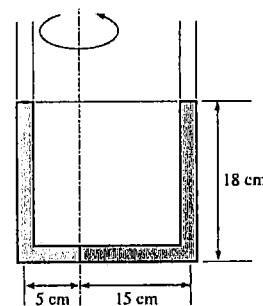


參考用

流體力學 (50 分)

1. A horizontal water jet from a nozzle of constant exit cross section impinges normally on a stationary vertical plate. A certain force  $F$  is required to hold the plate against the water stream. If the water velocity is doubled, will the necessary holding force also doubled? Please explain. (7%)

2. A U-tube contains water in the right arm, and another liquid in the left arm. It is observed that when the U-tube start rotates at 50 rpm about an axis that is 15 cm from the right arm and 5 cm from the left arm, the liquid levels in both arms, the liquid levels in both arms become the same, and the fluids meet at the axis of rotation. Please determine the density of the fluid in the left arm. (10%)



3. Water is being pumped from a large lake to a reservoir 25 m above a rate of 25 L/s by a 15-kW (shaft) pump. If the irreversible head loss of the piping system is 5m. Please determine the pump efficiency (8%)

4. The pressure drop ( $\Delta p$ ) along a straight pipe of diameter  $D$  has been experimentally studied, and it is observed that for laminar flow of a given fluid and pipe,  $\Delta p$  varies directly with the distance ( $l$ ) between pressure taps. Assume that  $\Delta p$  is a function of  $D$  and  $l$ , the velocity ( $V$ ) and the fluid viscosity ( $\mu$ ). Use the dimensional analysis to deduce how  $\Delta p$  varies with  $D$ . (10%)

5. Consider an incompressible viscous fluid inside the two moving horizontal plates without pressure gradient having a separate height of  $h$  in the  $y$ -direction. The two plates, respectively the upper and the lower plates, are moving along the  $x$ -direction at constant but different velocities,  $2U$  and  $-2U$ . If such flow is laminar, please find its velocity distribution  $u(y)$  between the two plates. (15%)

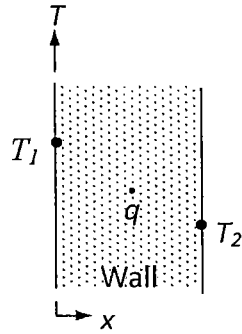
注意：背面有試題

參考用

熱傳學 (50 分)

6. Heat conduction questions:

- (a) Write down the general heat diffusion equation. (5%)
- (b) Please show (proof) that the heat flux is constant under steady-state, one-dimensional conditions with no energy generation. (5%)
- (c) Schematically draw the temperature profile in a plane wall with uniform heat generation ( $\dot{q}$ ) for given wall temperatures ( $T_1, T_2$ ) at the two boundaries. The cross-sectional view of the wall is shown in the figure, where  $T_1 > T_2$ . (5%)



- 7. What is the heat flux emitted by a real surface at a given temperature  $T$ . (5%)
- 8. Design a method to measure the thermal conductivity of sands. Please make your assumptions if necessary. (5%)

Convection

9. What are the definition and physical meaning of the following terms? (8%)

- (a) Friction coefficient                      (b) Biot number
- (c) Nusselt number                          (d) Prandtl number

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

- 10. Please sketch the velocity boundary layer and thermal boundary layer qualitatively of uniform air flow over a flat plate from the left to the right hand side. (6%)
- 11. Water at temperature of 300 K and mass flow rate of 0.3 kg/min is heated in a circular tube at constant wall temperature of 360 K and leaves at 340 K. The tube inside diameter is 10 mm.
  - (a) What temperature should you use for evaluating the fluid properties? (2%)
  - (b) If the properties are listed below, what is the Reynolds number for this flow? (2%)
  - (c) Is this a laminar flow or turbulent flow? (2%)
  - (d) Please calculate the heat transfer coefficient at fully developed region. (5%)

	$\rho(\text{kg/m}^3)$	$\mu(\text{Ns/m}^2)$	$k(\text{W/mK})$	Pr
Water	989.1	$577 \times 10^{-6}$	0.649	3.77

注意：背面有試題