

94 學年度 動力機械工程學系 甲 組碩士班入學考試

科目 熱流學(二) 科目代碼 1501 共 2 頁第 1 頁 \*請在試卷【答案卷】內作答

QUESTION 1 (20%)

Consider a fully developed laminar pipe flow

- Derive the momentum equation in differential form if the flow is driven by a pressure gradient.
- Determine the velocity profile  $u(r)$  if it is a circular pipe with inner radius  $r_0$ , where  $r$  is the radial coordinate of the circular pipe.
- Find the skin friction coefficient in terms of the Reynolds number.
- If we use electric analogy to simulate this pipe flow, what is the flow resistance?

QUESTION 2 (20%)

Answer the following questions briefly

- Describe the variation of the boundary layer thickness for a laminar boundary layer flow parallel to a flat plate. Could there be a separation point?
- Explain the physical significance for a boundary layer flow problem that has a similarity solution (such as the Blasius flow).
- Explain the Magnus effect for a flying rotational sphere.
- Explain the Kutta condition for flow over an airfoil.

QUESTION 3 (20%)

- What is the general Unsteady Heat Conduction Equation of a solid cylinder with heat source? (3%)
- If the radius is  $r_0$ , what is the temperature distribution along the radius  $r$  at steady state? (5%)
- What is the heat flux at the wall? (5%)
- If we use electric analogy to simulate this heat conduction process, what is the thermal resistance? (3%)
- What are the similarities between the pipe flow, heat conduction and the electric circuit? (4%)

QUESTION 4 (12%)

What is the physical significance and definition of the Nusselt number for

- Flow over a flat plate of length  $L$ ,
- Flow over a cylinder of outer diameter  $D_o$ ,
- Flow in a circular tube of inner diameter  $D_i$ ,
- Flow in a rectangular tube of cross-section  $a \times b$ ?

QUESTION 5 (7%)

Consider laminar flow of air across a hot circular cylinder. At what point on the cylinder will the heat transfer be highest? What would your answer be if the flow were turbulent? Explain in detail.

(以下接 QUESTION 6)

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QUESTION 6 (9%)

Forced convection in a circular tube

- (a) Consider a laminar forced convection in a circular tube. Will the heat flux be higher near the inlet of the tube or near the exit? Why?
- (b) Consider turbulent forced convection in a circular tube. Will the heat flux be higher near the inlet of the tube or near the exit? Why?
- (c) How does surface roughness affect the heat transfer in a tube if the fluid flow is turbulent? What would your response be if the flow in the tube were laminar? Explain in detail.

QUESTION 7 (12%)

For combined natural and forced convection

- (a) Under what condition does natural convection enhance forced convection, and under what conditions does it hurt forced convection?
- (b) When neither natural nor forced convection is negligible, is it correct to calculate each independently and add them to determine the total convection heat transfer? Explain in detail.
- (c) A question that frequently arises in the cooling of heat-generating equipment such as a notebook PC is whether to utilize natural or forced convection in the cooling of the equipment. What your answer be and explain in detail.

(以下空白)