

I. Answer the following questions: (25%)

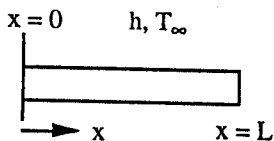
1. Which one has the higher thermal conductivity, wood or copper? How do you prove that?
2. With what assumptions can the heat diffusion equation be written as

$$\rho c \frac{\partial T}{\partial t} = k \frac{\partial^2 T}{\partial x^2}$$

3. What's the difference between Bi and Nu?
4. What is the boundary layer theory?
5. In an experiment, if you want to make one boundary heat-insulated, how would you do?

II. 對一個發熱元件, Fin是可以幫助散熱。不過以熱阻的觀點來看, 加Fin反而增加熱阻(像人穿衣服, 穿越多越暖和), 如此又如何能對散熱有所助益? 請分析說明。(10%)

III. (a) In what conditions a fin can be regarded as a one-dimensional problem mathematically? (5%)



(b) Prove that the (one-dimensional) energy equation of a fin with constant cross-sectional area is

$$\frac{d^2 T}{dx^2} - \frac{hP}{kA} (T - T_\infty) = 0,$$

where A is the cross-sectional area and P is the perimeter. (10%)

(c) The boundary conditions of the fin are $x = 0, T = T_b$; $x = L, \frac{dT}{dx} = 0$. Find the temperature solution. (10%)

(d) Calculate the heat loss by the fin. (5%)

IV. Consider the heat transfer in a parallel plate duct. The u-velocity in the duct is assumed uniform, $u = U_\infty$ (constant) and $v = 0$.

(a) What's meaning of "the temperature profile being fully-developed"? (5%)

(b) Derive the expression of Nu for the case of constant wall heat flux in the fully-developed area. (10%)



V. The following two problems belong to natural convection.

(a) A vertical plate (in Fig. 5(a)) of temperature T_w is in an environment of temperature T_∞ .

Draw the temperature and velocity distributions vs. x (i.e. T vs. x and u vs. x) at $y = y_A$. y_A is the y-coordinate of point A. Explain why the velocity profile is like that you draw. (10%)

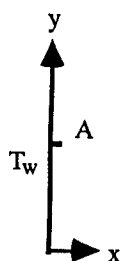


Fig. 5(a)

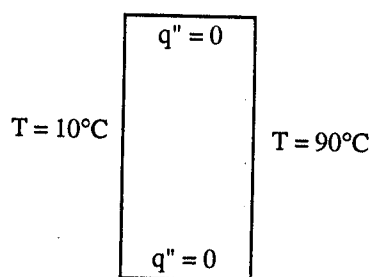


Fig. 5(b)

(b) Draw the isotherms for the case of Fig. 5(b) without considering the effect of natural convection. (3%)

(c) Considering the natural convection, draw the isotherms and streamlines for the case of Fig. 5(b). Explain why are they like those you draw? (7%)