Advanced Computation in Fluid Mechanics
Computer Lab 2010

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Unicorn provides a G2 solver for the incompressible Navier-Stokes equations. Use Unicorn to solve the problems below, to be presented in a report of 5 pages, together with a cover page. The report should be submitted individually by each student as one single pdf-file.

Problem 1: Use Unicorn to compute the drag coefficient c_D for a cube in a uniform velocity field, with

$$c_D = \frac{F_D}{\rho \frac{1}{2} U_\infty^2 A} \tag{1}$$

where F_D is the drag force (saved in file `drag_file.m`), A is the surface area of one side of the cube, and U_∞ is the inflow velocity. Use the mesh `mesh.xml`, an inflow velocity $U_\infty = 1$, and set the viscosity so that the Reynolds number $Re = UD/\nu$ based on D the diameter of the cylinder is $Re = 10^4$.

Problem 2: Refine the mesh 5 times using adaptive mesh refinement with respect to the error in drag force. Comment on the results: how is the solution changing when you refine the mesh? Plot $c_D(t)$ as a function of time for all 5 meshes in the same figure.

Problem 2: Describe the velocity field and the pressure, separation and turbulent wake, as you refine the mesh. How is it changing? Plot the velocity for the 5 meshes. For the finest mesh: change the viscosity to correspond to $Re = 100$ and $Re = 10^6$, respectively. How is the flow changing?

Problem 3: Plot the dual velocity and pressure for the finest mesh. Describe the dual solution: where is it large/small, can you motivate why?