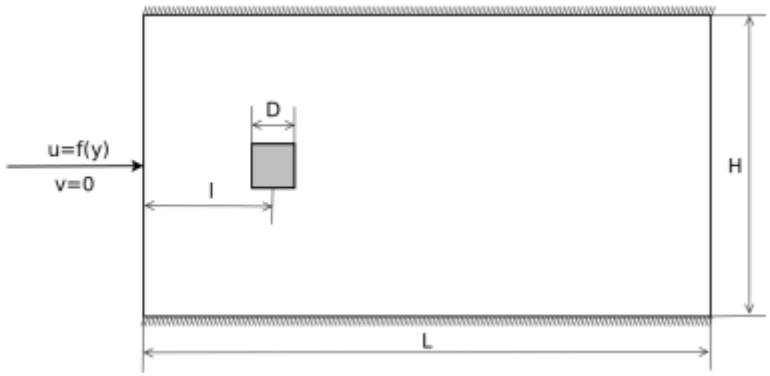
AE 433 CFD – HW2

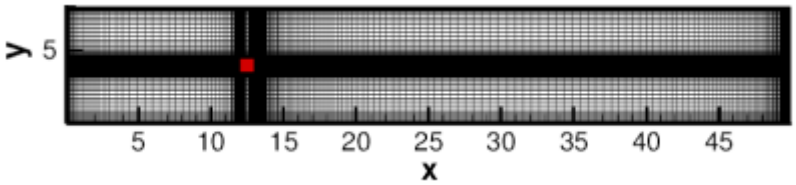
DUE DATE: Beginning of the next lecture (17.12.2021 Friday, 8:30)

Consider a turbulent flow around a square cylinder. The figure is given as follows:



where D/H=1/8, L=50D, l=L/4. Take D= 4 cm.

Construct mesh similar to:



Run your simulation at (a) Re=1, (b) Re=30, (c) Re=60, (d) Re=200, (e) Re=22000. Use both steady and transient solution like in the case of tutorial 2. Compare the steady solution with transient solution.

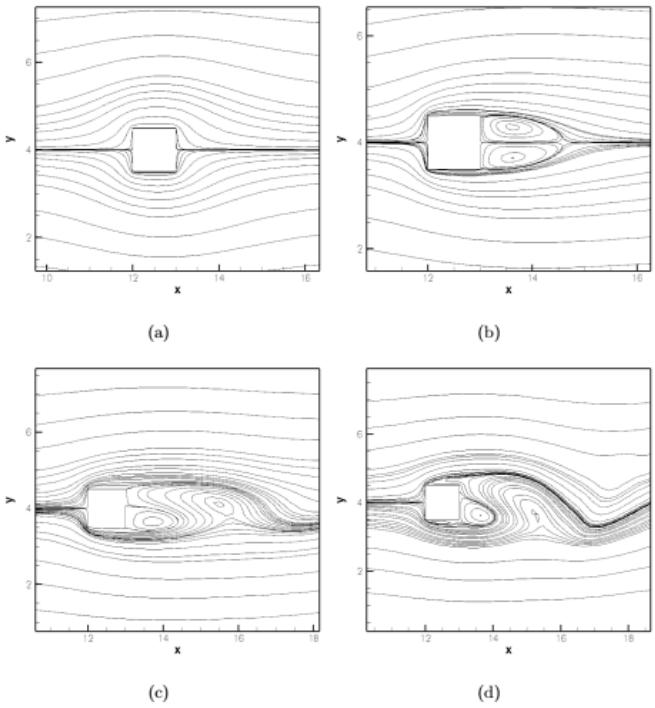
1. Solve laminar for a, b, c, and d. Solve turbulent for e. Select your models, etc by your own, remembering the tutorials 1 and 2. Leave default for non-given parameters.
2. Compare the velocity and vorticity contours for a, b, c and d. Comment on it.
3. Find drag coefficients (Cd) for a, b, c and d. Draw Cd vs Re graph.
4. Find Strouhal (St) numbers for a, b, c and d. Draw St vs Re graph.
5. Find lift coefficients (Cl) for a, b, c and d. Draw Cl vs Re graph.
6. Find drag coefficient (Cd), Strouhal (St) number, lift coefficient (Cl) for e. Comment on the differences from the results on a, b, c and d.

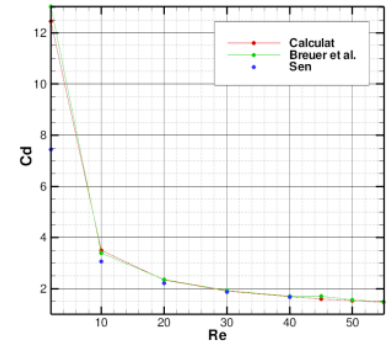
NOTES:

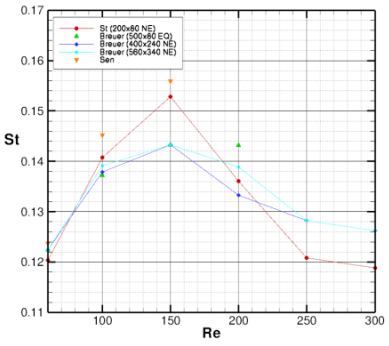
1. Report cannot be longer than 20 pages.
2. No additional submissions are needed other than **one printed report with a cover page**.

Example solutions for your comparison:

1. Laminar cases:



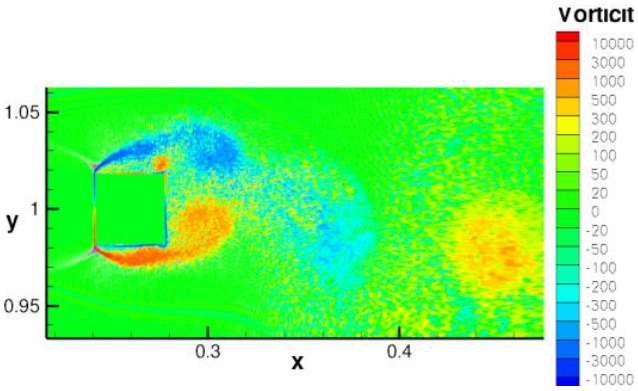




Turbulent case:

Model	$\overline{Cd}$	$\overline{Cl}$	Cd_{rms}	Cl_{rms}	St
DNS (200x80)	0,7575	0,0309	0,3951	0,4617	0,1250
DNS (400x160)	1,6670	0,0119	0,3446	0,8760	0,0930
DNS (800x320)	1,2147	0,1312	0,2958	0,9685	0,0505
DNS (1131x453)	1,2549	-0,0323	0,3583	0,9449	0,0463
Smagorinsky (200x80)	2,5556	-0,0165	0,7748	1,4642	0,0734
Smagorinsky (400x160)	0,9112	0,1460	0,2123	0,2123	0,4304
Vreman (200x80)	1,3839	0,1610	0,0930	0,5257	0,0664
Vreman (400x160)	1,4743	0,1191	0,1295	0,7397	0,0605

Model	$\overline{Cd}$	St
2D (500x500)	1,45	0,062
2D (708x708)	1,44	0,06
2D (1.000x1.000)	1,46	0,086
3D (500x500x64)	2,15	0,124
3D (708x708x64)	2,13	0,125



Reference: Valcarce A. Estudi de fluxes convectius en base a tècniques de CFD&HT, Spain: Technical University of Catalonia; 2012. [Master thesis]