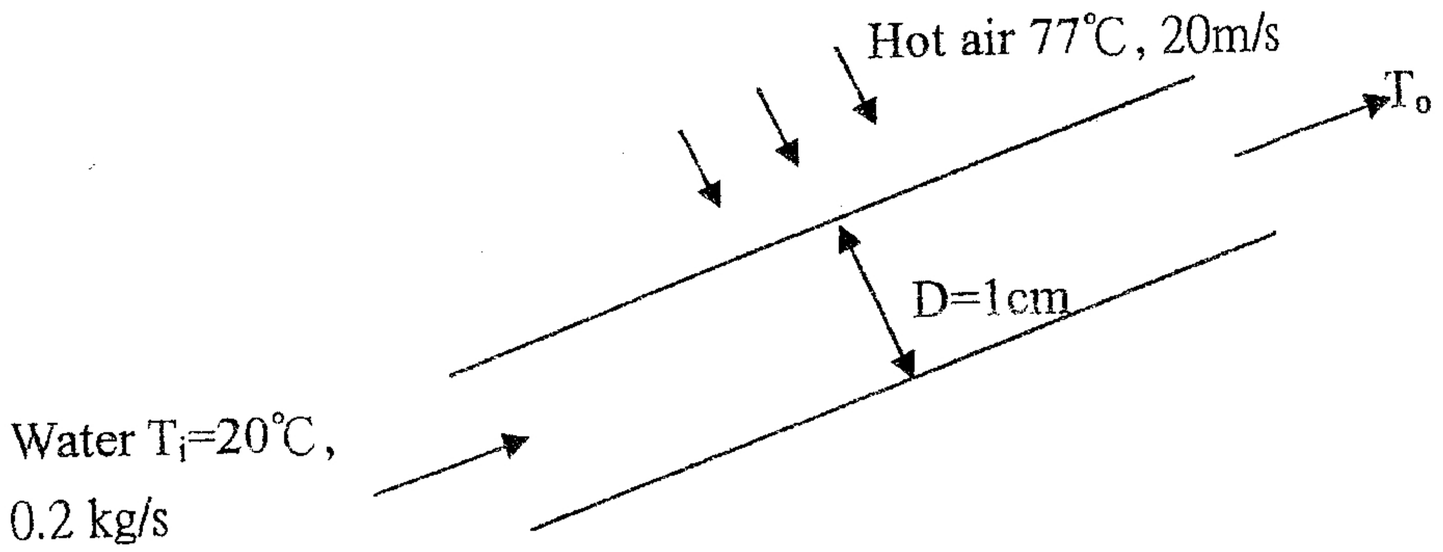
國　立　清　華　大　學　命　題　紙

97 學年度 工程與系統科學系 系（所） 乙 組碩士班入學考試

科目 熱傳學 科目代碼 2904 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. A plane wall is composed of two materials, A and B with perfect contact. The wall of material A has uniform heat generation g, thermal conductivity K_A and thickness L_A. The wall material B has no heat generation with thermal conductivity of K_B and thickness of L_B. The inner wall of material A, i.e. x=0, is well insulated, while the outer surface of material B is cooled by a coolant at temperature T_C and heat transfer coefficient h. Please determine the temperature distribution in both materials and determine the maximum temperature in the system. Show your derivation. (20%)
2. A heated surface of area A_t and temperature T_b is cooled by an array of N pin fins attached to the surface by an adhesive joint. The coolant temperature is T_C and both the heat transfer coefficients between the surface and coolant and between each fin and coolant are h. The diameter, length, and thermal conductivity for each fin are D, L and k, respectively. The thermal contact resistance between heated surface and each fin is R (m^2K/W) and each fin tip may be assumed to be well insulated. Determine the total heat transfer rate from the surface. Show your derivation. (20%)
3. Thermal stress is of significant concern for the growing of a silicon crystal from its melt. Consider a cylindrical silicon crystal being grown from melt with its interface temperature between solid crystal and melt, i.e. z =0, of T_m, the melting temperature, and the outside surfaces, including the side surface, i.e. r = R, and top surface, i.e. z =L, are cooled by a coolant at T_C and heat transfer coefficient h. Where R and L, respectively, are the diameter and length of the cylindrical silicon crystal. Determine the steady state temperature distribution in the crystal. Show your derivation. (20%)
4. Consider a semi-infinite solid initially at T_i and its surface at x = 0 is suddenly raised to T_s for t > 0. Obtain an expression for the transient temperature distribution in the solid and the heat flux at x = 0. Show your derivation. (20%)

5. Waste heat of exhaust hot air from a manufacturing process may be recovered by passing water through a thin-walled tube of 1 cm diameter as shown. Assume the temperature of the hot air is 77℃ in cross flow with a velocity of 20 m/s over the tube. The inlet and outlet temperature of water are 20℃ and 60℃, respectively, and the flow rate is 0.2 kg/s.. Determine the length of the tube and the total heat transfer rate from air to water. (20%)



Hint : $Nu_D = 4.36$ if the flow is laminar in the tube, and

$Nu_D = 0.023 Re_D^{0.8} Pr^{0.4}$ if the flow is turbulent.

The water properties are:

ρ =992kg/m^3 ; Cp=4.179×10^3 J/kgK

k_f =0.631W/mK ; μ =6.539×10^{-4} kg/ms.

The air properties are: υ =17.4×10^{-6} m^2/s ;

k_f =0.0274W/mK ; α =24.7×10^{-6} m^2/s.