University of Illinois at Chicago
Department of Mechanical and Industrial Engineering
ME 528 - Numerical Heat Transfer

PROJECT 1

Time Developing Flow in a Parallel Plate Channel

Project report due on **November 3, 2014**

Consider the time evolution of the flow of a fluid (initially at rest) between two parallel plates separated by a distance $2h$. The governing Navier-Stokes equations for this flow are simplified to:

$$\frac{\partial u}{\partial t} = -\frac{1}{\rho}\frac{dp}{dx} + \nu\frac{\partial^2 u}{\partial y^2},$$

where dp/dx is a constant pressure gradient.

1. Nondimensionalize all the variables and the governing equation (including initial and boundary conditions).

2. Determine the 'exact' solution.

3. Find the numerical solution using (i) explicit and (ii) implicit methods.

Compare the results of your numerical solution with the exact solution. Investigate accuracy and stability by considering the effects of Δt, Δy, and $r = \Delta t/(\Delta y)^2$.

4. Find the numerical solution using a 4th-order Runge-Kutta method. Study the effect of Δt by running simulations with various Δt.

In the presentation of results, include plots of:
Velocity profile
Flow rate versus time
Wall shear versus time