國立中央大學107學年度碩士班考試入學試題

所別： 機械工程學系 碩士班 熱流組(一般生) 共3頁 第1頁

科目： 流體力學及熱傳學

本科考試可使用計算器，廠牌、功能不拘

*請在答案卷(卡)內作答

計算題需計算過程

1. The following are some basic concepts of fluid mechanics. Which of them are correct? (5%) (Hint: The answer is more than one)
   (A) If the shearing stress of a fluid is linearly proportional to the strain rate with zero shear stress at zero strain rate then such fluid is called as the Newtonian fluids.
   (B) The relationship between the absolute (dynamic) viscosity (μ) and the kinematic viscosity (ν) is $\nu = \mu \times \rho$.
   (C) The dimension of density (ρ) in F L T system is $FL^{-2}T^{4}$.
   (D) The dimension of energy (E) in M L T system is $ML^{2}T^{-2}$.

2. In Fig. 1, the dam is 4 *m* deep and 15 *m* width. Please determine the total force (F_R) acting on the wall. (7%)
   (A) 94176 N (B) 941760 N (C) 1177.2 kN (D) 11772 kN

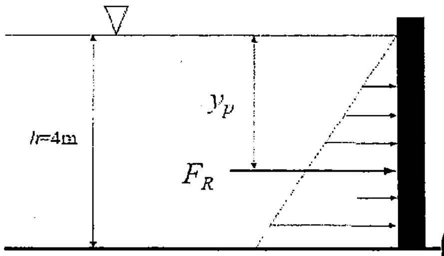

Fig. 1

參考用

3. Which one below is not the basic assumption of the simplified Bernoulli equation? (3%)
   (A) Steady flow (B) Inviscid flow (C) Compressible flow (D) Along a streamline

4. The followings are some descriptions of fluid kinematics, which one is correct? (5%)
   (A) Eulerian description: The flow within a fluid system can be defined by "tagging" each fluid particle, and then specifying its velocity and acceleration as a function of time as the particle moves form one position to the next.
   (B) A streamline is a curve that is drawn through the fluid in such a manner that it indicates the direction of velocity of particles located on it at a particular instant of time.
   (C) The Reynolds Transport Theorem describes the laws governing fluid motion using both system concepts and control surface.
   (D) The material derivative is $\frac{d()}{dt} = \frac{\partial()}{\partial t} + (\vec{V} \cdot \nabla)() = \frac{\partial()}{\partial t} + \frac{\partial()}{\partial x} + \frac{\partial()}{\partial y} + \frac{\partial()}{\partial z}$

5. An incompressible, viscous fluid is placed between horizontal, infinite, parallel plates as shown in Fig. 2. The two plates move in opposite directions with constant velocities, U_1 and U_2, as shown. The pressure gradient in the *x* direction is zero, and the only body force is due to the fluid weight. Please use the Navier-Stokes equations to derive an expression for the velocity distribution between the plates. Assume the flow is laminar. (15 %)

注意:背面有試題

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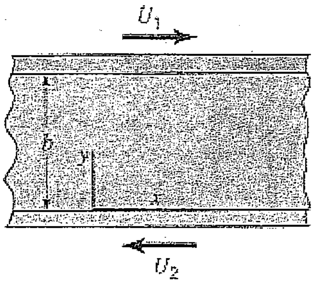
Fig. 2



6. The drag, $\mathcal{D}$, on a sphere located in a pipe through which a fluid is flowing is to be determined experimentally (see Fig. 3 below). Assume that the drag is a function of the sphere diameter, d, the pipe diameter, D, the fluid velocity, V, and the fluid density, ρ. (a) What dimensionless parameters would you use for this problem? (b) Some experiments using water indicate that for d = 0.5cm, D = 1.3cm, and V = 0.6m/s, the drag is 6.7×10^{-3}N. Please estimate the drag on a sphere located in 0.6m diameter pipe through which water is flowing with a velocity of 1.8m/s. The sphere diameter is such that geometric similarity is maintained. (15%) (a: 8%, b: 7%)

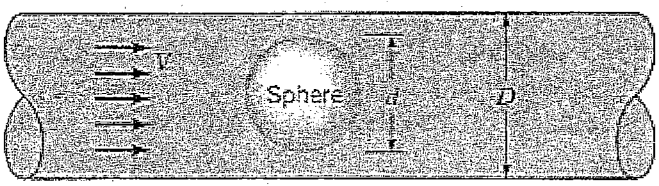
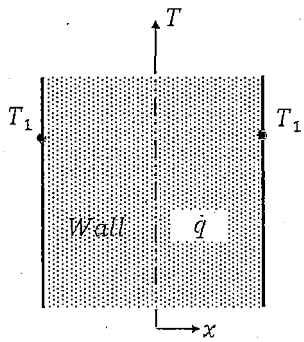


Fig. 3

7. (a) Write down the one-dimensional transient heat equation with heat generation. (3%)

(b) For a uniform distribution of heat sink $(\dot{q} < 0)$ with a common surface temperature, schematically draw the steady-state temperature profile in the plane wall. (5%)

(c) For the same case in (b), schematically draw the steady-state heat flux profile in the plane wall. (5%)



參考用

8. (a) Define the radiosity J. (2%)

(b) Assuming the absorptivity is equal to the emissivity, show that the net radiative flux at the surface of an opaque medium has the form

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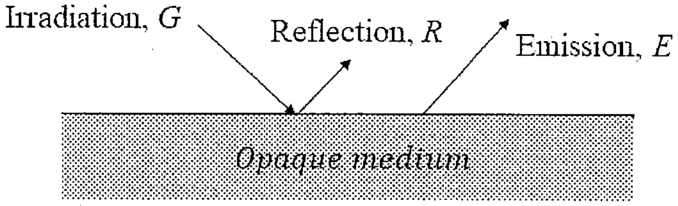
$$q'' = \frac{\varepsilon}{1-\varepsilon}(\sigma T_s^4 - J)$$

where ε is the emissivity, σ the Stefan-Boltzmann constant and T_s the surface temperature. (5%)

(c) If the medium is a blackbody then $\varepsilon = 1$. Is it true that the equation in (b) gives an infinite radiative flux? Explain. (5%)



9. What are the definition and physical meaning of the following terms? (10%)

(i) Friction coefficient (ii) Prandtl number (iii) Thermal fully developed

(iv) Nusselt number (v) Entrance length

[Example]: Reynolds number: $Re_D = \rho uD/\mu$, ratio of inertia force to viscous force

10. Please make a brief description of Reynolds analogy? (5%) (no more than 50 words)

11. Water at temperature of 300 K and mass flow rate of 0.3 kg/s is heated in a circular tube with inside diameter of 1.27 mm and leaves at 320 K. The tube wall is controlled at constant wall temperature of 360 K. Please calculate the heat transfer coefficient at fully developed region. (10%) Water properties and useful equations are listed below.

Temperature (K)	ρ (kg/m^3)	c_p (kJ/kg K)	μ (Ns/m^2)	k (W/mK)	Pr
300	997.0	4.179	855×10^{-6}	0.613	5.83
320	989.1	4.180	577×10^{-6}	0.640	3.77
340	979.4	4.188	420×10^{-6}	0.660	2.66
360	967.1	4.203	324×10^{-6}	0.674	2.02

Nu = 4,36 for q" = constant

Nu = 3.66 for T_w = constant

$Nu = 0.332\ Re^{1/2}Pr^{1/3}$

$Nu = 0.023\ Re^{4/5}Pr^n$, where n = 0.3 for cooling, n = 0.4 for heating