MAE 598 Applied CFD Project # 3

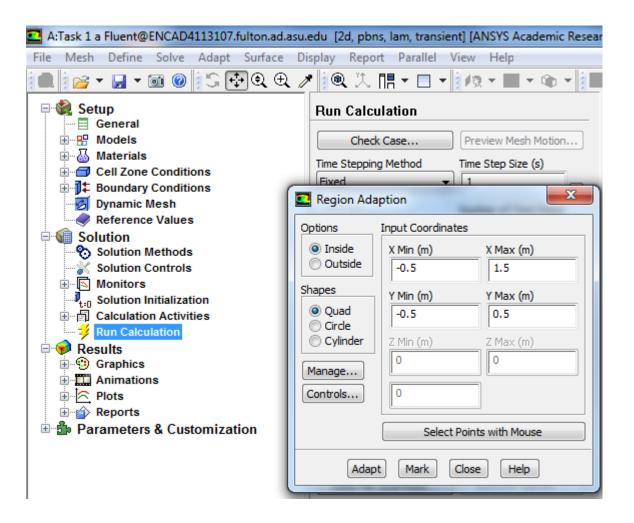
# Task 1

For this problem the time is used as transient. The mesh used is Fine. The setup uses No Slip Condition.

For Task 1 (a) we use viscous laminar flow and the material used is water.

For Task 1 (b) we use Viscous-turbulence k-epsilon and the material used is air.

For Mesh refinement we refine the mesh around the cylinder with the co-ordinates given in the problem statement.

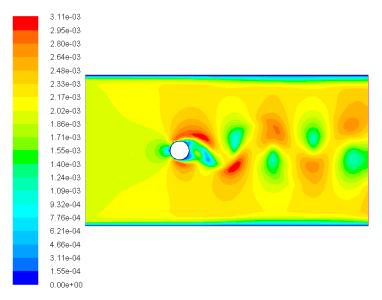


We initialize the solution and run the calculations with time step 1 and for 3600 number of time steps for the period of 1 hour.

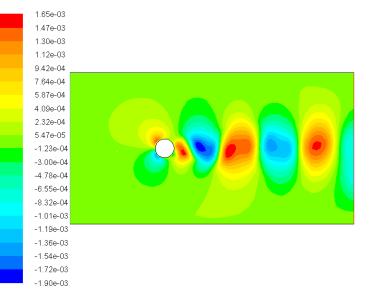
A:Task 1 a Fluent@ENCAD4113107.fulton.ad.asu.	edu [2d, pbns, lam, transient] [ANSYS Academic Resear
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Setup General Models Materials Cell Zone Conditions Dynamic Mesh Reference Values Solution Solution Methods Solution Controls Monitors Solution Initialization Calculation Activities Results Calculation Results Calculations Plots Plots Parameters & Customization	Run Calculation         Check Case       Preview Mesh Motion         Time Stepping Method       Time Step Size (s)         Fixed       1         Settings       Number of Time Steps         3600       Image: Color of the step size (s)         Options       Image: Color of the step size (s)         Data Sampling for Time Statistics       Sampling Interval         1       Image: Color of the statistics         Sampling Interval       Image: Color of the statistics         Max Iterations/Time Step       Reporting Interval         40       Image: Color of the step size (s)         Profile Update Interval       Image: Color of the step size (s)         Image: Color of the step size (s)       Acoustic Signals         Calculate       Help

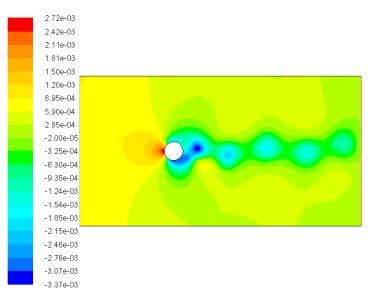
# **Results** Task 1 (a)

### Velocity Magnitude



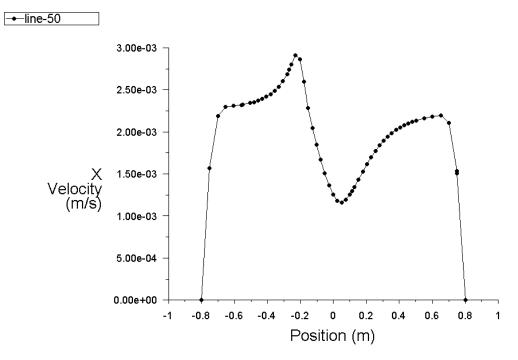
#### **Y-Component of Velocity**

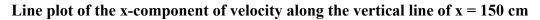


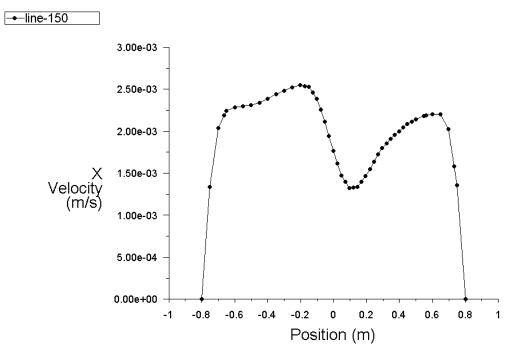


#### Pressure

Line plot of the x-component of velocity along the vertical line of x = 50 cm

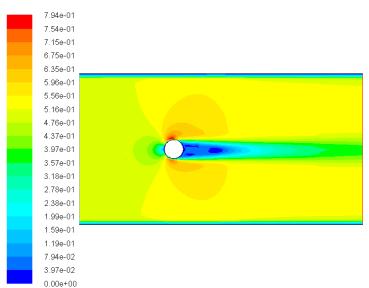




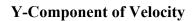


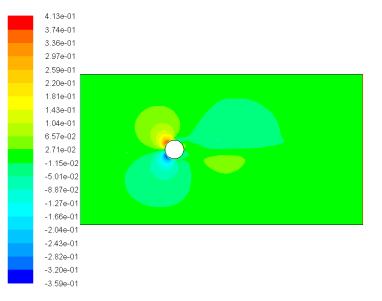
Reynolds number = 
$$\frac{\rho v d}{\mu} = \frac{998.2 \times 0.002 \times 0.2}{0.001003} = 398.08$$

# Results Task 1 (b)



### Velocity Magnitude

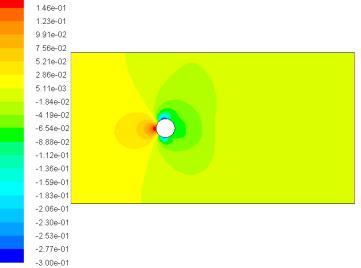




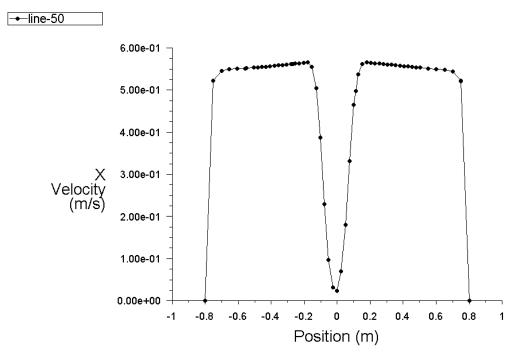


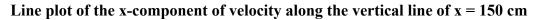


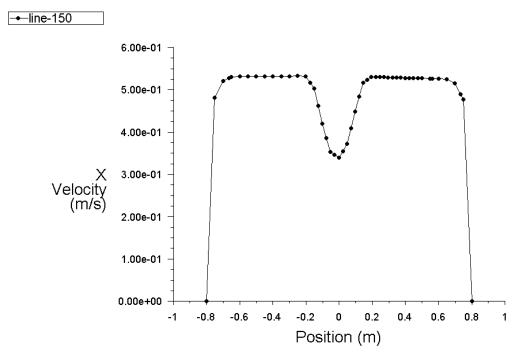
1.70e-01



Line plot of the x-component of velocity along the vertical line of x = 50 cm







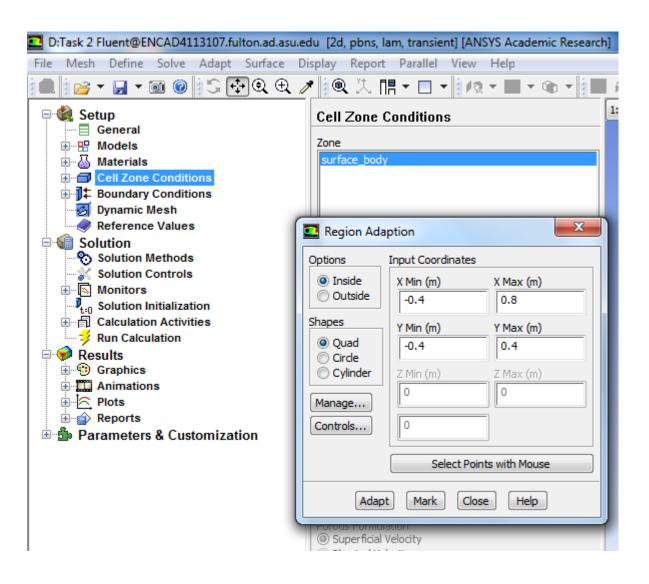
Reynolds number = 
$$\frac{\rho v d}{\mu} = \frac{1.225 \times 0.5 \times 0.2}{1.7894e - 05} = 6845.87$$

# Task 2

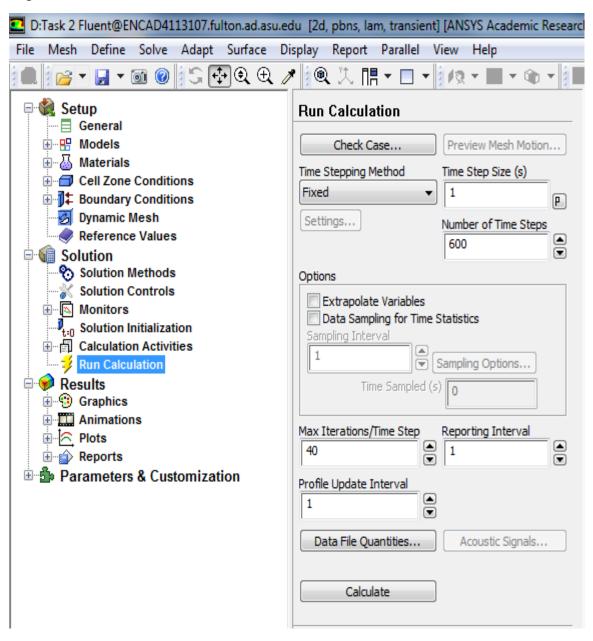
For this problem the time is used as transient. The mesh used is Fine. The setup uses **No Slip Condition.** 

We use viscous laminar flow and the material used is water.

For Mesh refinement we refine the mesh around the half fish with the co-ordinates given in the problem statement.

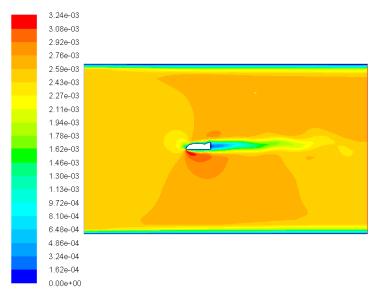


We initialize the solution and run the calculations with time step 1 and for 600 number of time steps for the period of 10 minutes.

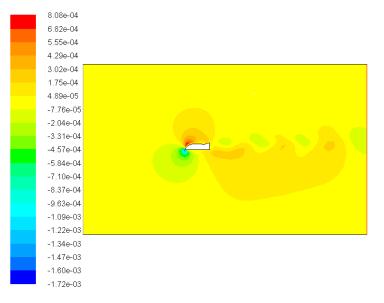


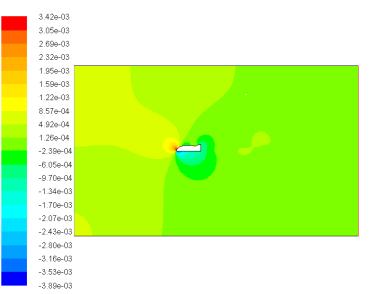
# Results Task 2











#### Pressure

### The lift on the Half Fish

🖻 🍓 Setup	Reports	1: Mesh
Run Calculation	Reports         Fluxes         Forces         Projected Areas - Unavailable         Surface Integrals         Volume Integrals         Discrete Phase:         Sample         Histogram         Summary         Heat Exchanger - Unavailable         Projected Areas - Unavailable         Projected Phase:         Sample         Histogram         Summary         Heat Exchanger - Unavailable         Direction Vector         Wall Zones         Orizontal Wall         Orizontalwall         antwall         Y         1         2         0         Wall-surface	
	Vall Name Pattern Match Save Output Parameter Print Write Close Help	

Forces - Direction Vector	(0 1 0) Forces (n)		
Zone	Pressure	Viscous	Total
bottomwall	-0.00028849812	-5.2016144e-06	-0.00029369974
curvewall	-1.5696318e-05	7.1400909e-06	-8.5562269e-06
horizontalwall	6.9865669e-06	4.0345776e-07	7.3900246e-06
slantwall	2.1394808e-06	-7.9726919e-07	1.3422116e-06
verticalwall	0	5.4576702e-07	5.4576702e-07
Net	-0.00029506839	2.0904321e-06	-0.00029297796

The Lift exerted by pressure on the whole half fish = -0.00029506839 N

The Lift exerted by viscosity on the whole half fish = 2.0904321e-06 N

The Lift that is exerted on the whole half fish = -0.00029297796 N

The lift is negative. From the Pressure plot we can see that the maximum pressure is exerted on the top curve of the fish. From the image above we can see that maximum lift of 8.55 N is applied on the curve wall of the half fish and it is in the negative direction. The vertical wall will exert no lift so that wont be considered into account. Thus the pressure on top will cause a negative lift on the half fish.

# Task 3

For this problem the time is used as transient. The mesh used is Fine. The setup uses **No Slip Condition.** 

The transient simulation time t=10 minutes

We use viscous laminar flow and the material used is water.

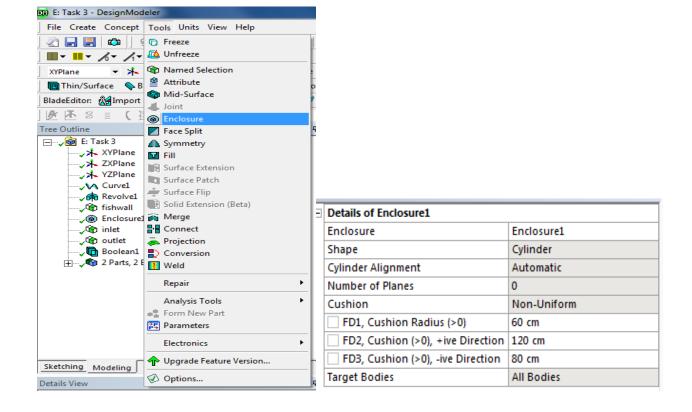
The Mesh is refined with a 3-D sphere centered at (x,y,z) = (0,0,0) with a radius of 40 cm.

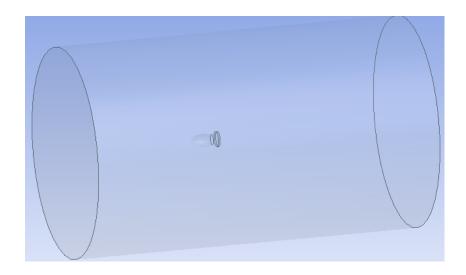
## **Problem Setup**

### Geometry

- 1) Use the text file and import it in geometry using 3D curve. Use the revolute command to create the 3D object.
- 2) Using the name selection we name the 3D object.
- Create the cylindrical enclosure using the Enclosure command in the Tools Tab in the toolbar. Select Cylinder under the Shape.

Input in the dimensions of the cylinder.





- 4) Using the Boolean operation subtract the Target Body (enclosure) and the tool body (3D fish).
- 5) Name the Velocity-inlet and Pressure-outlet on the enclosure.

## Setup

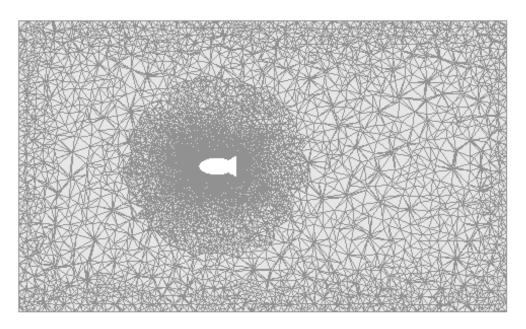
For Mesh refinement we refine the mesh around the cylinder with the co-ordinates given in the problem statement.

F:Copy of Task 3 Parallel Fluent@ENCAD411310	7.fulton.ad.asu.edu [3d, pbns, lam, transient] [ANSYS Aca
File Mesh Define Solve Adapt Surface [	Display Report Parallel View Help
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Setup     General     Gen	Run Calculation         Check Case         Time Stepping Method         Time Step Size (s)         Fixed         I         Settings         Number of Time Steps         600         Options         Input Coordinates         Inside         Options         Input Coordinates         Input Coordinates         P Center (m)         Y Center (m)         Y Center (m)         Y Center (m)         V Center (m)         V Center (m)         V Center (m)         V Center (m)         Z Center (m)         O         Radius (m)         O.4         Select Points with Mouse         Adapt         Mark       Close

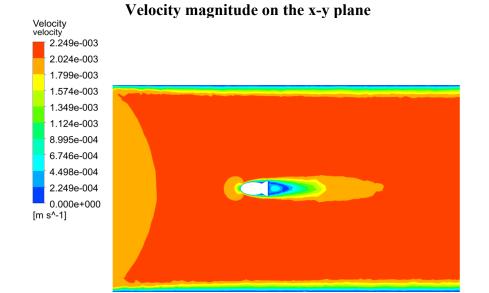
We initialize the solution and run the calculations with time step 1 and for 600 number of time steps for the period of 10 minutes.

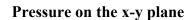
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Setup General Models Materials Cell Zone Conditions Boundary Conditions Cell Zone Conditions Dynamic Mesh Reference Values Solution Solution Methods Solution Controls Solution Initialization Calculation Activities Calculation Activities Run Calculation Results Calculations Calc	Run Calculation     Check Case   Time Stepping Method   Time Stepping Method   Time Stepping Method   Time Stepping Method   Fixed   1   Settings   Number of Time Steps   600   Options   Extrapolate Variables   Data Sampling for Time Statistics   Sampling Interval   1   Sampling Options   Time Sampled (s)   Max Iterations/Time Step   40   Profile Update Interval   1   1   Data File Quantities   Acoustic Signals
	Calculate

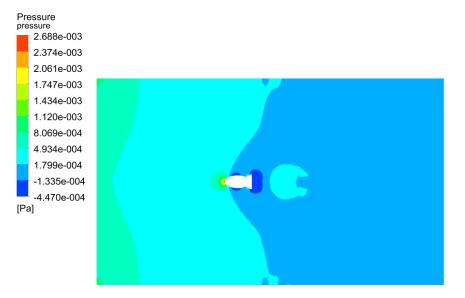
## Mesh of the system

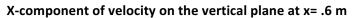


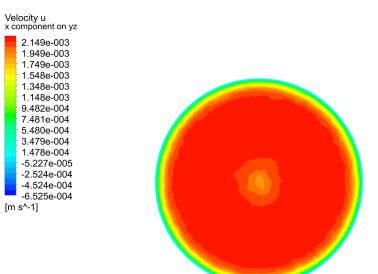
## Results Task 3











# Task 4

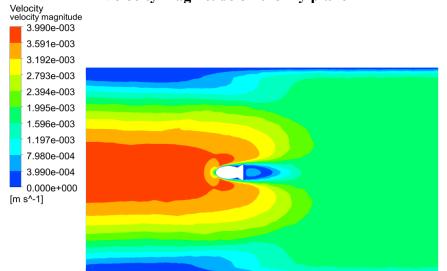
It uses the same setup as Task 3.

Instead of constant inlet velocity, a parabolic profile is created by using the User Defined Function.

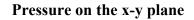
## **UDF** Code

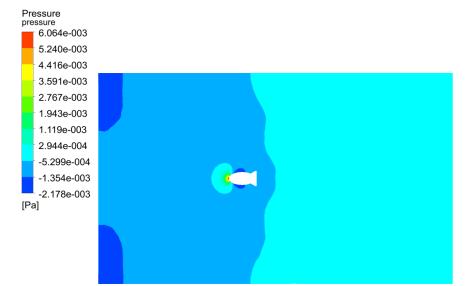
```
#include "udf.h"
DEFINE PROFILE(inlet x velocity, thread, position)
{
real x[ND_ND]; /* this will hold the position vector */
real y;
real z;
real R = 0.6;
real V max=2*.002;
face t f;
begin_f_loop(f, thread)
{
F_CENTROID(x,f,thread);
y = (x[1]);
z = (x[2]);
F PROFILE(f, thread, position) = 2*.002 - y*y/(R*R)*2*.002 - z*z/(R*R)*2*.002;
}
end_f_loop(f, thread)
}
```

## **Results** Task 4



#### Velocity magnitude on the x-y plane





#### X-component of velocity on the vertical plane at x = .6 m

