Cover Page Laboratory Report

Lab-DF

Investigating Basic CFD Methods with DEMOFLOW

Name 1:

Name 2:

Name 3:

This written assignment was done:
By the undersigned with no help from anyone else
By the undersigned with some help
from:

Signature student 1 Signature student 2 Signature student 3

	Question 1	Question 2	Question 3	Question 4	Question 5	Grade
Max points	10	20	20	25	25	100
Your points						
Grader's comments						

For Lab tutorial and background description please see Course Handbook, pages 126-137.
DEMOFLOW matlab software package available at PingPong in Documents and under Software section

1 Questions

Carry out the following tasks with the DEMOFLOW Matlab code and then answer each of the questions below. Explain your observations and the conclusions that you draw from them. The percentage of the grade for each question is indicated.

1.1 Iterative solution procedure [10%]

- The unsteady governing equations are being solved to reach a steady solution. Why do you need to solve the unsteady equations ?

1.2 Speed of convergence to steady flow: time step size Δt [20%]

The time step size is adjusted by changing the CFL number value for the Explicit solver. Run the Explicit Roe solver with all the default settings except:

```
Timesteps = 2000
CFL Number set to 1, then repeat with 2, then repeat with 4
```

It might be necessary to run the solver several times in a row for low CFL number before reaching convergence. Note that convergence is signalled by the SOLVE-button changing into a button CONVERGENCE.

- Describe the convergence behaviour in each of the three cases. Are they all stable?
- Explain the reasons for this behaviour. Does there seem to be an optimal size for the time step Δt ?

1.3 Effect of the choice of the solver: Explicit vs Implicit [20%]

Run the Implicit Roe solver with the default parameters except:

```
Timesteps = 50
```

- Describe the convergence behaviour. Is it stable?
- Observe the timestep size variation (by noticing "Stepsize dist") and compare it to the timestep size in the Explicit Roe computations in 1.2.
- Compare the time per iteration with the one of the Explicit Roe computation in 1.2. Explain the difference.
- Observe the number of iterations and the time elapsed needed to converge and compare them with those for the Explicit Roe computations in 1.2. Explain the reasons for the differences.
- State your conclusions about the trade-off between the number of time steps and the time taken per time step to reach steady state solution.
- Observe and compare the residual history when running with the default parameters for Explicit Roe and Implicit Roe. State your conclusions about which solver to use when only a moderate (i.e. 'engineering' residual $\approx 10^{-3}$) is needed for the solution. And which solver is more efficient when a more fully converged solution is needed ? Do you see any practical difference, e.g. in the pressure distributions, from an 'engineering' converged solution compared to one from a more fully converged solution, say max residual $\approx 10^{-6}$?

1.4 Effect of grid size Δx on accuracy [25%]

Run the implicit solver with more nodes in the x direction, thus reducing the size of Δx. Use default settings, plus:

```
Nodes = 20 (and then repeat with 50, and then repeat with 100)
Timesteps = 100
```

- What effects do you observe on the accuracy of the solution and on convergence?
- State your conclusions about the effect of refining the grid and the speed of convergence.

1.5 Effect of artificial dissipation coefficients Vis2 and Vis4 [25%]

Run the explicit Jameson solver with the default parameters except:

```
500 iterations
 Vis2 set to 0.1 (and then repeat with 1, and then repeat with 2)
 CFL Number = 1.5
```

- What do you observe for the lowest value of Vis2?
- State your conclusions about the effect of the artificial viscosity coefficient Vis2.

Then run again the explicit Jameson solver with the default parameters except:

```
Vis4 set to 0.02 (and then repeat with 0.04)
CFL Number = 2.15
```

- State your conclusions about the effects of the artificial viscosity coefficient Vis4.