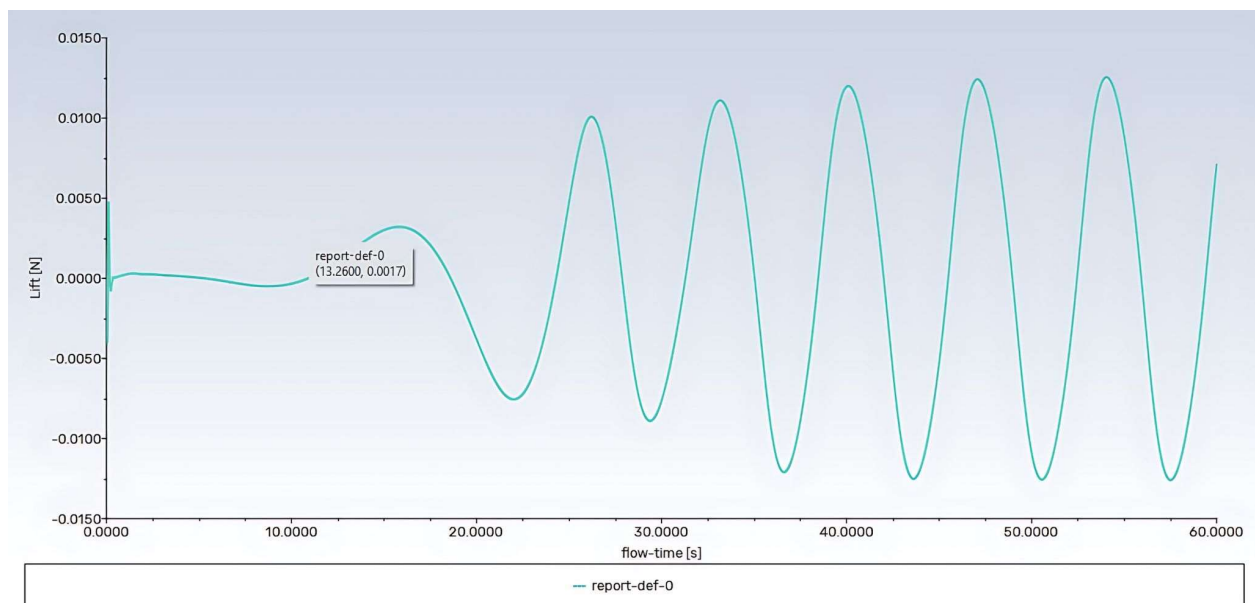**Contour plots of y-velocity at t = 1 min**
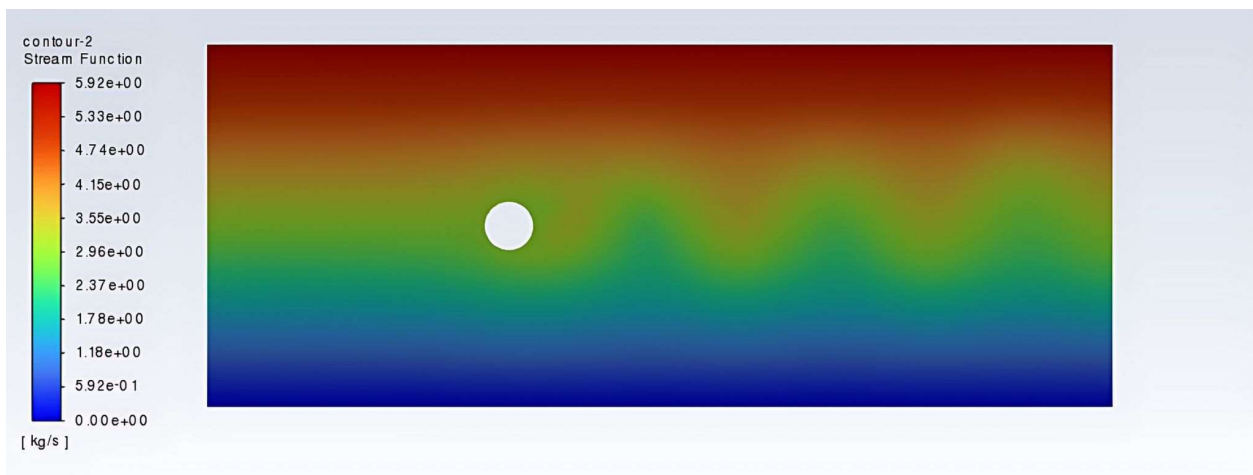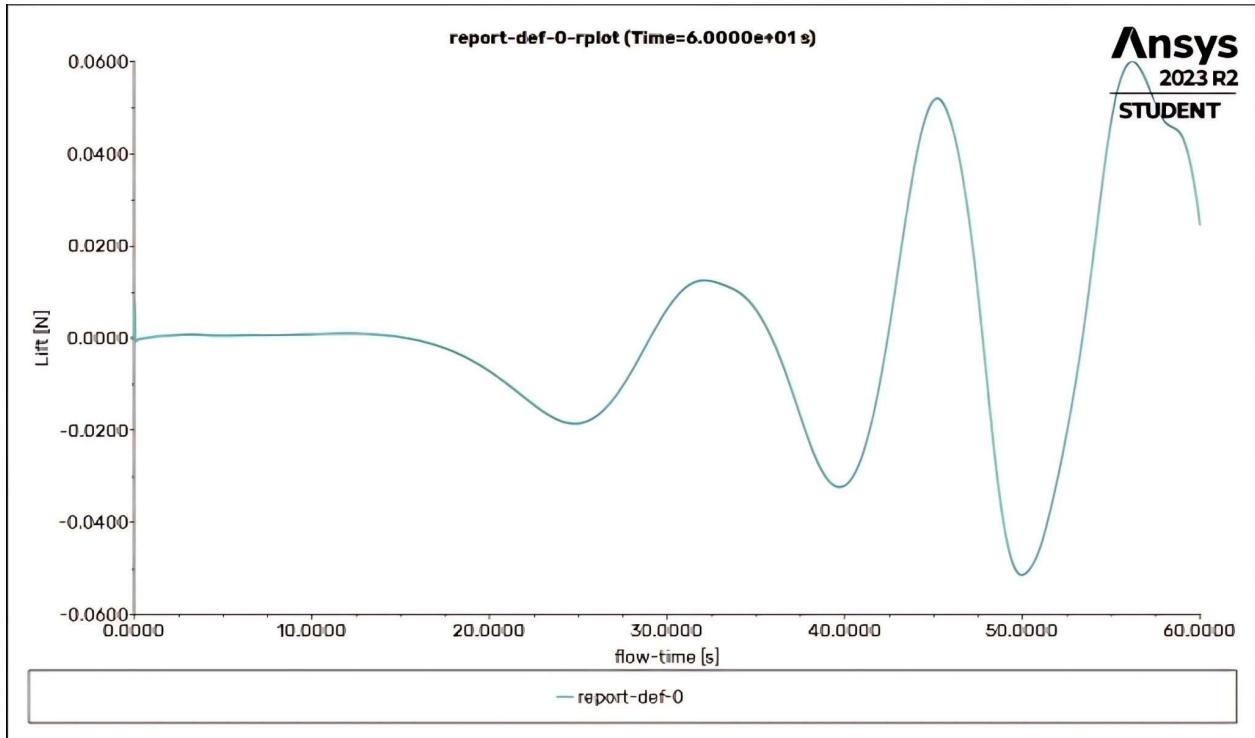

Contour plot of stream function at t = 1 min

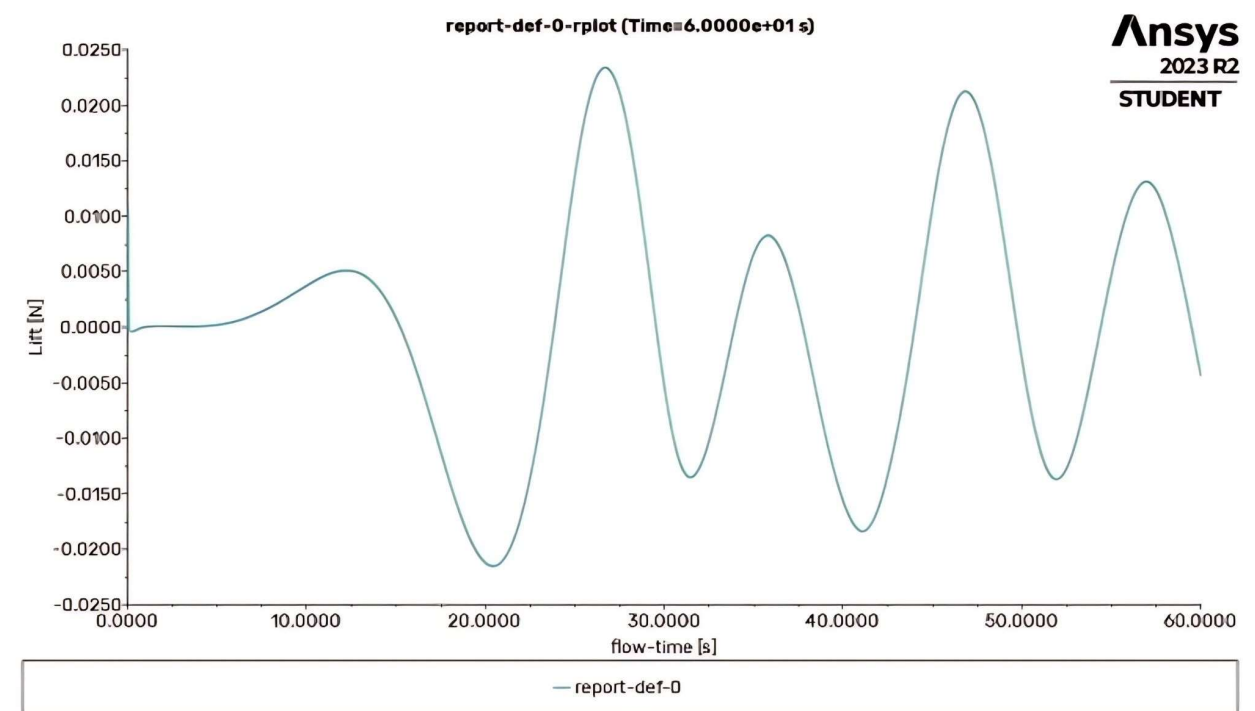**Contour plot of vorticity magnitude at t = 1 min**

(D3)

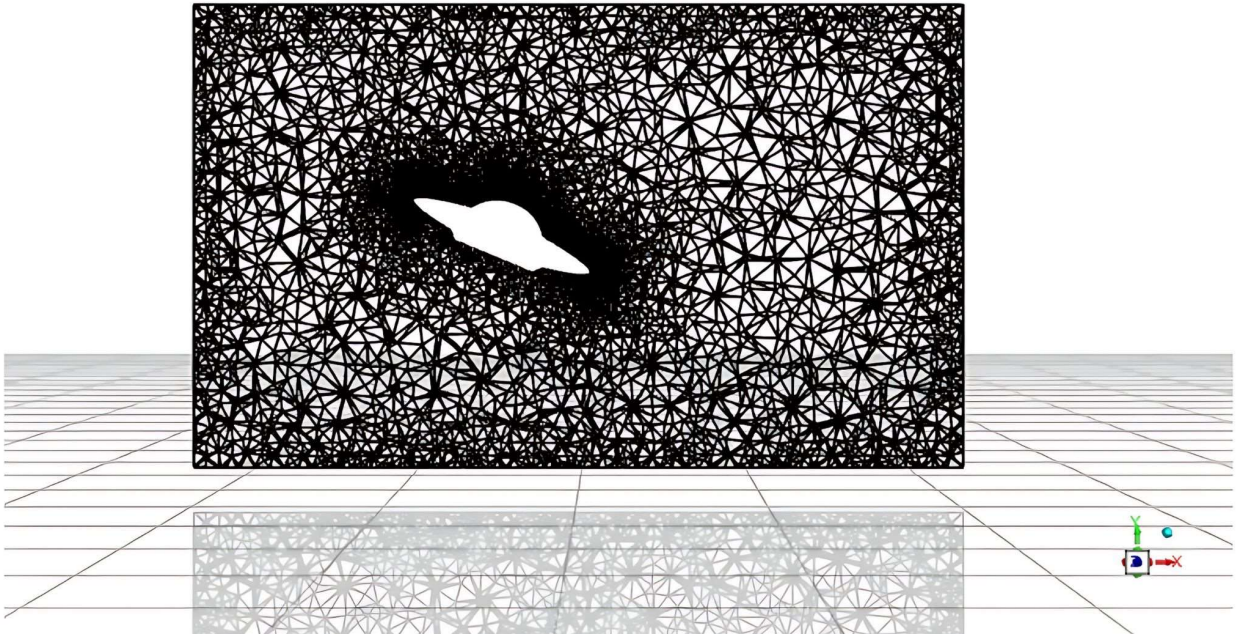**A plot of the lift force as a function of time t=0 to t=1 min**

(D4)

Run 1

Run 2

	Amplitude (in Newton)	Period (in seconds)
Circular cylinder	0.0129	7.7s
Elliptical cylinder, Run 1	0.0581	10.1s
Elliptical cylinder, Run 2	0.0153	12.7s

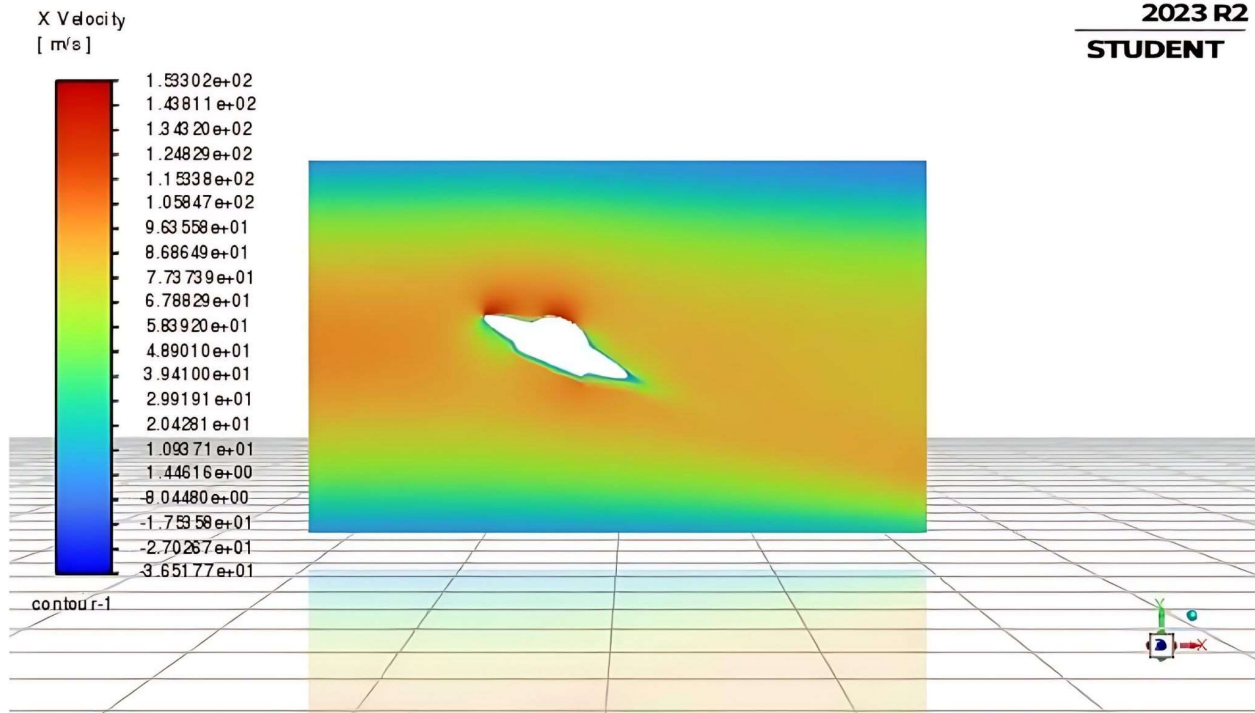**Task 2**

Plot of mesh along the plane of symmetry for the case with θ = 22.5°.
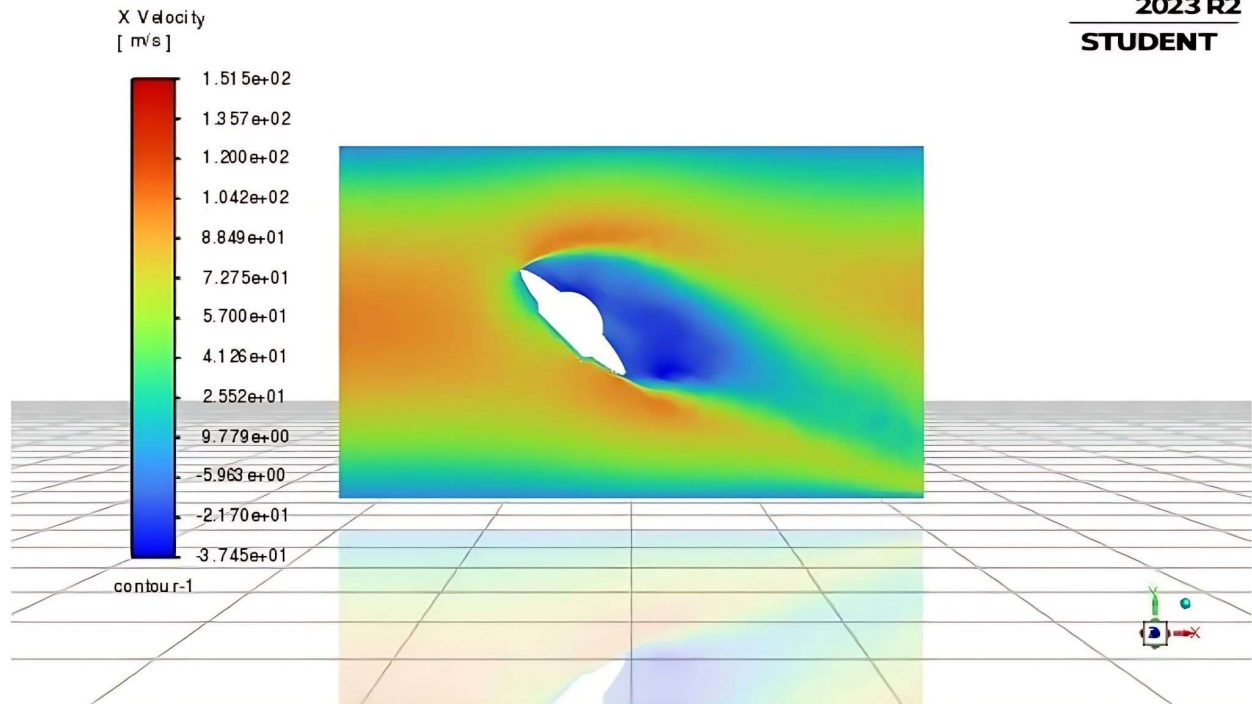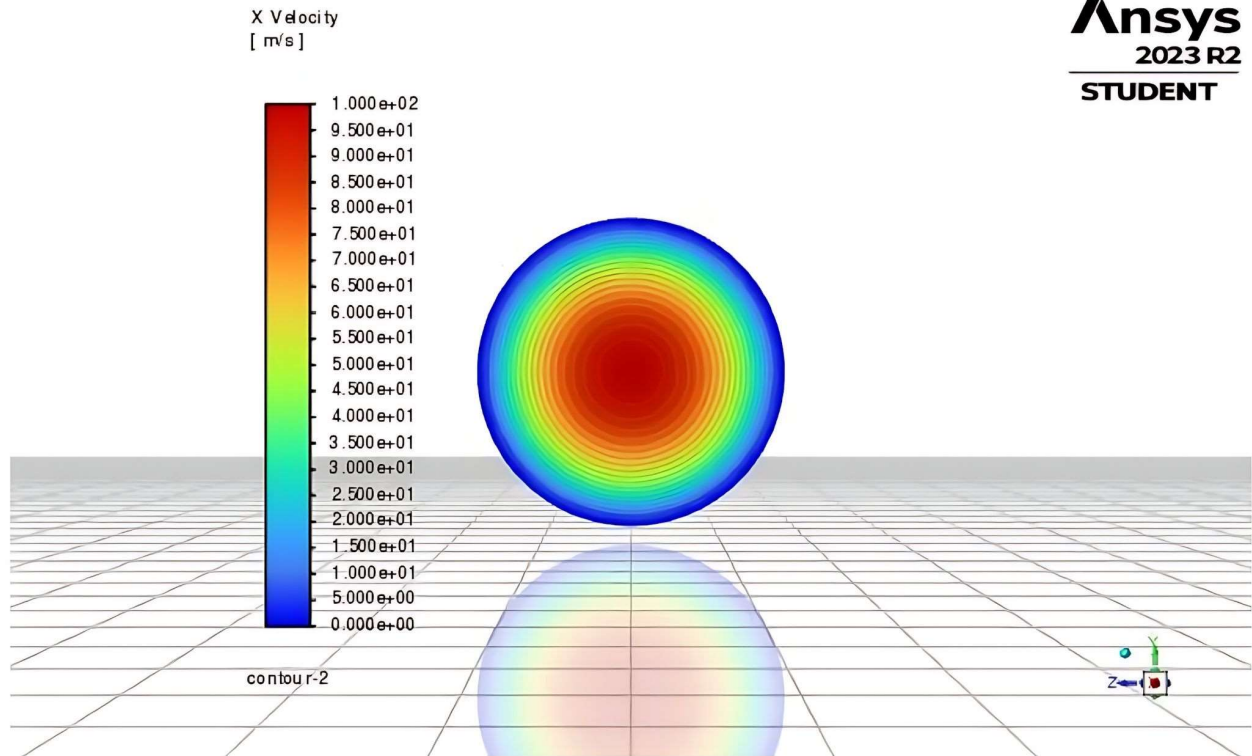
(D6)
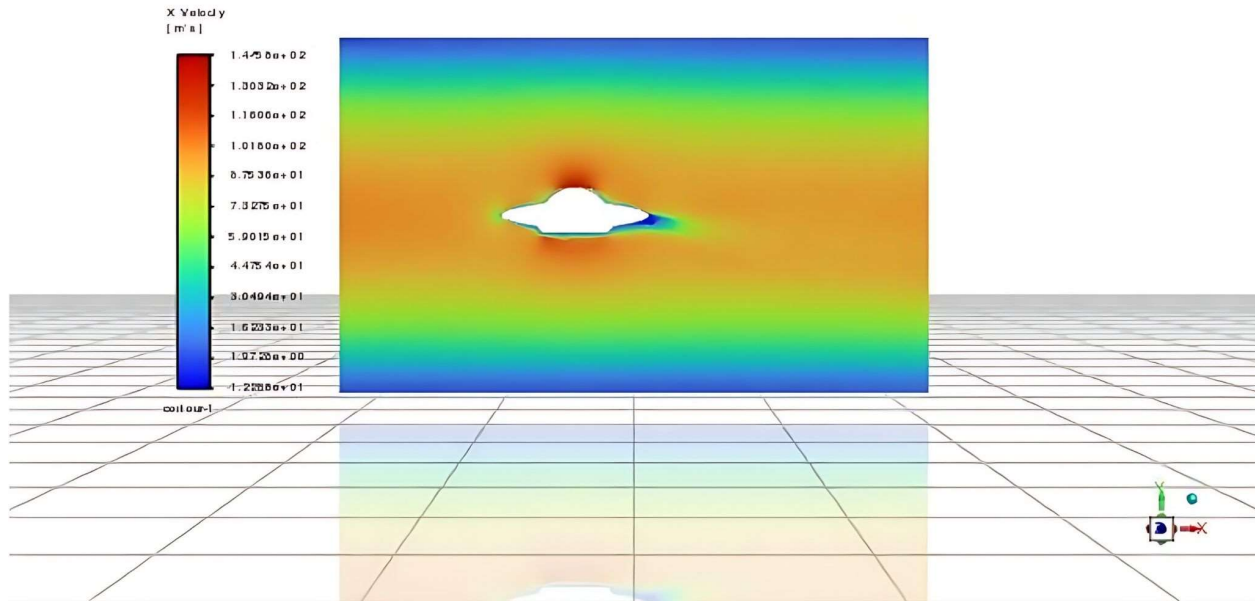
X-velocity on the plane of symmetry for the case with θ = 0°

X-velocity on the plane of symmetry for the case with θ = 22.5°

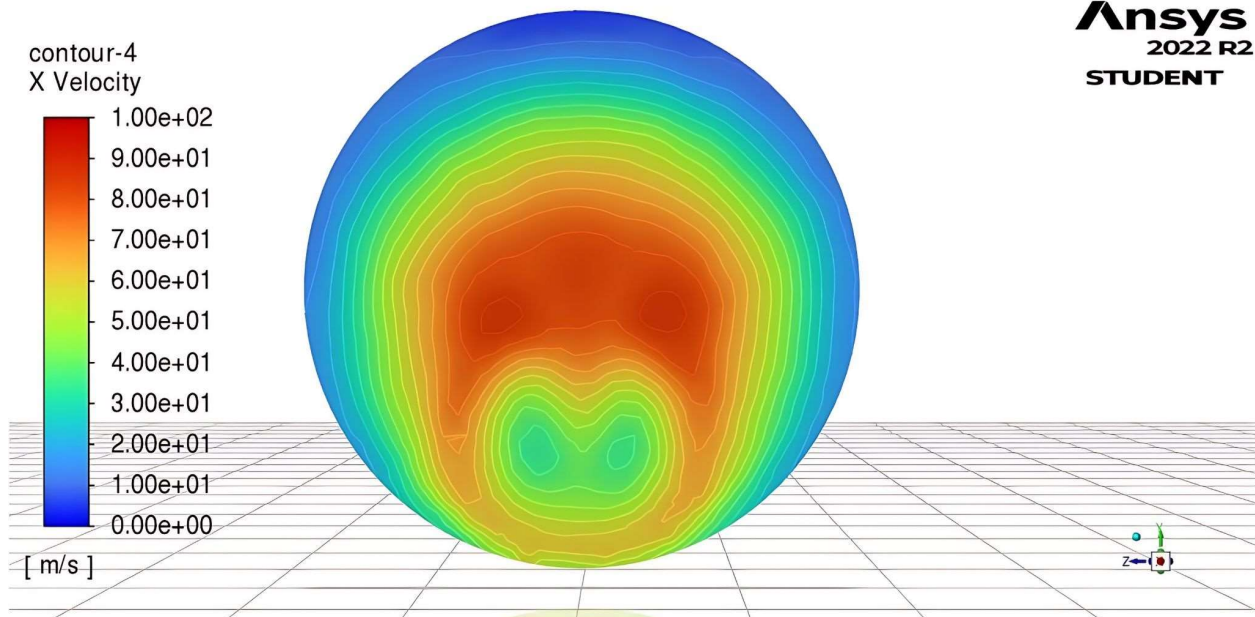**X-velocity on the plane of symmetry for the case with θ = 45°**

(D7)

Contour plots of X-velocity over the inlet, at θ = 45°,

Contour plots of X-velocity over the outlet, at θ = 45°,

(D8)

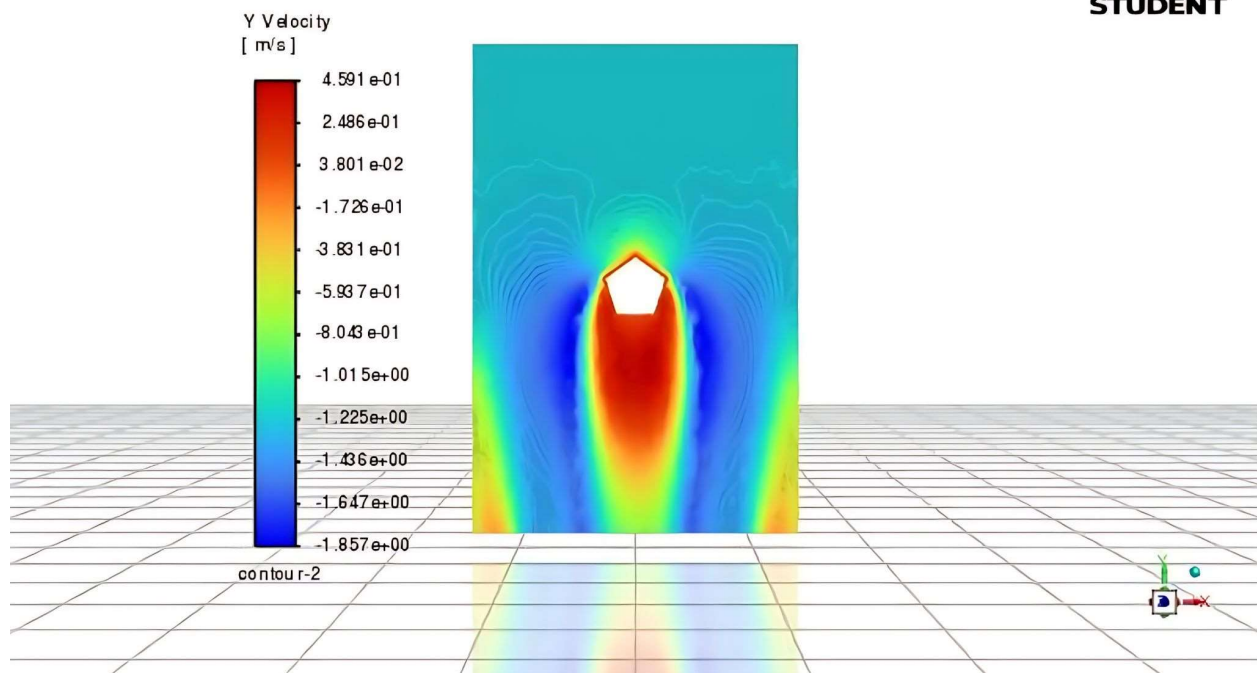|	Lift Force (in Newton)	Drag Force (in Newton)
θ = 0°	7.40	3.4905
θ = 22.5°	63.21	19.1325
θ = 45°	44.57	59.8663

Task 3

(D9)

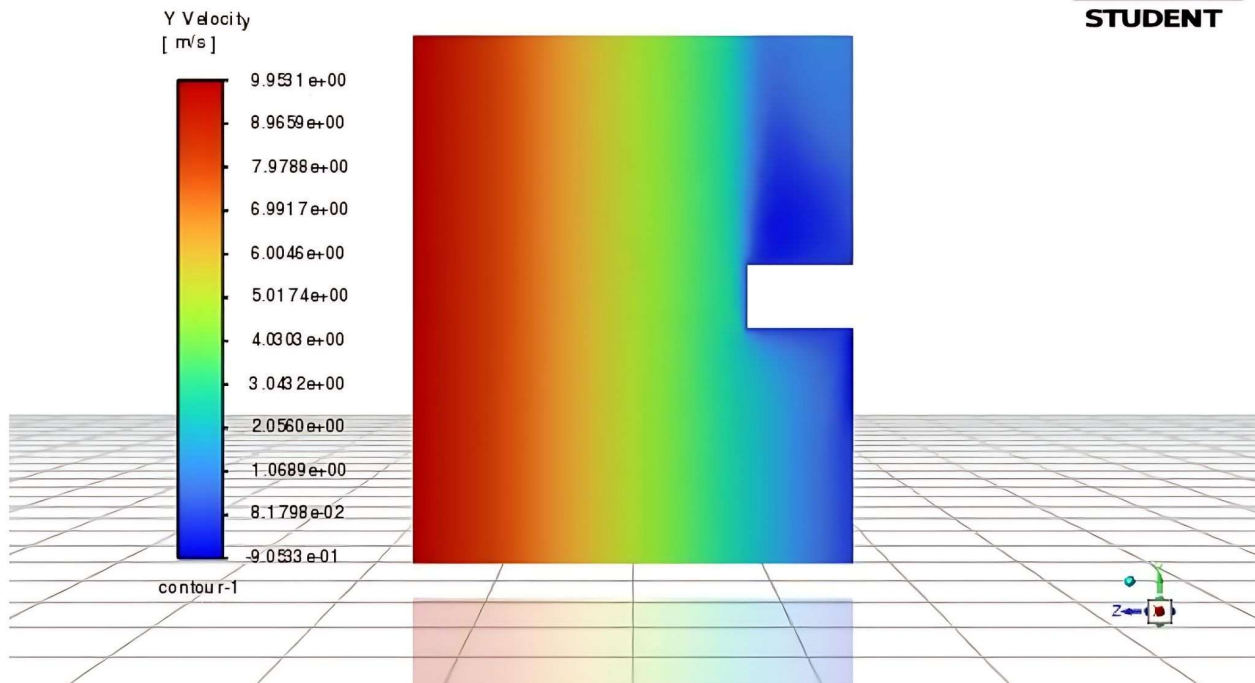**(i) contour plots of y-velocity on the horizontal plane at z = 3 m.**
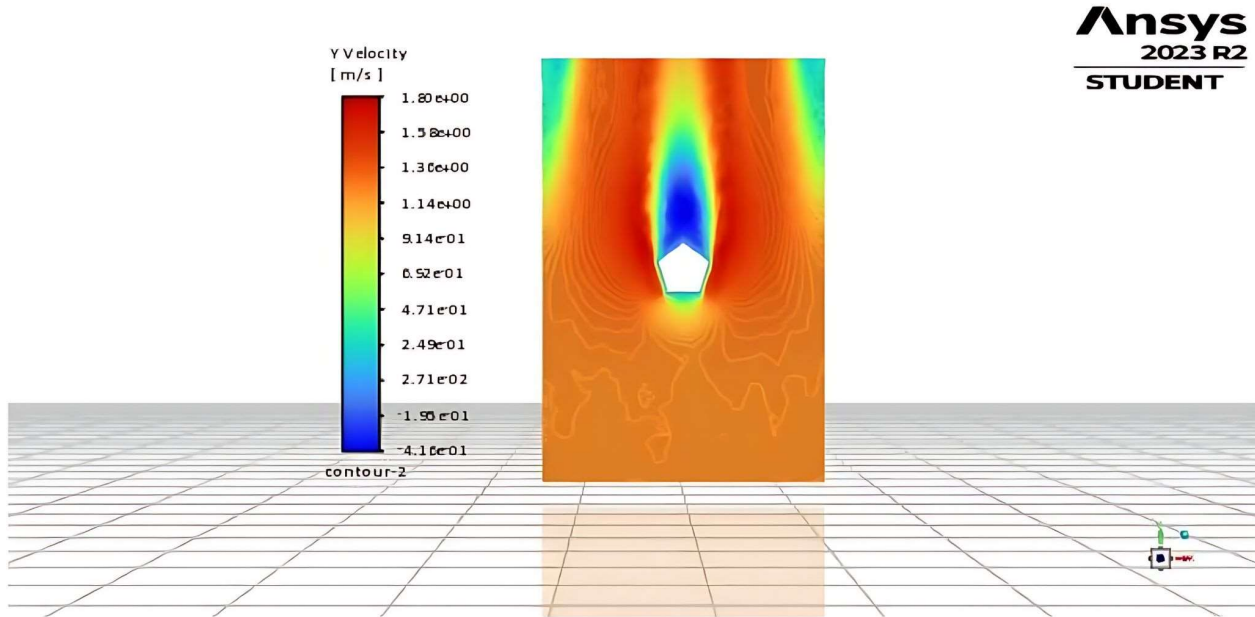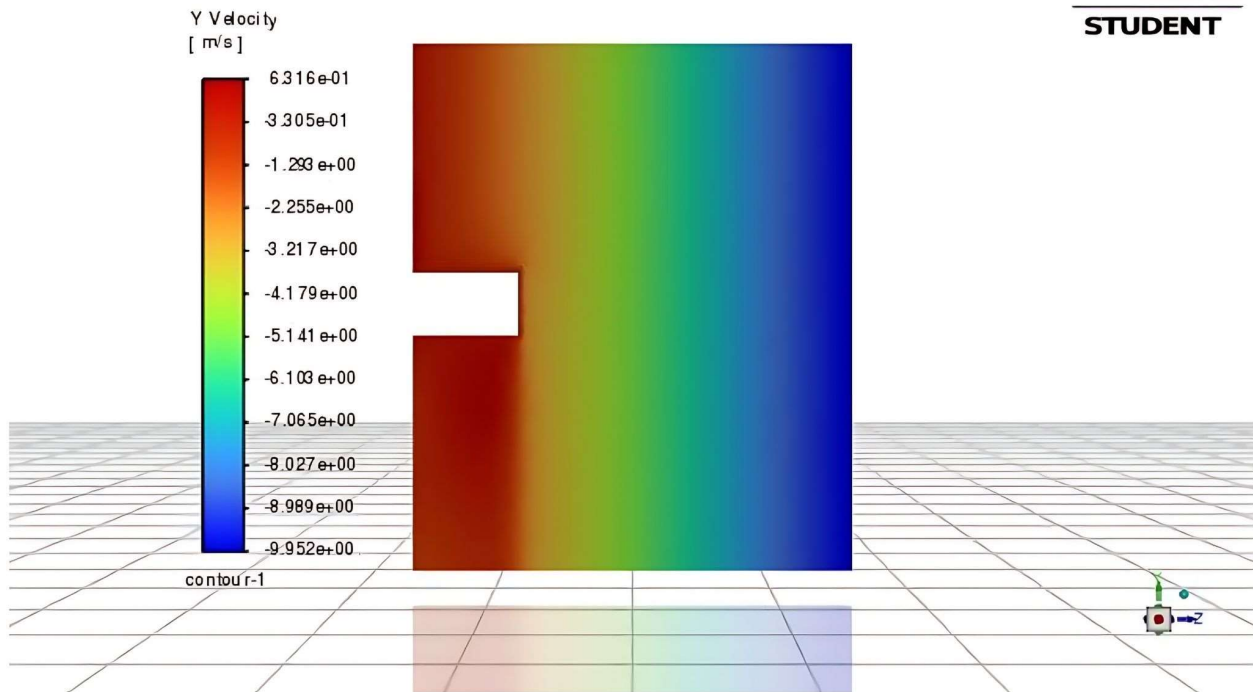

Run 1

Run 2

(ii) contour plots of y-velocity on the vertical plane that is the plane of symmetry for the system
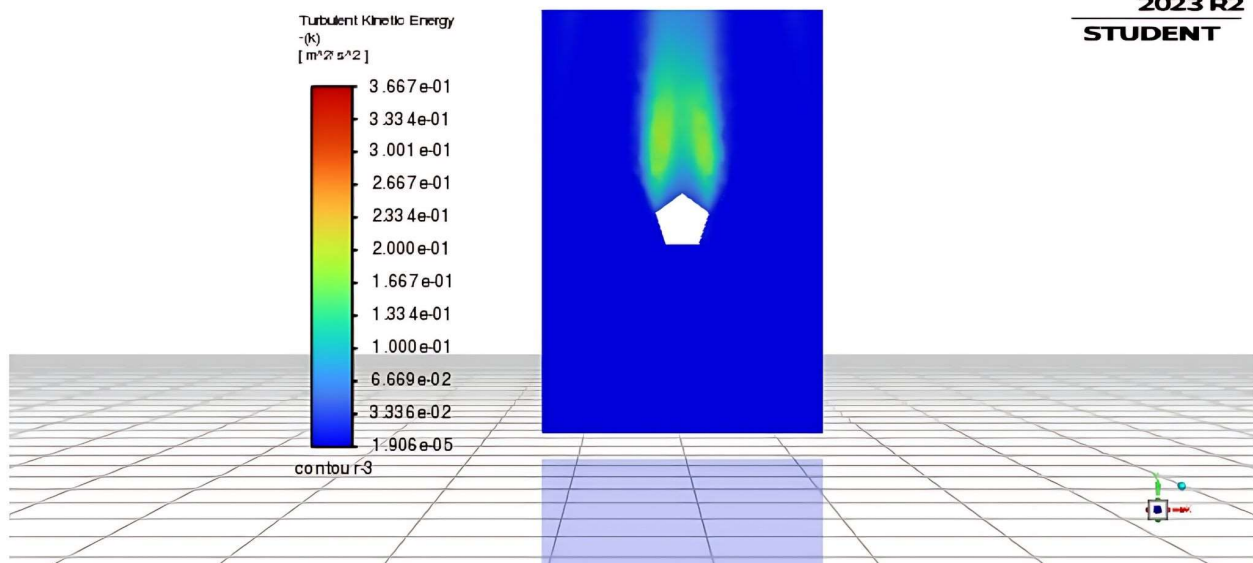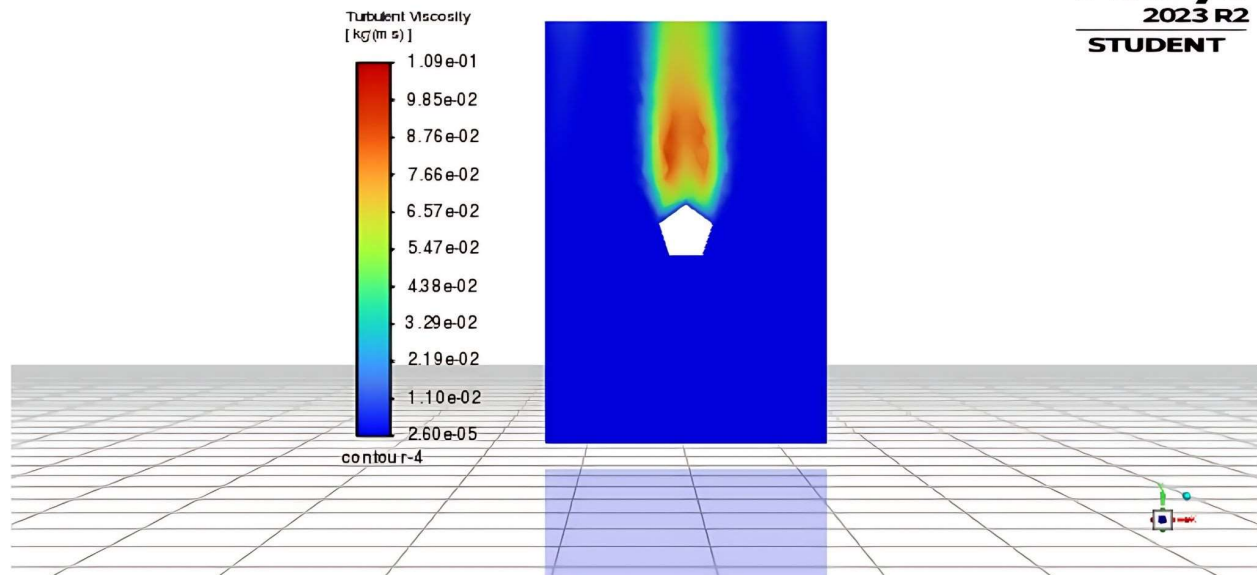
Run 1

Run 2

(D10)

contour plots of turbulence kinetic energy

contour plots of turbulence Viscosity

- Maximum Turbulent viscosity on this plane (μTmax): 5.73 x 10^(-2)
- $\mu T max / \mu$ = 3.21 x 10^3

Comparison
- Turbulent viscosity = 0.0573925
- Molecular viscosity = 1.7994e-05

The maximum turbulent viscosity is over 3 orders of magnitude larger than the molecular viscosity of air.
This shows that the turbulent viscosity is much greater than the molecular viscosity, indicating that turbulent effects dominate over molecular effects in this flow on the horizontal plane at z = 3 m.
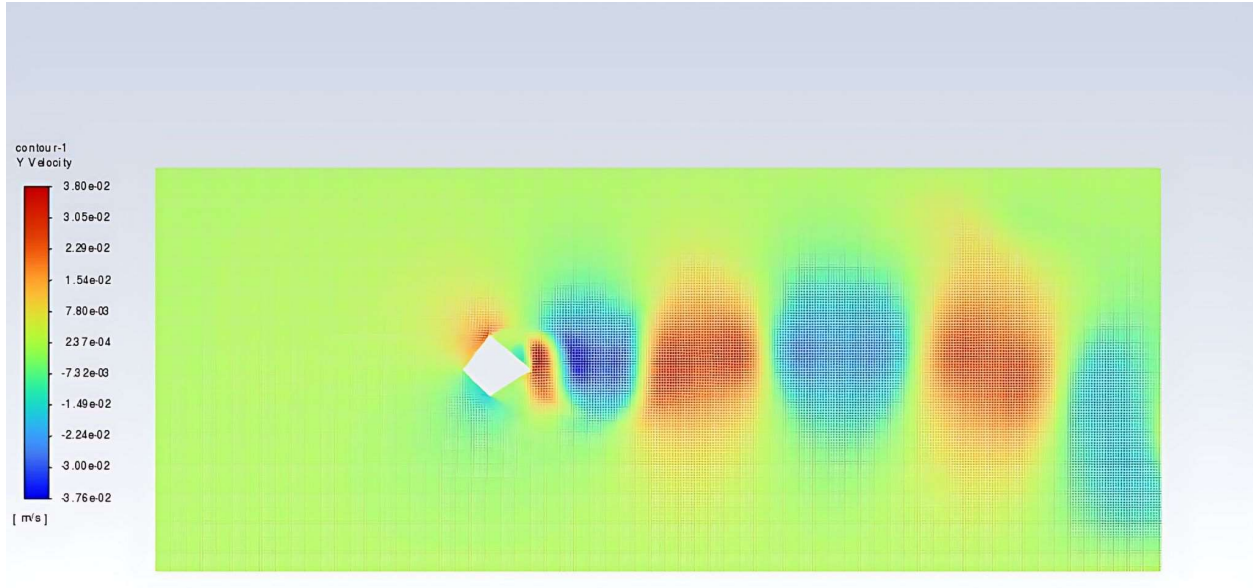
(D11)

	Total drag (N)	Pressure term of drag (N)	Viscous term of drag (N)
Run 1 (X- direction)	0.65419	0.66501	-0.0006995
Run 2 (X- direction`)	-1.18543	-1.15142	-0.001907

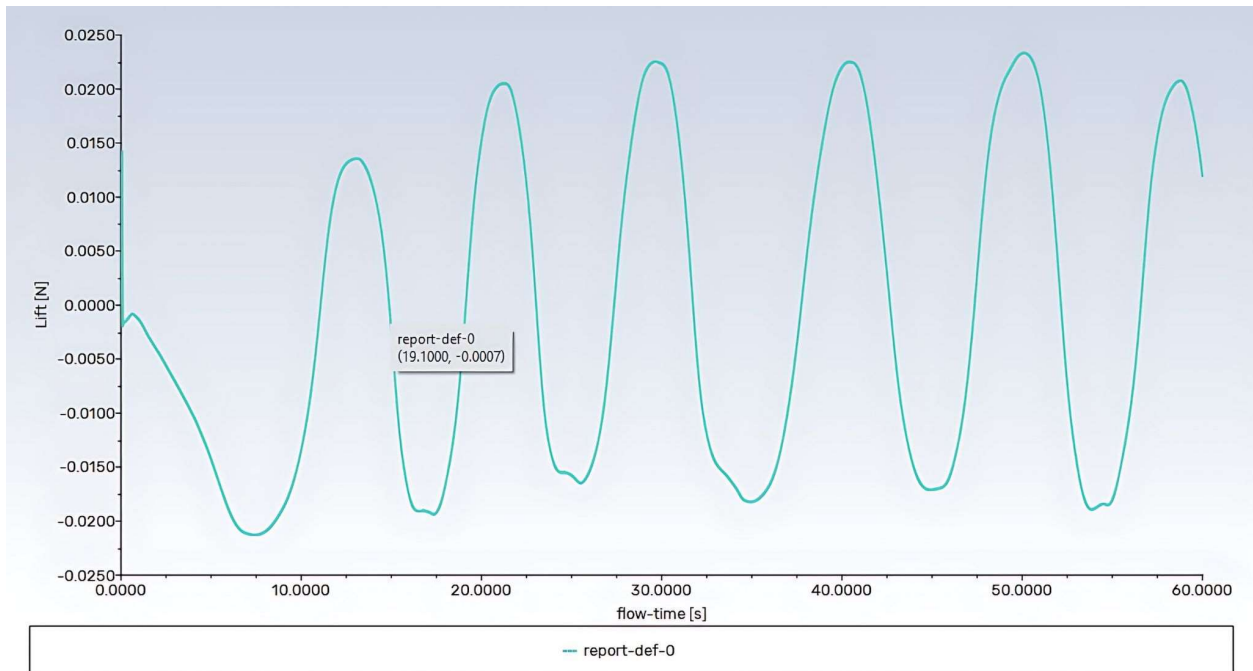|			
Run 1 (Y- direction)	29.6339	28.982134	0.155987
Run 2 (Y- direction`)	-40.98852	-40.9789	-0.0745711

Task 4

(D12)

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

(D13)

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