國立清華大學 103 學年度碩士班考試入學試題

系所班組別：工程與系統科學系碩士班 乙組

考試科目（代碼）：熱傳學(2704)

 *請在【答案卷、卡】作答

1. Please describe the basic laws governing heat conduction and derive the time-dependent, three dimensional heat diffusion equation in Cartesian coordinates. Define the variables used clearly. Please also describe the three basic types of boundary conditions for heat conduction. (20%)

2. A thin silicon chip is adhered to a 5-mm-thickness aluminum substrate by an epoxy joint. The chip and substrate are each 5 cm on a side, and their exposed surfaces are cooled by forced air convection and by thermal radiation. The air and surrounding temperatures are all at 25 °C. The heat transfer coefficient due to air convection is of 300 W/m^2K. If the maximum allowable temperature of the chip is 80°C. Determine the maximum possible heat dissipation rate from the chip. The thermal conductivity for pure aluminum is 240W/mK and the contact thermal resistance for the epoxy joint is $1*10^{-4}$ m^2K/W for a unit area. The emissivity for both silicon and aluminum surfaces are assumed to be 0.7. The Stefan-Boltzmann constant is σ=5.678*10^{-8} W/m^2K^4. (20%)

3. A plane wall with a thickness of L is initially at temperature T_i and for t > 0 the plane surface at x =0 is elevated instantly to T_s, while the surface at x=L remains insulated. Please determine (a) the transient temperature distribution in the wall for t > 0, and (b) the heat flux at x=0 for t > 0. (20%)

4. Considering hydrodynamically and thermally fully-developed fluid flow in a tube with a mass flow rate of m (kg/s) and inlet temperature of T_i, please determine <u>the mean temperature of the fluid</u> and <u>wall temperature</u> as a function of distance from the inlet if (a) the tube is heated uniformly with a heat flux of q”, and (b) the tube is heated with a uniform surface temperature of T_s and the heat transfer coefficient is determined to be h. (c) Sketch the temperature distribution for both cases. (20%)

5. For a counter flow heat exchanger, please show that the total heat transfer rate can be expressed as $q = UA\Delta T_{lm}$, where U is the overall heat transfer coefficient, A is the heat transfer area and ΔT_{lm} is the log mean temperature difference, which is defined as

$$\Delta T_{lm} = (\Delta T_2 - \Delta T_1)/\ln(\Delta T_2/\Delta T_1)$$

$$\Delta T_1 = T_{h,i} - T_{c,o};\ \Delta T_2 = T_{h,o} - T_{c,i}$$

Where $T_{h,i}$ and $T_{h,o}$ are the inlet and outlet fluid temperature of the hot side; $T_{c,i}$ and $T_{c,o}$ are the inlet and outlet fluid temperature of the cold side. Neglect possible heat loss from the system. (20%)