國立成功大學

112學年度碩士班招生考試試題

編　號：156

系　所：生物醫學工程學系

科　目：流體力學

日　期：0206

節　次：第 2 節

備　註：可使用計算機

編號： 156

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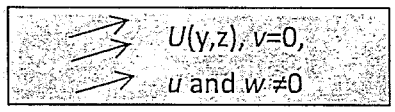
※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. ____ Which of the flow visualization methods is **NOT** time-dependent? (4%) **A)** Streamlines **B)** Streaklines **C)** Pathlines **D)** All **E)** None.
2. ____ Stokes number (S_t) is defined as a measure of the ratio of the response time of particles to the response time of the fluid. Determine what will happen when $St>>1$? (4%) **A)** particles will hit an obstacle in their paths; **B)** particles will move along the streamlines faithfully; **C)** there will be no velocity difference between the particles and the fluid; **D)** particles are ideal to be tracers in the fluid.
3. ____ Which of the following descriptions is **Incorrect** when flow past an infinitely cylindrical object (with viscosity)? (4%) **A)** A wake region is formed behind the object. **B)** Viscous effects are negligible outside the boundary layer. **C)** The boundary layer dwindles when Reynolds number (*Re*) increases. **D)** Streamlines can penetrate the boundary layer. **E)** Separation flow is easier to be observed in low *Re* flow than in high *Re* flow.
4. ____ In Buckingham pi theorem, the original problem can be simplified and defined with pi terms by using dimensional analysis. Given that a differential pressure is a function of diameter, density, viscosity, and velocity. Determine ***the number of pi terms***. **A)** 0 **B)** 1 **C)** 2 **D)** 3 **E)** 4 **F)** 5. (6%)
5. ____ Derive an **appropriate expression** for the time rate of change of the **steady** flow show in the figure. (**Hint**: Material Derivative) (8%)

A) $\frac{\partial U}{\partial t}+u\frac{\partial U}{\partial x}+v\frac{\partial U}{\partial y}$　**B)** $u\frac{\partial U}{\partial x}+w\frac{\partial U}{\partial z}$　**C)** $u\frac{\partial U}{\partial x}$　**D)** $v\frac{\partial U}{\partial y}$

E) $w\frac{\partial U}{\partial z}$　**F)** 0　**G)** $\frac{\partial U}{\partial t}$



6. Define the following terms: (20%)
   a) Fluid
   b) Ideal fluid
   c) Vena Contracta
   d) Assumptions of Bernoulli Equation
   e) Magnus Effect

7. The velocity of a fluid particle moving along a horizontal streamline that coincides with the x axis in a plane, two-dimensional, incompressible flow field is experimentally found to be described by the equation $u=x^2$. Along this streamline, determine an expression for (**a**) the rate of change of the v component of velocity with respect to y (**Hint:** Continuity Equation), (**b**) the acceleration of the particle (**Hint:** Material Derivative), and (**c**) the pressure gradient in the x direction. The fluid is Newtonian (**Hint:** Navier-Stokes Equation). (27%)

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Navier-Stokes Equation in x and y axes:

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left[\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right]+\rho g_x$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left[\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right]+\rho g_y$$

8. A source of strength m is located a distance l from a vertical solid wall as shown in Fig. 1. The velocity potential for this incompressible, irrotational flow is given by

$$\emptyset=\frac{m}{4\pi}\{ln[(x-l)^2+y^2]+ln[(x+l)^2+y^2]\}$$

(a) Show that there is no flow through the wall. **(b)** Determine the velocity distribution along the wall. **(c)** Determine the pressure distribution along the wall, assuming $p=p_0$ far from the source. Neglect the effect of the fluid weight on the pressure. (27%) (**Hint:** $u=\frac{\partial \emptyset}{\partial x}$ $v=\frac{\partial \emptyset}{\partial y}$ *and Bernoulli Equation*)

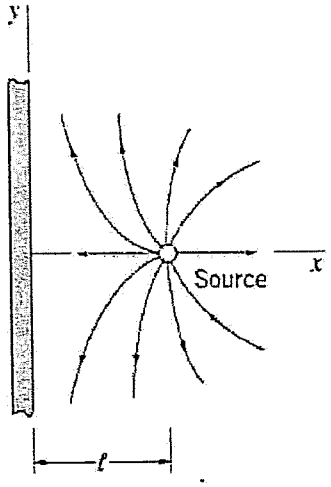

Fig. 1