COLLEGE OF ENGINEERING & TECHNOLOGY

Department : MECHATRONICS DEPARTMENT

Lecturer : Dr. Sameh Shaaban

Course : Advanced Fluid Mechanics **Exam : Final**

Course No. : ME 761 **Marks: 40**

Date : June, 2015 **Time: Two Hours**

Attempt All Questions, Use Sketches Whenever Possible and Assume Any Missing Data

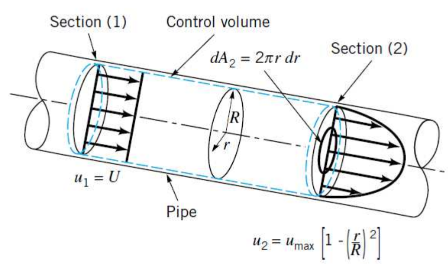
Question 1: (Marks 10)

a. It is proposed that a two-dimensional, incompressible flow field be described by the velocity components

$$u = Ay \qquad v = Bx$$

where A and B are both positive constants. Will the continuity equation be satisfied? Is the flow irrotational?

b. Incompressible, laminar water flow develops in a straight pipe having radius R as indicated in Figure. At section (1), the velocity profile is uniform; the velocity is equal to a constant value U and is parallel to the pipe axis everywhere. At section (2), the velocity profile is axisymmetric and parabolic, with zero velocity at the pipe wall and a maximum value of at the centerline. How are U and u_{max} related? How are the average velocity at section (2) and u_{max} related?



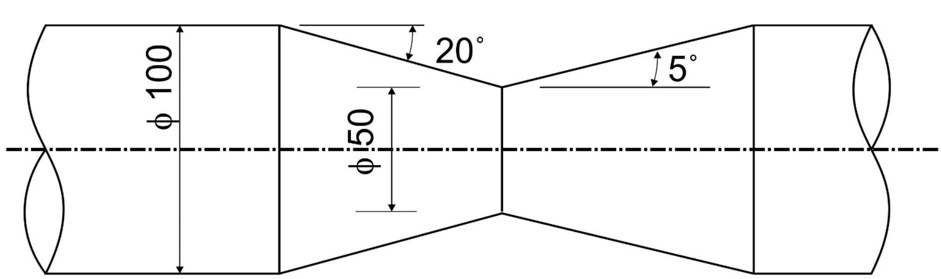
Question 2: (Marks 10)

a. What is the importance of "wall functions" in modelling the turbulent flow?
b. Discuss in details and with sketches the importance of the non-dimensional wall distance y+ in 1 equation and 2 equations turbulence models.

Question 3: (Marks 20)

Using CFD, it is required to simulate and solve the flow field through the venturi meter shown in figure for an inlet air velocity of 3 m/s. For air, $\rho = 1.225\ kg/m^3$, $\mu = 0.000018375$ kg/m s.

$$Re_x = \frac{\rho U_\infty L}{\mu} \qquad C_f = \frac{0.026}{Re_x^{1/7}} \qquad \tau_{wall} = \frac{C_f \rho U_\infty^2}{2} \qquad U_{fric} = \sqrt{\frac{\tau_{wall}}{\rho}} \qquad \Delta s = \frac{y^+ \mu}{U_{fric}\rho}$$



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Good Luck