Department of Mechanical Engineering, BUET.

ME 6189: Computational Fluid Dynamics

Assignment-4

(**Due date: 24 March 2013**, **Saturday**. *Submit hard-copy, at class*)

Note: *(i) Symbols have their usual meanings.*

(ii) Clearly sketch the C.V. (control volume), show the nodal points, and C.V. faces.

(iii) Consider uniform grid; show details of the discretization process.

(v) Submit your code with necessary results plotted.

(vi) ***Show the grid independency test, and compare the results with the analytical solutions.***

1. Consider two infinite plates, a distance of 0.3 cm apart. The upper plate is stationary and the lower plate oscillates according to

$$u(0,t) = u_0\, cos(1000t) = u_0\, cos(1000n\Delta t)$$

where *n* represents the computational time level, selected to be 1 at $t = 0.0$.

The governing equation is obtained from the Navier-Stokes equation as

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial y^2}$$

Assume the kinematic viscosity ν is constant and has a value of 0.000217 m^2/s, and $u_0 = 40$ m/s.

Use the following methods in time discretization,

(i) explicit, (ii) implicit, (iii) Crank-Nicolson

Plot the velocity profile for at least four time levels.

2. Two parallel plates extended to infinity are a distance of *h* apart. The fluid within the plates has a kinematic viscosity ν of 0.000217 m^2/s and density ρ of 800 kg/m^3. The upper plate is stationary and the lower plate is suddenly set in motion with a constant velocity of 40 m/s. The spacing *h* is 4 cm. A constant streamwise pressure gradient of *dp/dx* is imposed within the domain at the instant motion starts.

The governing equation is reduced from the Navier-Stokes equation and is given by

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial y^2} - \frac{1}{\rho}\frac{\partial p}{\partial x}$$

Compute the velocity within the domain for

(i) $dp/dx = 0.0$ (ii) $dp/dx = 20000$ $N/m^2/m$ (iii) $dp/dx = -30000$ $N/m^2/m$

Use any suitable method for time discretization. Plot the velocity profile for at least three time levels.
