

國立清華大學 101 學年度碩士班入學考試試題

系所班組別：工程與系統科學系乙組

考試科目（代碼）：熱傳學(2604)

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

1. Double-panes window is used to improve insulation of houses. The design of double-panes window included two glasses separated by. The improvement of insulation is due to the presence of air as an insulator. Is it correct to say that the effectiveness of double-panes window is proportional to the thickness of the gap? Why?

Equations you need:

$$Nu_{\delta} = 0.197(Gr_{\delta} Pr)^{\frac{1}{4}} \left(\frac{L}{\delta}\right)^{-\frac{1}{9}} \quad \text{Laminal}$$

$$Nu_{\delta} = 0.073(Gr_{\delta} Pr)^{\frac{1}{3}} \left(\frac{L}{\delta}\right)^{-\frac{1}{9}} \quad \text{Turbulent}$$

$$Gr_{\delta} = \frac{g\beta(T_1 - T_2)\delta^3}{\nu^2}$$

T_1 and T_2 are temperature difference between two glasses and L is the length of the window.

2. Consider a homogenous spherical ball encased inside a cladding also in spherical shape. The thermal conductivity of ball and cladding are k_f and k_c , respectively. The radius of the ball and cladding is r_f and r_c , respectively. The volumetric heat generation rate in the ball is uniformly distributed at q''' . There is no heat generation within the cladding. The thermal contact resistance between the outer surface of the ball and the inner surface of cladding is R''_c ($m^2 K/W$) per unit area of interface. The ball is cooled by a coolant at T_{∞} with a heat transfer coefficient h . Obtain an expression for the centerline temperature of the ball. (20%)

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left(kr^2 \frac{\partial T}{\partial r} \right) + q''' = \rho C_p \frac{\partial T}{\partial t}$$

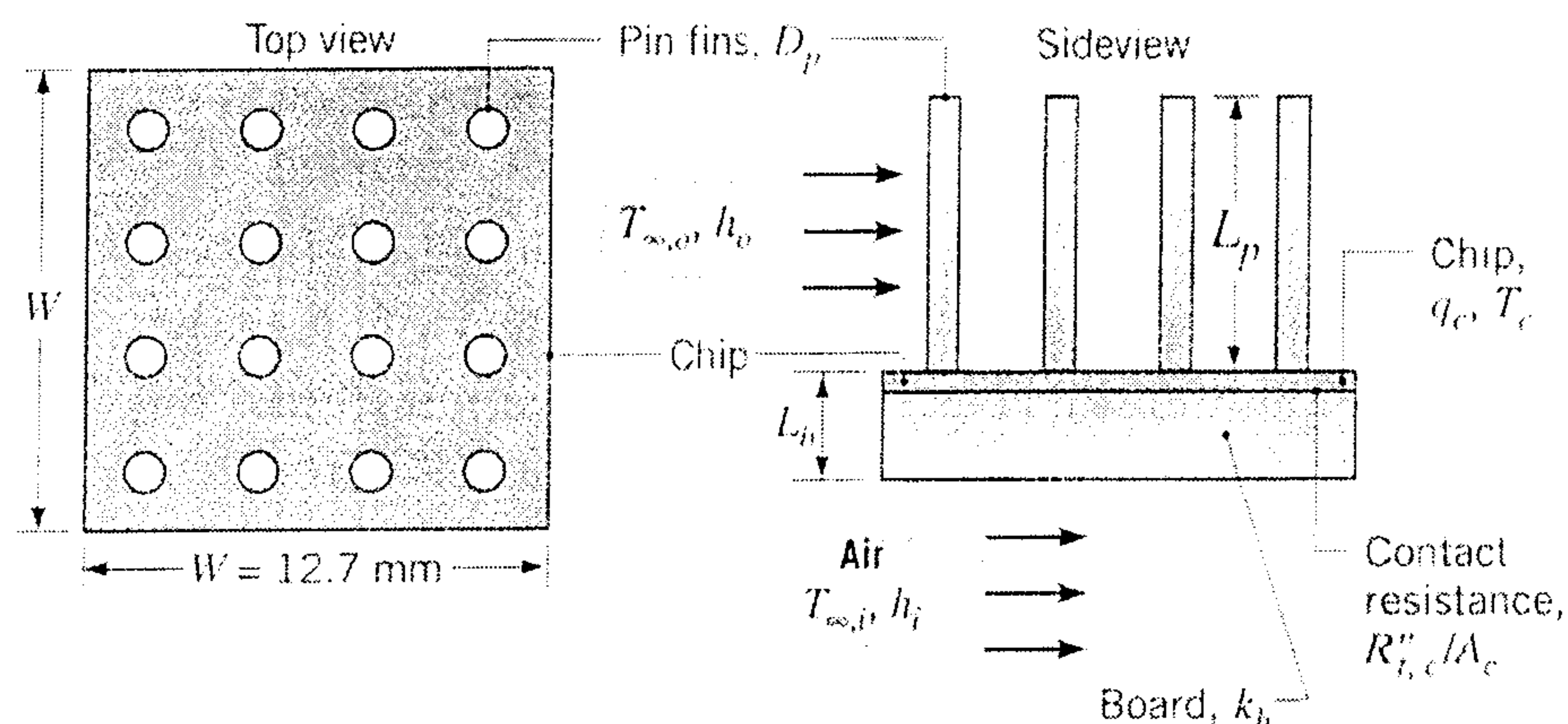
國立清華大學 101 學年度碩士班入學考試試題

系所班組別：工程與系統科學系乙組

考試科目（代碼）：熱傳學(2604)

共 3 頁，第 2 頁 *請在【答案卷、卡】作答

3. As more and more components are placed on a single integrated circuit. To maximize heat dissipation, it is proposed that a 4×4 array of copper fins be metallurgically joined to the outer surface of a square chip that is 12.7 mm on a side, as shown in the following figure. Determine the maximum heat dissipation rate from the chip if the maximum allowable chip temperature is 80°C . The pin diameter is 1.5 mm and length is 15 mm. The fins are exposed to a dielectric liquid with $h_o = 1000 \text{ W/m}^2\text{K}$ and $T_{\infty,o} = 20^\circ\text{C}$. Assume there is no heat dissipation from the tip of fins. The thermal contact resistance between the chip and the board is $10^{-4} \text{ m}^2\text{K/W}$, and the board thickness and thermal conductivity are $L_b = 5 \text{ mm}$ and $k_b = 1 \text{ W/mK}$, respectively. The other surface is exposed to ambient air for which $h_i = 40 \text{ W/m}^2\text{K}$ and $T_{\infty,i} = 20^\circ\text{C}$. The thermal conductivity for copper is 400 W/mK . (20%)



4. In applying the Newton's law of cooling, the heat transfer coefficient is determined by various heat transfer empirical correlations. When an engineer wants to choose a heat transfer correlation to calculate the heat transfer coefficient for his very specific situation, please list the important things he has to pay attention to (20%).

國立清華大學 101 學年度碩士班入學考試試題

系所班組別：工程與系統科學系乙組

考試科目（代碼）：熱傳學(2604)

共 3 頁，第 3 頁 *請在【答案卷、卡】作答

5. (a) Please write the general form of energy differential equation to determine the temperature distribution in the longitudinal direction of an extended surface (fin) (15%). The cross section of the fin is varied along the longitudinal direction. The thermal conductivity K of the fin is constant and the convective heat transfer coefficient is h along the fin surface. The temperature of the cooling medium is T_∞ . The heat conduction is one dimensional. (b) If the length of the fin is L , please give all the possible boundary conditions can be used to solve the equation (5%).

