Flow Past a Cylinder

1)Important Info's: -

➔*The flow of fluid behind a blunt body such as an automobile is difficult to compute due to the unsteady flows. The wake behind such a body consists of unordered eddies of all sizes that create large drag on the body.*

➔*The following model examines unsteady, incompressible flow past a long cylinder placed in a channel at right angle to the oncoming fluid.*

➔*With a symmetric inlet velocity profile, the flow needs some kind of asymmetry to trigger the vortex production. This can be achieved by placing the cylinder with a small offset from the center of the flow.*

➔*A key predictor is the Reynolds number, which is based on cylinder diameter.*

➔***For low values (below 100**) the flow is steady. In this simulation, the Reynolds* *number equals **100**, which gives a developed **von Karma´n vortex street**, but the flow still is not fully turbulent.*

2)Physics and Equations: -

➔*The drag and lift forces themselves are not as interesting as the dimensionless drag and lift coefficients. These depend only on the Reynolds number and an object's shape, not its size. The coefficients are defined as using the following parameters:*

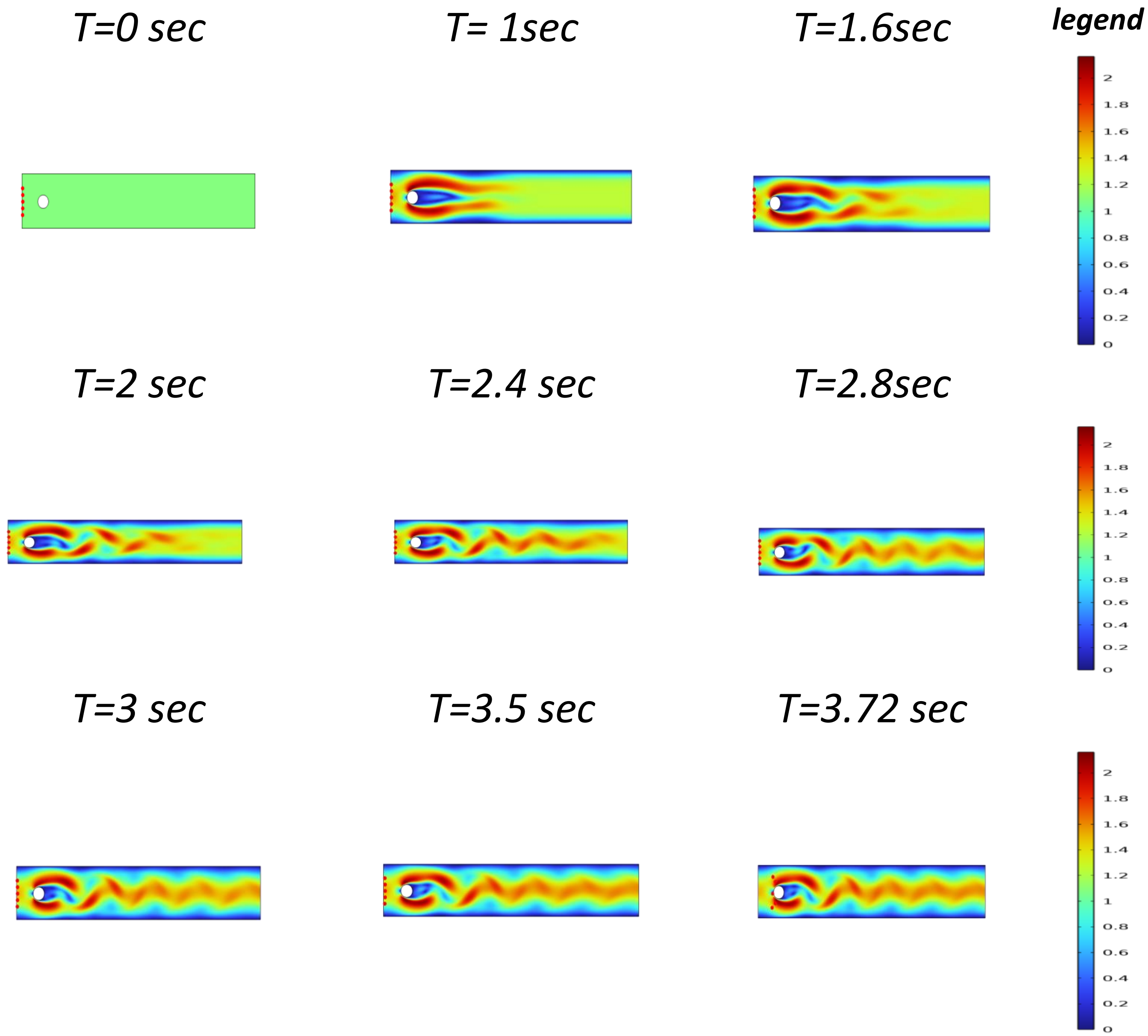
$$C_d = \frac{2F_d}{\rho U_{mean}^2 A}$$

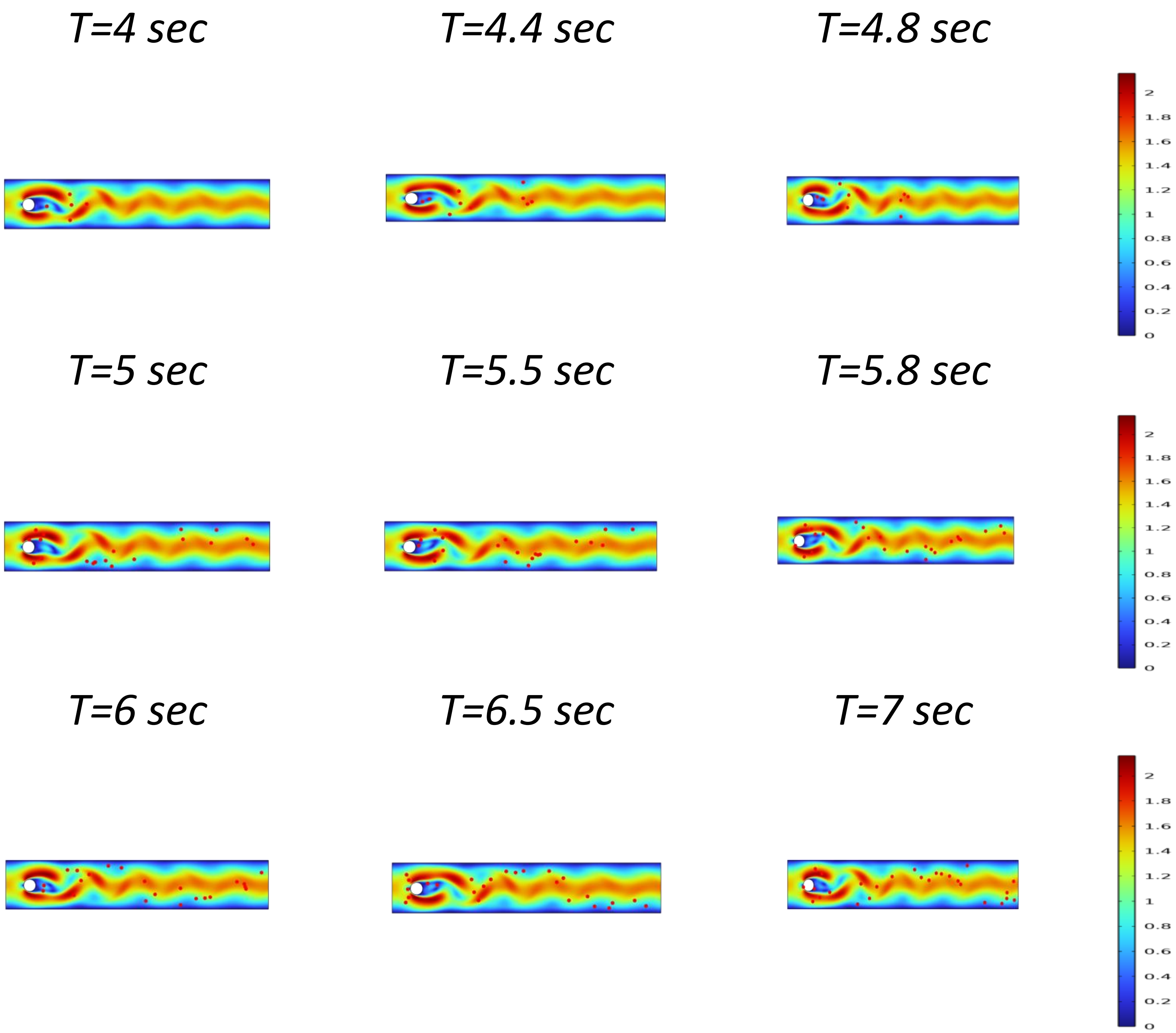
$$C_L = \frac{2F_L}{\rho U_{mean}^2 A}$$

- *F_D and F_L are the drag and lift forces*
- *ρ is the fluid's density*
- *U mean is the mean velocity*
- *A is the projected area (product of thickness and diameter of cylinder)*

3)*Results: -*

➔*Velocity Surface Plot: -*

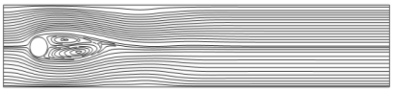



T=4 sec
T=4.4 sec
T=4.8 sec
T=5 sec
T=5.5 sec
T=5.8 sec
T=6 sec
T=6.5 sec
T=7 sec
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

➔Streamline Plot: -

T=0 sec

T= 1sec



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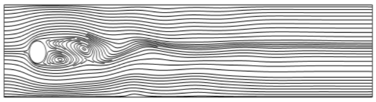

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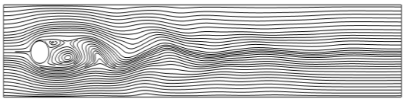
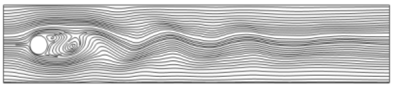
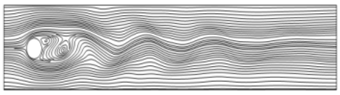


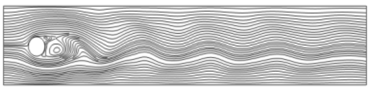
T=2.4 sec



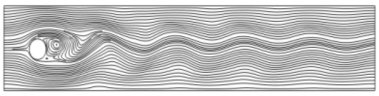
T=2.8sec



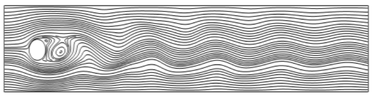
T=3 sec



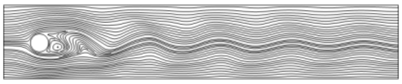
T=3.5 sec



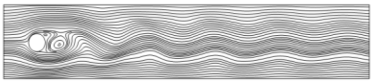
T=3.72 sec



T=4 sec



T=4.4 sec



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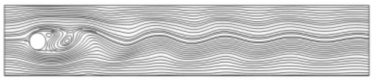

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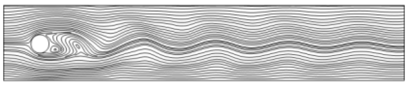

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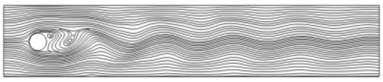
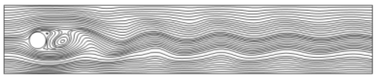
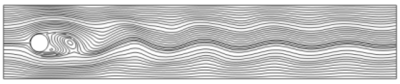


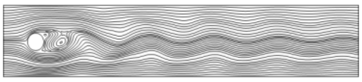
T=5.8 sec



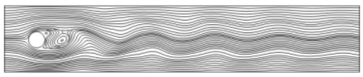
T=6 sec



T=6.5 sec

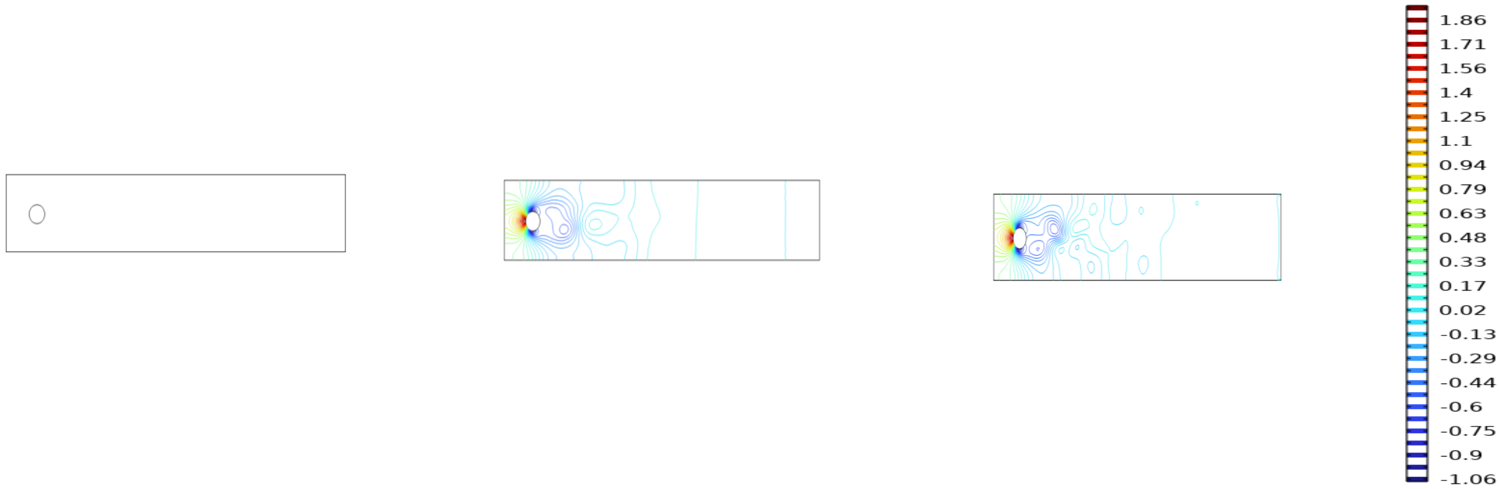


T=7 sec

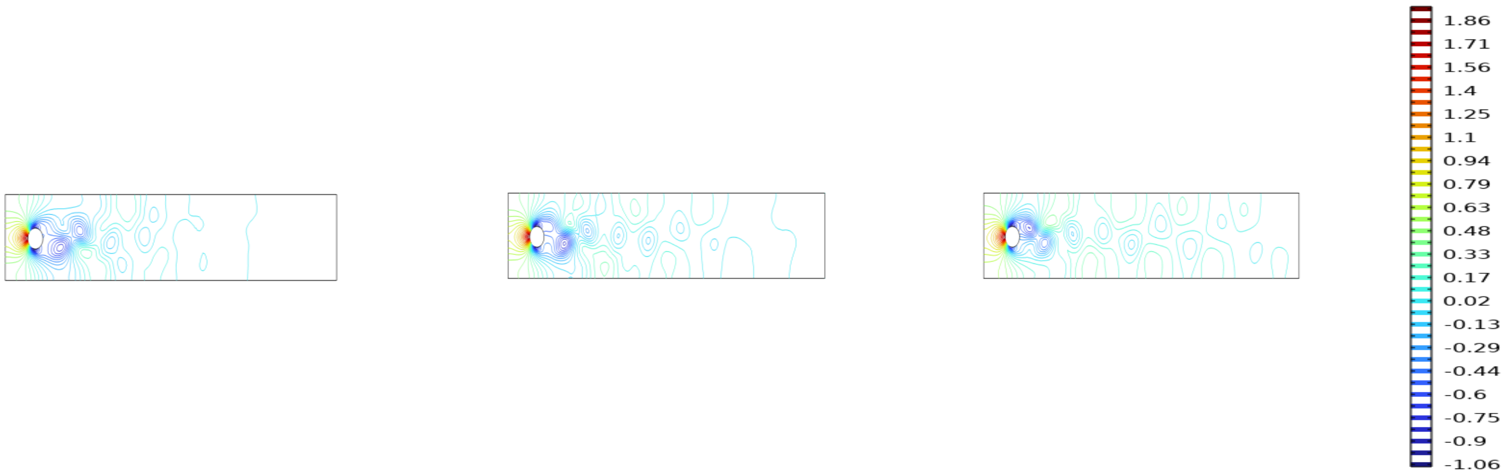


➔Pressure Gradient plot: -

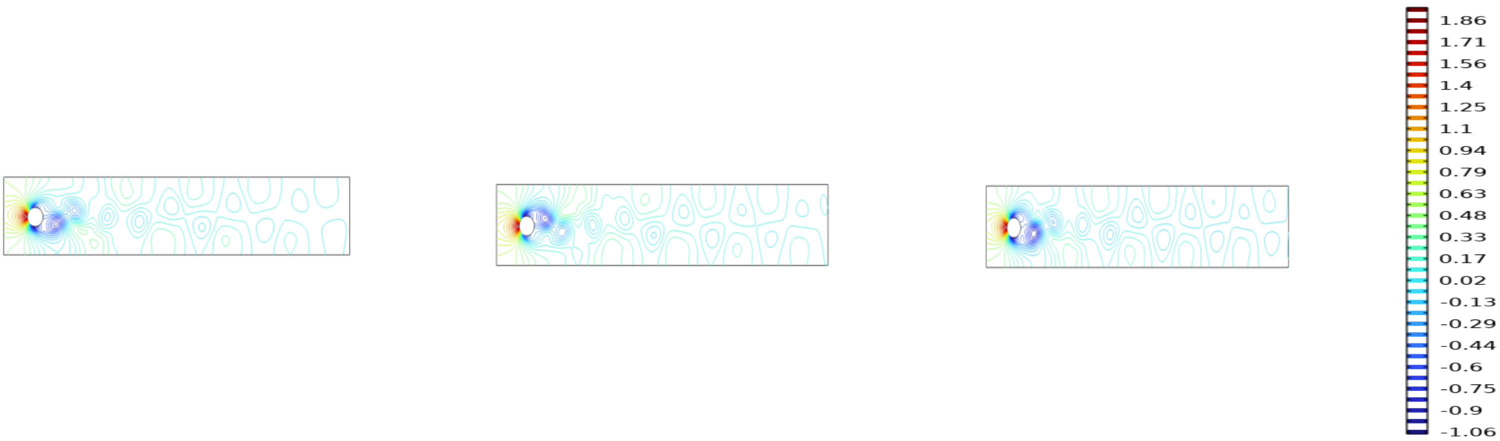
T=0 sec T= 1sec T=1.6sec *legend*



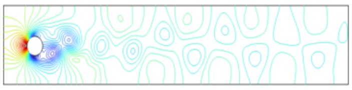
T=2 sec T=2.4 sec T=2.8sec

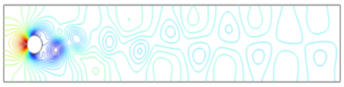


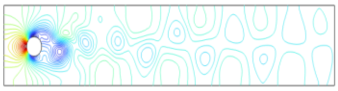
T=3 sec T=3.5 sec T=3.72 sec

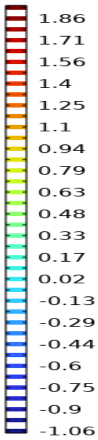


T=4 sec T=4.4 sec T=4.8 sec

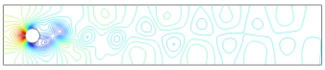


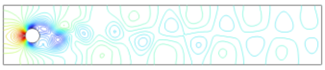


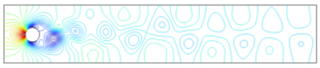


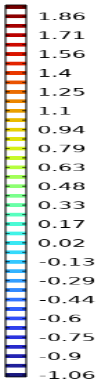


T=5 sec *T=5.5 sec* *T=5.8 sec*

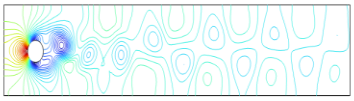


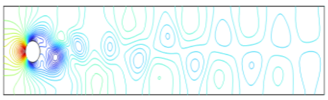


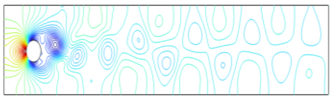


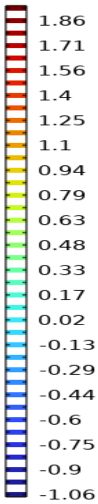


T=6 sec *T=6.5 sec* *T=7 sec*

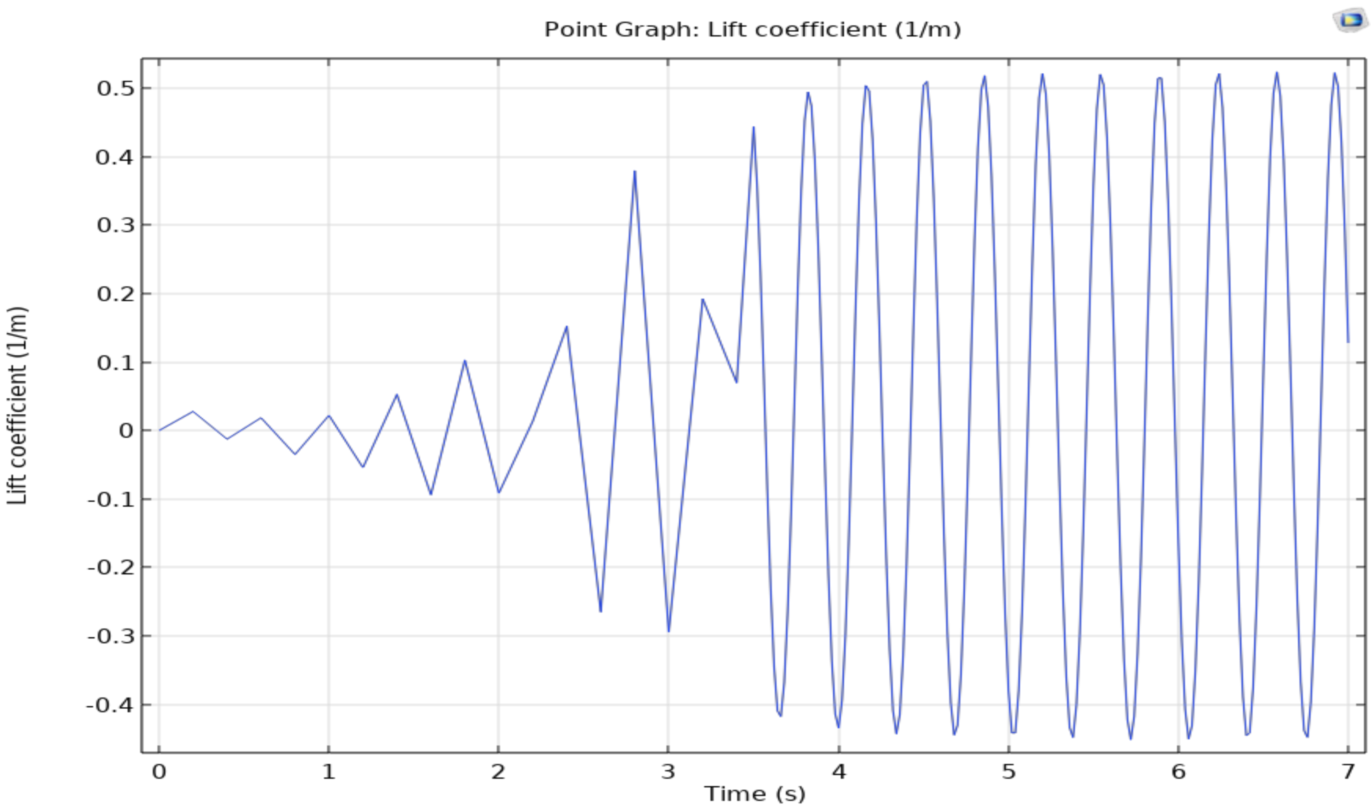








➔*Lift Coeffient vs Time plot: -*



➔*Drag Coeffient vs Time plot: -*