

八十六學年度工程系統科學(所)

組碩士班研究生入學考試

科目 流體力學

科號 4010 共 1 頁第 1 頁

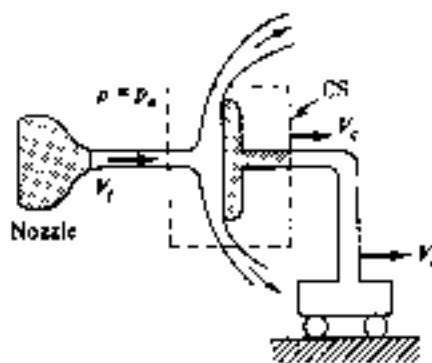
\*請在試卷【答案卷】內作答

- Define the following terms and give physical meaning  
 (a) streamline (e) Prandtl number  
 (20%) (b) inviscid flow (f) turbulent flow  
 (c) vorticity (g) boundary layer thickness  
 (d) Reynolds number (h) separation point
- A water jet of velocity  $V_1$  impinges normal to a flat plate which moves to the right at velocity  $V_c$ . Find the force required to keep the plate moving at constant velocity  $V_c$ . Neglect the weight of the jet and plate and assume steady flow with respect to the moving plate with the jet splitting into an equal upward and downward half-jet.
- The water-jet pump injects water at  $U_1 = 100$  ft/sec through a 3-in pipe and entrains a secondary flow of water  $u_2 = 10$  ft/sec in the annular region around the small pipe. The two flows become fully mixed downstream, where  $U_3$  is approximately constant. If the flow is steady and incompressible, compute  $U_3$  in feet per sec.
- Navier-Stokes equations governing the flowfield. Nondimensionalize the equation using a reference length  $L$ , free stream velocity  $U$  as parameters for defining dimensionless variable. Please explain the importance of the dimensionless group with the fluidflow.
- Derive Prandtl's boundary layer equation from Navier-Stokes equations

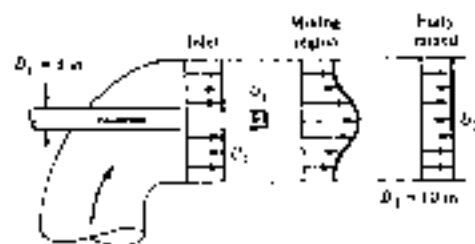
$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$$\rho \left( u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} \right) = -\frac{\partial p}{\partial x} + \mu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right)$$

$$\rho \left( u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} \right) = -\frac{\partial p}{\partial y} + \mu \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right)$$



(problem 2)



(problem 3)