

所別：水文與海洋科學研究所碩士班 不分組(一般生) 科目：流體力學 共 2 頁 第 1 頁  
水文與海洋科學研究所碩士班 不分組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

1. (10%) A jar of jam has been vacuum-sealed so that the pressure inside the jar is 2 percent below atmospheric pressure. If the area of the lid is  $0.05 \text{ m}^2$  and atmospheric pressure is  $10^5 \text{ Pascals}$ , what is the net force in Newtons that presses on the lid? Write your answer in this box, being sure to include units.

2. Consider the vector field  $\vec{V}$  and the scalar function  $\phi$

$$\vec{V} = xy^2\vec{i} + 3xz^2\vec{j} + 2z^2\vec{k}$$

$$\phi = 2x^2 + 3y^3 + z^4$$

If it is possible, find the quantities (with derivations) requested below. If it is not possible to find the quantity, write down "not possible".

(1) (5%)  $\nabla\vec{V}$

(2) (5%)  $\nabla^2\vec{V}$

(3) (5%)  $\nabla\cdot\phi$

(4) (5%)  $\nabla^2\phi$

3. Answer the following questions:

(1) (10%) Explain the meaning of substantial derivative  $\frac{D}{Dt} = \frac{\partial}{\partial t} + \vec{V}\cdot\nabla$  in

which  $\vec{V}$  is the velocity of a fluid motion described in Eulerian view

$$\vec{V} = \vec{V}(x, y, z, t)$$

(2) (10%) Explain the physical meaning of  $\nabla\cdot\vec{V}$  and  $\nabla\times\vec{V}$

(3) (10%) A student standing on a boat which travels with a velocity

$$\vec{V}_b = u_b\vec{i} + v_b\vec{j} \text{ across a river at the velocity } \vec{V} = 2x\vec{i} + 7xy\vec{j}. \text{ What is the}$$

time rate of change of the vorticity ( $D\Omega/Dt$ ) the student see for the river?

4. A viscous, incompressible liquid flows down a vertical plain surface in a steady, fully developed laminar film with thickness  $h = 1\text{mm}$ .

The continuity equation and Navier-Stokes equations are:

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

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

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

參考用

注意：背面有試題

國立中央大學103學年度碩士班考試入學試題卷

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- (1) (10%) Simplify(with explanation) the continuity equation and Navier-Stokes equations for this case.
- (2) (10%) Express the boundary conditions for this flow field.
- (3) (10%) Find the velocity profile  $u(y)$
- (4) (10%) Find the shear stress distribution  $\tau(y)$

注意：背面有試題

參考用