

國立中央大學101學年度碩士班考試入學試題卷

所別：機械工程學系碩士班 丙組(熱流)(一般生)

科目：流體力學及熱傳學

共 2 頁 第 / 頁

本科考試可使用計算器，廠牌、功能不拘

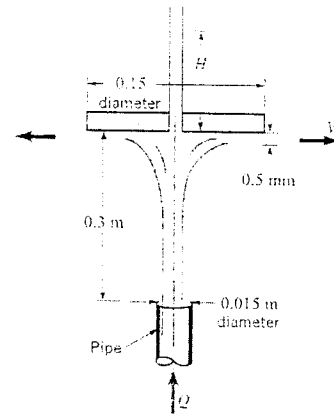
*請在試卷答案卷(卡)內作答

流體力學 (50 分)

1. Water flows from the pipe as shown below as a free jet and strikes on a circular flat plate, where the flow geometry is axisymmetric.

Please determine:

- (a) The flow rate, Q (7%)
 (b) the manometer reading, H . (8%)



2. A given velocity field, $\vec{V} = Ax\hat{i} - Ay\hat{j}$ where x and y are in meters and $A = 0.3 \text{ s}^{-1}$. Please answer the following questions: (15%, each 3%)

- (a) What is the equation of the streamlines in the xy plane?
 (b) What is the velocity of particle at point $(2, 8, 0)$?
 (c) What is the position at $t = 6 \text{ s}$ of particle previous located at $(2, 8, 0)$ at $t = 0$?
 (d) What is the velocity of particle at position found in (c)?
 (e) What is the equation of pathline of particle located at $(2, 8, 0)$ at $t = 0$?

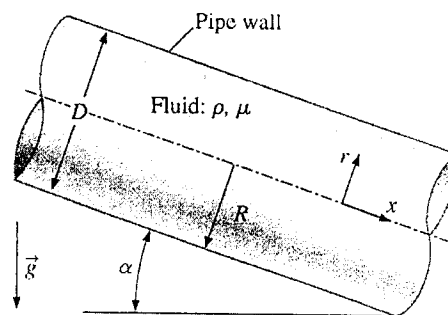
3. A propeller of diameter D rotates at angular velocity w in a liquid density ρ , and viscosity μ . The required torque is determined to be a function of D , w , ρ and μ .

- (a) Use dimensional analysis and choose fluid density ρ , length scale D , and angular velocity w as repeating variables to generate a dimensionless relationship (6%)
 (b) Identify and explain the dimensionless parameters appear in (a) (4%)

4. Consider a steady, incompressible, laminar flow of a Newtonian fluid in an infinitely long round pipe of diameter D of radius $R=D/2$ inclined at angle α as shown in the figure.

There is no pressure gradient ($\frac{\partial p}{\partial x} = 0$), instead, the fluid flows

down the pipe due to gravity alone. We adopt the coordinate system shown, with x down the axis of the pipe. Please derive expression for the x -component of velocity u as a function of radius r and the other parameters of the problem. Calculate the volume flow rate and the average axial velocity through the pipe.



(10%)

注意：背面有試題

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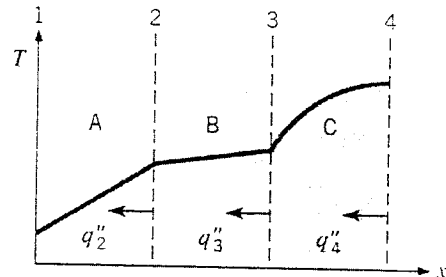
熱傳學 (50 分)

5. The steady-state temperature distribution in a composite plane wall of three different materials, each of constant thermal conductivity is shown as the figure.

(a) Please comment on the relative magnitudes of q_2'' and q_3'' and of q_3'' and q_4'' (5%)

(b) Please comment on the relative magnitudes of k_A and k_B and of k_B and k_C (5%)

(c) Sketch the heat flux as a function of x (5%)



6. Please write down the equation of Fick's law of diffusion in the direction x . What is the dimension of diffusion coefficient (or mass diffusivity)? (4%)

7. A long rod is used to cool the engine of a car. The rod is 5 cm in diameter, 1 m long, and is made of aluminum. The car is traveling at 108 km/hr and the air temperature is 20 °C. What is the heat transfer rate (W/sec) if the surface temperature of the antenna is held at 100 °C? (10%)

The physical properties of air at 60°C are listed below: Conductivity: 0.02808 W/m-K, Pr = 0.7202, kinematic viscosity: 1.896×10^{-5} m²/s. Nusselt number = $C Re^m Pr^{1/3}$ where C and m are listed in the attached table.

Re	C	M
0.4 - 4	0.989	0.330
4-40	0.911	0.385
40-4000	0.683	0.466
4000-40,000	0.193	0.618
40,000-400,000	0.027	0.805

8. The electromagnetic radiation covers a wide range of wavelengths including X-rays, visible light, gamma rays, infrared radiation, thermal radiation, microwaves, radio waves, and ultraviolet radiation. The electromagnetic radiation emitted by the sun is known as solar radiation.

(a) Solar radiation covers what range of wavelength(s)? (4%)

(b) The sun has a diameter of 1.4×10^9 m and is located at a distance of 1.4×10^{11} m from the earth. We measured the solar energy reaching the earth's atmosphere is 1400 W/m². Please estimate the effective surface temperature of the sun. Stefan-Boltzmann constant = 5.67×10^{-8} W/m²-K⁴ (6%)

9. Please write down the definition of Prandtl number (Pr). What can you say about the velocity and thermal boundary layers when Pr = 1? (4%)

10. What is the difference between evaporation and boiling? Plot the boiling curve and identify the different boiling regimes. (7%)

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