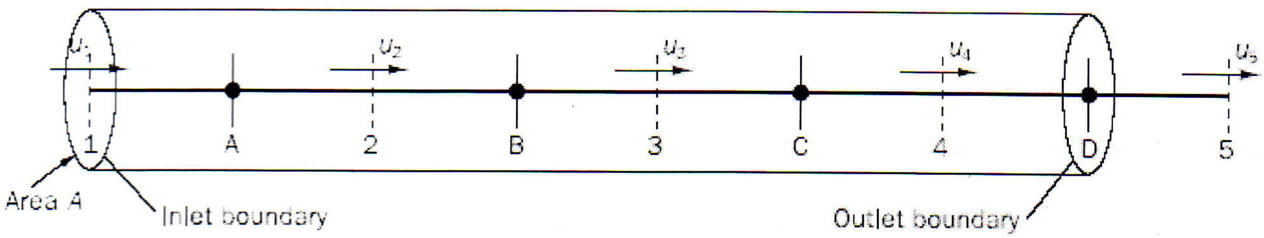
Menoufiya University
Faculty of Engineering
Shebin El-Kom
Final Exam
Academic Year: 2014-2015

Post Graduate: MSc
Department: Basic Engineering science
Subject: Numerical Analysis (1) (BES 601)
Time Allowed: 3hrs
Date: 30/05/2015

Note: Assume any data required, state your assumption clearly. Answer all questions

Question (1) (25 Marks)

Consider the steady, one-dimensional flow of a constant-density fluid through a duct with constant cross-sectional area. Use the staggered grid shown in figure below, where the pressure p is evaluated at the main nodes I = A, B, C and D, whilst the velocity u is calculated at the backward staggered nodes i = 1, 2, 3 and 4. Boundary conditions: $u_1 = 10$ m/s and $p_D = 0$ Pa.



Question (2) (25 Marks)

Show how the following equations

$$\zeta_{xx} + \zeta_{yy} = 0, \qquad \eta_{xx} + \eta_{yy} = 0$$

Can transformed to: $ax_{\zeta\zeta} - 2bx_{\zeta\eta} + cx_{\eta\eta} = 0, \quad ax_{\zeta\zeta} - 2bx_{\zeta\eta} + cx_{\eta\eta} = 0$

Where, $a = x_\eta^2 + y_\eta^2, \; b = x_\zeta x_\eta + y_\zeta y_\eta, \; c = x_\zeta^2 + y_\zeta^2$

Question (3) (25 Marks)

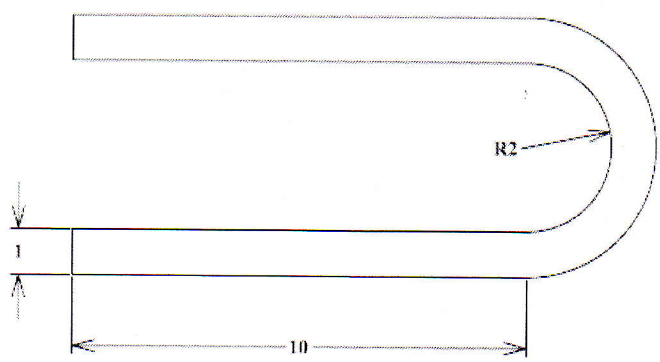
For the U-duct bend shown in the figure is composed from upstean and downstream ducts of length 10 and width 1 and a curved 180° bend of internal raduis of 2. Answer the following

a) Use an elliptic grid generator to obtain body fitted domain.

b) Describe in details the boundary conditions used.

c) Obtain the transformation metrics

d) Write computer program to obtain the transformation metrics



Question (4)

(25 Marks)

The x- component of Navier-Stokes equation in two-dimensional with no body force can be written as: $\dfrac{\partial \rho u^2}{\partial x} + \dfrac{\partial \rho uv}{\partial y} = -\dfrac{\partial p}{\partial x} + \mu\left(\dfrac{\partial^2 u}{\partial x^2} + \dfrac{\partial^2 u}{\partial y^2}\right)$

Transfer the above equation to body fitted coordinates

GOOD LUCK

Dr. Samy M. El-Behery