國立清華大學 101 學年度碩士班考試入學試題

系所班組別：動力機械系　甲組

考試科目（代碼）：熱流學(1101)

QUESTION 1　25%

Consider a fluid flow between two horizontal parallel flat plates of infinite length. The distance between the two plates is H. The flow is assumed two-dimensional, incompressible, and laminar.

(a) If the upper plate moves at a constant velocity U_0 while the bottom plate is fixed, write the governing equations and the associated boundary conditions for the flow. (7%)

(b) If both plates are fixed while a constant pressure gradient is applied on the fluid in the x-direction (i.e. $\partial p/\partial x = c = constant$, $\partial p/\partial y = 0$), write the governing equations and the associated boundary conditions for the flow. The flow is assumed fully-developed. (8%)

(c) Solve the problems in part (a) and part (b) and discuss the major difference between their solutions. (10%)

QUESTION 2　(25%)

Answer the following questions briefly

(a) Derive the Bernoulli equation from the first law of thermodynamics by making adequate assumptions. (10%)

(b) What are the physical significances $\nabla \cdot \vec{V}$ and $\nabla \times \vec{V}$ where $\vec{V}$ is the velocity vector of a fluid flow? (5%)

(c) What is the Moody chart? (5%)

(d) 某大樓高度 36 公尺，若擬將地下室蓄水池的自來水抽打至樓頂的水塔，則抽水機應該設置在那裡？地下室或屋頂？理由安在？ (5%)

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QUESTION 3　25%

For the transient process of a large thin hot flat plate (initial temperature at T_0, thickness H=2 cm, k_s= 10 W/mK) suddenly submerged in a cold fluid (k_f=1 W/mK) environment at T_∞, we may consider the spatial plate temperature variation only across the plate thickness.

(a) If the convection heat transfer coefficient on the plate is h= 5 W/m^{2}K, do you expect significant temperature variation across the plate thickness? Discuss.

(b) For the situation in (a), write the appropriate energy equation and initial condition for the consideration of plate temperature variation.

(c) If the convection heat transfer coefficient on the plate is h= 1000 W/m^{2}K, write the appropriate energy equation and initial and/or boundary conditions for the consideration of plate temperature variation.

(d) Draw and compare the transient temperature variation processes in (a) and (c), emphasizing on their spatial (空間) and temporal (時間) differences.

QUESTION 4　12%

When treating a heat convection problem, we usually attempt to determine the suitable Nusselt number (Nu) expression. (a) Why don't we directly determine the expression for the heat convection coefficient h? (b) What non-dimensional parameters will Nu depend on for forced convection and natural convection problems, respectively? (c) Consider a cylinder with a diameter of D in air at a relative speed of U. The cylinder temperature is fixed at T_s and the air temperature is T_∞. What would you do to calculate the forced convective heat transfer rate from the cylinder? Describe the key steps.

QUESTION 5　13%

An incandescent light can be considered as a blackbody surface at 3000K. An LED light is assumed to illuminate uniformly over the visible-light band (wavelength λ of 0.4μm to 0.7μm). Suppose the total emissive powers (E) of both lights are the same. (a) Schematically draw their curves of spectral emissive power (E_λ) versus λ on a single E_λ- λ diagram for comparison. (b) Which light has a higher efficiency as far as illumination is concerned? Explain.