Department of Mechanical Engineering, BUET.

ME 6189: Computational Fluid Dynamics

Assignment-1

(**Due date: 02 March 2013**, **Saturday**. *Submit hard-copy, at class*)

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

(ii) Use ***finite difference method*** *for discretization.*

(ii) Clearly sketch the flow domain, show the nodal points etc.

(iii)Your write-up should include a detailed description of the numerical solution. Enclose the text of the program and printouts of the results in support of your conclusions. Describe your convergence criteria, level of accuracy, efficiency of the iteration scheme etc.

(iv) ***Make sure that your results are grid independent.***

1. Write a program to solve the following equation:

$$f'' + 2\eta f' - 4mf = 0 \qquad f = 1 \text{ at } \eta = 0, \quad f \to 0 \text{ as } \eta \to \infty$$

run the program for the case of $m = 0$, in order to debug the program by comparing your result with the exact solution. The case of $m = 0$ arises in the analysis of motion of fluid above a suddenly accelerated flat plate (Stokes' first problem, see Schlichting for details).

When you have solution for $m = 0$, run the program with $m = 2$.

2. The following equation is known as Falkner-Skan equation used for the analysis of boundary layer flow

$$f''' + \alpha f f'' + \beta\left(1 - f'^2\right) = 0 \qquad f = f' = 0 \text{ at } \eta = 0, \quad f \to 1 \text{ as } \eta \to \infty.$$

(i) Write a program to solve this equation.

(ii) Use $\alpha = 0.5$, $\beta = 0$ to obtain Blasius solution for flow over a flat plate. Compare your results with the analytical solution.
