

國立中央大學101學年度碩士班考試入學試題卷

所別：大氣科學學系大氣物理碩士班 不分組(一般生) 科目：流體力學 共 2 頁 第 1 頁
 大氣科學學系大氣物理碩士班 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. An airplane flies along a warm front northward at a speed of 360 Km/hr. The temperature at a ship anchored in the vicinity shows an increase of 12 °C/day. A satellite measures a horizontal temperature gradient in the weather system of - 0.06 °C /Km northward. What is the temperature measurement in the airplane? (10 %)

2. The circulation equation can be written as

$$\frac{d\Gamma}{dt} = \frac{d}{dt} \oint \vec{V} \cdot d\vec{\ell} = - \oint \frac{dp}{\rho}$$

Please explain the physical meaning of each term in this equation and Kelvin Circulation Theorem. (10%)

3. The fluid element may undergo several types of change as it is in motion.

(a) Give four different types and briefly explain them. (10%)

(b) Please show that the volumetric dilatation rate is equal to divergence $\nabla \cdot \vec{V}$, i.e.,

$$\frac{1}{\delta V} \frac{d\delta V}{dt} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \quad (\text{note that } \delta V = \delta x \delta y \delta z).$$

(5%)

(c) For a plane flow, under what kind of velocity field will the fluid element undergo pure rotation without angular deformation? (5%)

4. The vorticity vector ζ is given by

$$\nabla \times \vec{V} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ u & v & w \end{vmatrix} = \frac{1}{r} \begin{vmatrix} \hat{e}_r & r\hat{e}_\theta & \hat{e}_z \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial z} \\ v_r & rv_\theta & v_z \end{vmatrix}$$

For a cylinder fluid that rotates about its vertical axis with a constant angular velocity $\Omega \hat{e}_z$,

(a) show that the associated vorticity vector ζ is constant and is equal to $2\Omega \hat{e}_z$. (10 %)

(b) What is the vorticity and divergence for the flows given by

$$\vec{V} = (3x, 1, 0). \quad (10 \%)$$

注意：背面有試題

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5. (a) Please show that a plane free vortex ($v_\theta = A/r$ with constant A) is rotational or irrotational. (5%)
(b) Determine the circulation of the free vortex for any path enclosing the origin. (5%)
(c) Determine the circulation of the free vortex for any path excluding the origin. (5%)
6. If you are to design an experiment to evaluate a mountain-valley wind, which has a strong diurnal cycle, discuss the points you must consider to obtain a good ensemble of measurements. (10%)
7. Assume a raindrop can be approximated as a sphere of diameter D falling with velocity W . Using dimensional analysis to obtain an expression for the drag force F_D , as it falls through air of viscosity μ and density ρ . (15%)

注意：背面有試題