

國 立 清 華 大 學 命 題 紙

98 學年度 動力機械 系 (所) 甲 組碩士班入學考試

科目 熱流學 (二) 科目代碼 1001 共 2 頁第 1 頁 \*請在【答案卷卡】內作答

1. Please answer the followings
  - (a) Please indicate the function of the dimple on the surface of a golf ball. (4%)
  - (b) What is the generation mechanism of the trailing vortex behind the wing tip of an aircraft? (4%)
  - (c) For flow over a cylinder, please draw the surface pressure distributions if the flows are either irrotational, laminar or turbulent. Explain your results. (4%)
2. Please derive the momentum integral equation for the boundary layer flow in a flat plate with zero pressure gradient. (8%)
3. Please answer the followings
  - (a) Is the speed of sound for air in a combustor at room temperature different from that at 2000K? Give the reason for your answer. (5%)
  - (b) How do you choke a channel or nozzle flow? (5%)
  - (c) How do you vary the mass flow rate for a choked channel or nozzle flow? (10%)
4. Please answer the followings
  - (a) Please derive the heat-conduction equation and explain the physical meaning of each term in the equation. (15%)
  - (b) Please define the thermal resistance associated with conduction and give its physical meaning. (5%)

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5. Air at  $27^\circ\text{C}$  and  $1\text{ atm}$  flows over a **flat plate** at a speed of  $u_\infty=2\text{ m/s}$ . Assume unit depth in the  $z$  direction (2-D flow); the viscosity, heat conductivity, and the Prandtl number of air at  $27^\circ\text{C}$  is  $\mu = 1.85 \times 10^{-5}\text{ kg/m.s}$ ,  $k = 0.02749\text{ W/m.K}$ ,  $Pr = 0.7$ , respectively.
- (a) Calculate the Reynolds number at distances of  $x=20\text{ cm}$  and  $x=40\text{ cm}$  from the leading edge of the plate. (5%)
- (b) Evaluate the boundary layer thickness  $\delta$  at the above two positions. (5%)
- (c) Derive the general expression for  $\frac{u}{u_\infty} = a + b\frac{y}{\delta} + c\left(\frac{y}{\delta}\right)^2 + d\left(\frac{y}{\delta}\right)^3$ , where  $a, b, c, d$  are coefficients. (5%)
- (d) Evaluate the mass flow rate enters the boundary layer between  $x=20\text{ cm}$  and  $x=40\text{ cm}$ . (5%)
- (e) If the plate is heated over its entire length to a temperature  $60^\circ\text{C}$ , evaluate the heat convection rate in the first 20 cm and in the first 40 cm of the plate. (10%)

Hint: If you haven't got a calculator, just express how to evaluate all those variables and what their units are.

6. The absorptivities of various surfaces to solar and low temperature thermal radiation are  $\alpha_S, \alpha_{LT}$  respectively. The Stefan-Boltzmann constant is  $\sigma = 5.669 \times 10^{-8}\text{ W/m}^2\text{K}^4$ .
- (a) Evaluate the radiation equilibrium temperature for a **white surface** plate exposed to a solar flux of  $700\text{ W/m}^2\text{K}^4$  and a surrounding temperature of  $27^\circ\text{C}$ . What will be the temperature if the surface is painted in **black**? (5%)
- $$\alpha_{S_{white}} = 0.12, \alpha_{LT_{white}} = 0.19, \alpha_{S_{black}} = 0.96, \alpha_{LT_{black}} = 0.95$$
- (b) Which color of the surface is cooler? Why? (5%)