國立成功大學

113學年度碩士班招生考試試題

編　號：63

系　所：機械工程學系

科　目：流體力學

日　期：0201

節　次：第 1 節

備　註：可使用計算機

編號： 63

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (20%) The velocity field is given as $\vec{V} = x(1+2t)\vec{i} + y\vec{j}$ (m/s). You can leave your answer in terms of exponential.

(a)(5%) A particle passes (1,1) at $t = 0$ s. Find where it is at $t = 3$ s.

(b)(3%) Find the acceleration in x direction at (1,1) at $t = 0$ s.

(c)(6%) Find the pressure difference between at (0,0) and (2,2) at $t = 0$ s assuming density is 1 kg/m^3.

(d)(3%) If this flow is incompressible, write down a partial differential equation that can solve density ρ (you don't need to solve this equation).

(e)(3%) Continue from (d), if density at (1,1) at $t = 0$ is ρ_0, find the density at (e^{12}, e^3) at $t = 3$ s.

2. (15%) A snow plow mounted on a truck clears a path of 3.6 m through heavy wet snow, as shown in Figure 1. The snow is 2.4 m deep and its density is 160 kg/m^3. The truck travels at 48 km/hr. The snow is discharged from the plow at an angle of 45° from the direction of travel and 45° above the horizontal, as shown Figure 1. Estimate the force required to push the plow.

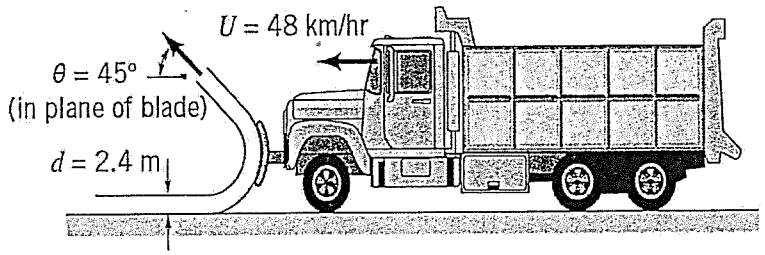

Figure 1

3. (15%) A table tennis ball weighing 2.45×10^{-2} N with diameter $D = 3.8\times10^{-2}$ m at a velocity of $U = 12$ m/s with a back spin of angular velocity ω (rad/s) as is shown in Figure 2. The air densitypis 1.23 kg/m^3, and the kinematic viscosity ν is 7.6×10^{-6} m^2/s.

(a) (5%) Determine, with the aid of dimensional analysis, how the lift force L depends on D, U, ω,ρ, and ν.

(b) (5%) Explain briefly why a back spin rotation can induce a lift force.

(c) (5%) The lift coefficient C_L is defined as shown in the vertical axis of Figure 3, and its value is function of D, U, and ω ($\omega D/2U$) as shown in the horizontal axis of that figure when the Reynolds number is 6×10^4. What is the value of ω of the ball is to travel on a horizontal path, not dropping due to the gravity?

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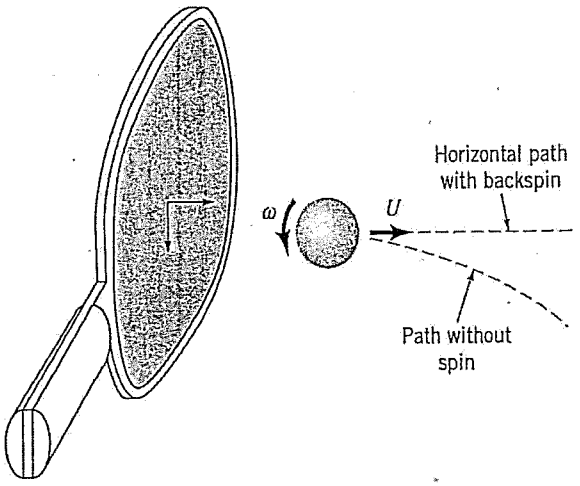

Figure 2

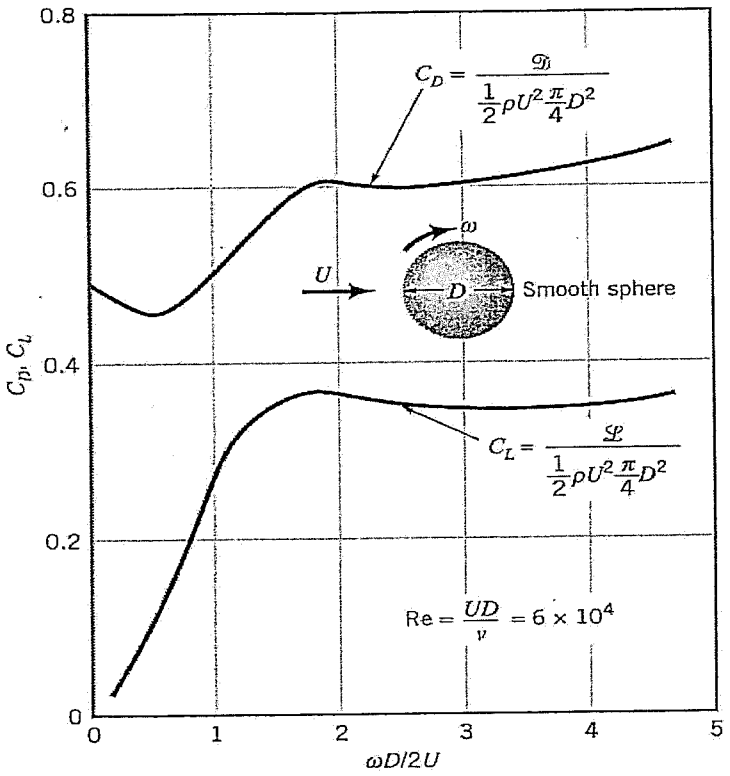

Figure 3. C_L as $\mathrm{Re} = 6\times10^4$

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考試日期：0201，節次：1

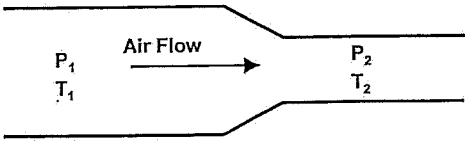
4. Multiple choice questions.

(1) (5%) Air flows through a well-insulated pipe and enters a section where the cross sectional area is smaller. Viscosity, friction, and gravitational effects are negligible. Select the letter of the correct statement regarding the temperatures, T, and pressures, P, of the air flow.

(a) $P_2 = P_1$ and $T_2 = T_1$　(b) $P_2 > P_1$ and $T_2 > T_1$

(c) $P_2 > P_1$ and $T_2 < T_1$　(d) $P_2 < P_1$ and $T_2 > T_1$

(e) $P_2 < P_1$ and $T_2 < T_1$

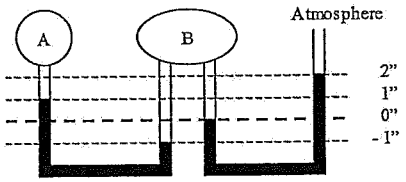


(2) (5%) Two tanks filled with air and connected by water-filled manometers are shown below. The water levels are as shown. Select the letter of the correct answer for the gage pressure for Tank A.

(a) $P_A = +3"$ water　(b) $P_A = +1"$ water

(c) $P_A = +0"$ water　(d) $P_A = -1"$ water

(e) $P_A = -3"$ water

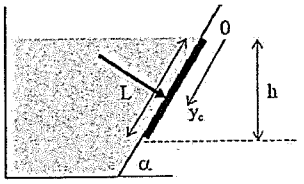


(3) (5%) A tank containing water with a plate of length L and width W is shown in the figure. The location of the force on the plate is?

(a) $y_c = L/2$　(b) $y_c = 3L/2$　(c) $y_c = h/2$

(d) $y_c = 3h/2$　(e) $y_c = h/(2\sin\alpha)$

(f) $y_c = 3h/(2\sin\alpha)$



5. Consider the steady, planar flow of an incompressible and inviscid fluid (density ρ) in a right-angle corner as given in Figure 4 (the stream function of the flow, $\psi = Axy$, where A is a constant).

(a) (5%) Show that this flow is irrotional.

(b) (8%) Find an expression for the pressure, p, at any point in the flow assuming that the pressure at the origin, p_0, is known. The y-axis is vertically upward and the only body force is that due to gravity, g.

(c) (7%) If the x-axis is a thin wall with a uniform pressure, p_0, on its underside, find the vertical force on that portion of the wall between $x = 0$ and $x = 1$. Assume unit depth perpendicular to the sketch.

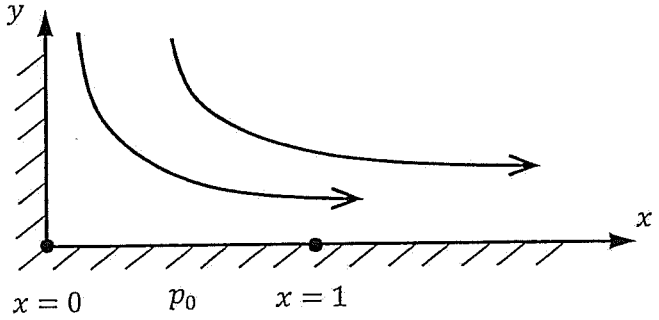


Figure 4

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6. (15%) A tank contains 1 m^3 of water at 20°C ($\rho =$ 998 kg/m^3, $\mu =$ 0.001 kg/m·s) and has a drawn-capillary outlet tube (wall roughness $\epsilon =$ 0.0015 mm) at the bottom, as in Figure 5. Neglecting all minor loss and using the Moody chart (shown below), find the outlet volume flux Q in **m^3/hour** at this instant.

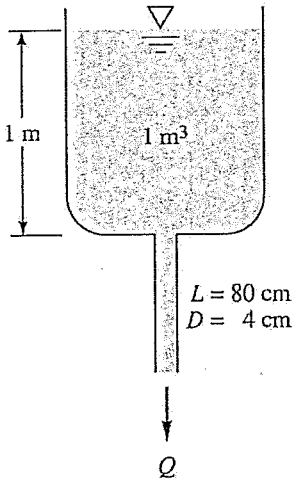

Figure 5