國立中央大學 106 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 2 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 請列出推導過程並標示答案 *請在答案卷 內作答

參考用

1. Water flows as two free jets from the tee attached to the pipe as shown in Fig. 1 with the control volume (CV). As indicated, the uniform flow exit speeds at sections (2) and (3) are 10 m/s, where the area of sections (1), (2) and (3) are 2 cm^2, 1 cm^2, and 0.8 cm^2, respectively. If viscous effects and gravity are negligible, please answer the following questions.
   (a) What is the x-component of the linear momentum equation that can be used to solve the x-component of the force exerted by the pipe on the tee? (5%)
   (b) What is the flow speed at the section (1) using the conservation of mass? (5%)
   (c) What is the pressure at the section (1) using the Bernoulli's equation for flow between sections (1) and (2)? (5%)
   (d) What are the x and y components of the force that the pipe exerts on the tee? (10%)

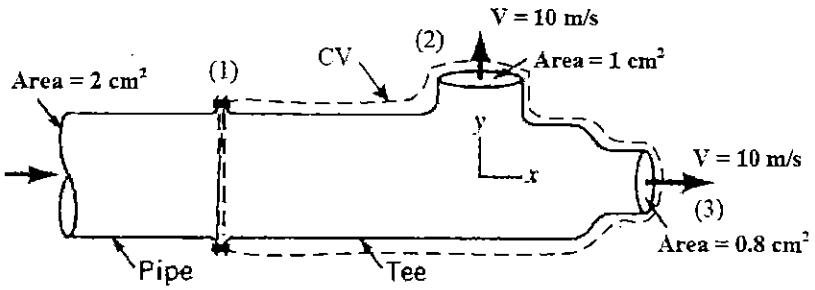

Fig. 1

2. Between two infinite, vertical, parallel plates, a fluid flows upwards as shown in Fig. 2. Assume the flow is steady, laminar, incompressible and uniform with viscosity of μ and density of ρ.
   (a) Write down complete Navier-Stokes equation in y-direction. (5%)
   (b) After deleting the terms that are zero, write down the remaining simplified differential equation. (5%)
   (c) Express the pressure gradient ($\partial p/\partial y$) in terms of the mean velocity V. (15%)

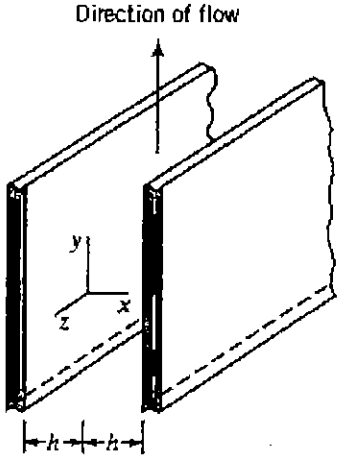

Fig. 2.

注意：背面有試題

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3. Please write down the definition and physical meaning of the following terms. Do not exceed 20 words for description of each term. (5%)
   (a) Reynolds analogy (b) Chilton-Colburn analogy

4. Fully developed flow in a circular tube is heated with constant wall temperature. The flow rate is 0.03 kg/s, and the tube inside diameter is 25.4 mm. Please evaluate the convective heat transfer coefficient for water and R-134a at temperature of 300K (properties listed below) respectively (20%).

Hint: You have to check the flow regime and choose appropriate equation (not must be listed below) for your calculation.

Properties:

	density (kg/m^3)	conductivity (W/m-K)	viscosity (Ns/m^2)	specific heat (kJ/kg-K)
Water	997.0	0.613	855×10^{-6}	4.179
R-134a	1200	0.0803	190×10^{-6}	1.432

Reference equations:

(a) $Nu=0.332Re^{0.5}Pr^{1/3}$, (b) $Nu=0.0296Re^{0.8}Pr^{1/3}$, (c) $Nu=0.023Re^{0.8}Pr^{1/3}$

5. A fin, with base area $A_b = 20$ mm^2 and surface area $A_f = 160$ mm^2, has the fin efficiency $\eta_f = 0.5$. The convective heat transfer coefficient $h = 100$ W/m$^2\cdot$K.
   (a) Evaluate the fin effectiveness ε_f. (3%)
   (b) Suppose the fin and the object are not in perfect contact that a thermal contact resistance per unit area, $R''_{tc} = 2 \times 10^{-3}$ m$^2\cdot$K/W, exists between the fin base and the object surface. Evaluate the fin effectiveness including the effect of thermal contact resistance. (5%)

6. A composite wall is composed of two different materials, A and B, with constant heat conductivity k_A and k_B, mass density ρ_A and ρ_B, specific heat per unit mass C_A and C_B, and wall thickness L_A and L_B, respectively. The wall is initially at uniform temperature T_0. Consider the outer surface of A is adiabatic, and the outer surface of B is subject to convection with an adjoining fluid temperature $T_f < T_0$, and convective heat transfer coefficient h.
   (a) Assume one-dimensional conduction. Write down for the transient problem the heat equation in domain A and B, respectively. (3%)
   (b) Assume the interfaces of A and B are in perfect contact that the thermal contact resistance can be neglected. Write down the appropriate boundary conditions for solving the one-dimensional heat transfer problem. Explain the physical meanings. (6%)
   (c) Consider the interfaces are not in perfect contact that there exists, between A and B, a finite-valued thermal contact resistance per unit area, R''_{tc}. Write down the appropriate interface boundary conditions for solving the one-dimensional problem. Explain the physical meanings. (4%)
   (d) Explain under what condition, you may assume that the whole composite wall has a uniform temperature in (c). Define appropriate dimensionless parameters. (4%)