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℃* and *1 atm* flows over a **flat plate** at a speed of $u_\infty = 2\ m/s$. Assume unit depth in the z direction (2-D flow); the viscosity, heat conductivity, and the Prandtl number of air at *27℃* is $\mu = 1.85\times10^{-5}\ kg/m.s,\ k = 0.02749\ W/m.K,\ Pr = 0.7$, respectively.

(a) Calculate the Reynolds number at distances of *x=20 cm* and *x=40 cm* from the leading edge of the plate. (5 %)

(b) Evaluate the boundary layer thickness δ at the above two positions. (5%)

(c) Derive the general expression for $\frac{u}{u_\infty} = a + b\frac{y}{\delta} + c(\frac{y}{\delta})^2 + d(\frac{y}{\delta})^3$, where *a, b, c, d* are coefficients. (5%)

(d) Evaluate the mass flow rate enters the boundary layer between *x=20 cm* and *x=40 cm*. (5%)

(e) If the plate is heated over its entire length to a temperature *60℃*, 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 α_S, α_{LT} respectively. The Stefan-Boltzmann constant is $\sigma = 5.669\times10^{-8}\ W/m^2K^4$.

(a) Evaluate the radiation equilibrium temperature for a **white surface** plate exposed to a solar flux of $700W/m^2K^4$ and a surrounding temperature of *27℃*. 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%)