大葉大學九十學年度研究所碩士班招生考試試題紙

系 所 組 別	考 試 科 目（中 文 名 稱）	考 試 日 期	備 註
機械所乙組	流體力學	4 月 22 日 第 2 節	p2-1

註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶）

1.(20%)

Give the definitions of (a) Reynolds number; (b) Mach number; (c) Froude number; (d) Knudsen number. From the definition, derive the physical significance of each dimensionless number.

2.(25%)

Following Aristotle, we may suppose that the time of fall, t, of the dropped stone is in fact influenced by its mass. Specifically, if the falling stone is sufficiently light in weight, we expect the time of fall to be influenced by fluid resistance. Consider a sphere of diameter, d; the mass of the sphere will be contained implicitly in our list of variables by including the density ρ_s and the diameter d. The fluid resistance should depend on the viscosity μ and the fluid density ρ_f. Thus the dimensional variables are expected: height, h, d, ρ_s, ρ_f, μ, t, and acceleration of gravity, g. Determine a set of dimensionless groups that can be used to correlate data.

3.(30%)

Consider steady flow between the two horizontal, infinite parallel plate of Fig. 1. For this geometry the fluid particles move in the x direction parallel to the plates, and there is no velocity in the y and z direction. Furthermore, there would be no variation of u in the z direction for infinite plates. Determine (a) the velocity distribution; (b) volume flow rate; (c) average velocity; (d) maximum velocity; (e) pressure variation throughout the fluid.

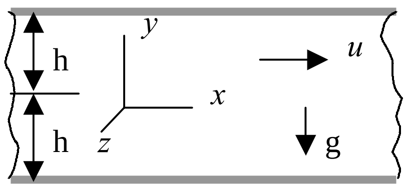

Fig.1

Note:

The continuity equation for incompressible fluids is

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

The Navier-Stokes equations are

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

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

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

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4.(25%)

Consider the symmetrical flow of air around the cylinder. The control volume, excluding the cylinder, is shown in Fig. 2. The velocity distribution downstream of the cylinder is measured to be as shown. Determine (a) the mass flux across the surface BC; (b) the drag force per meter of length acting on the cylinder. Use ρ=1.23 kg/m^3.

Note

$$0 = \frac{d}{dt}\int_{\text{c.v.}} \rho\, dV + \int_{\text{c.s.}} \rho\hat{n}\cdot\mathbf{V}\, dA$$

$$\Sigma\,\mathbf{F} = \frac{d}{dt}\int_{\text{c.v.}} \rho\mathbf{V}\, dV + \int_{\text{c.s.}} \rho\mathbf{V}(\mathbf{V}\cdot\hat{n})\, dA$$

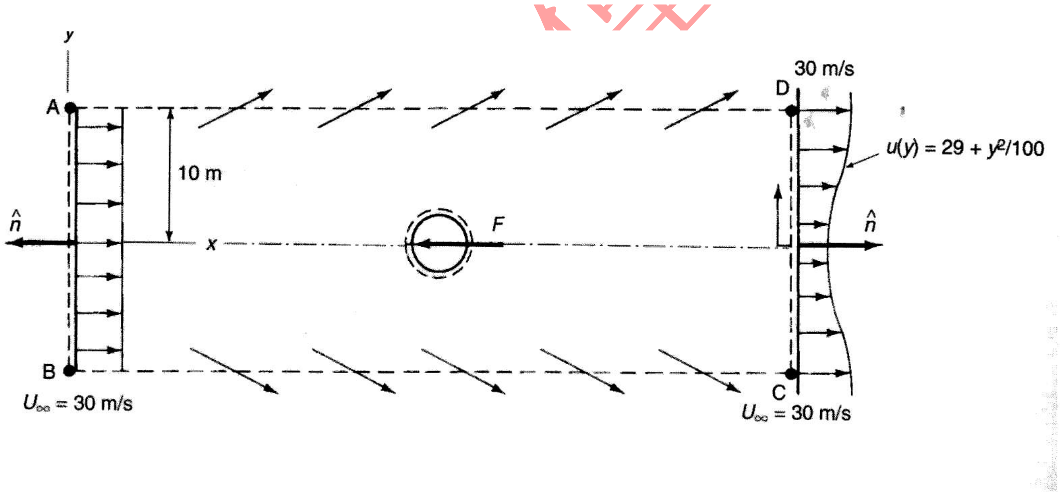

Fig. 2