I. The one-dimensional Fourier law can be written as

$$q'' = -k\frac{\partial T}{\partial x}$$

(1) What are q'', k and $\partial T/\partial x$? (6%)

(2) What are the units（單位）of q'', k and $\partial T/\partial x$? (6%)

(3) What is the meaning of the negative sign in the equation? (3%)

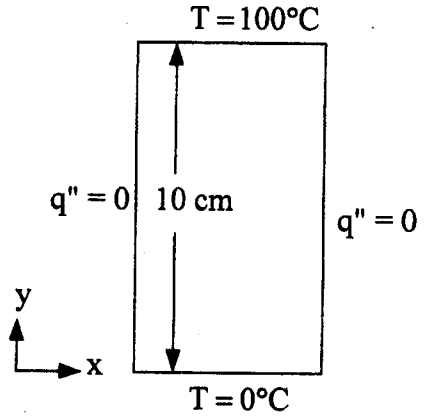
II. Explain the following terms: (12%)

(1) Biot number

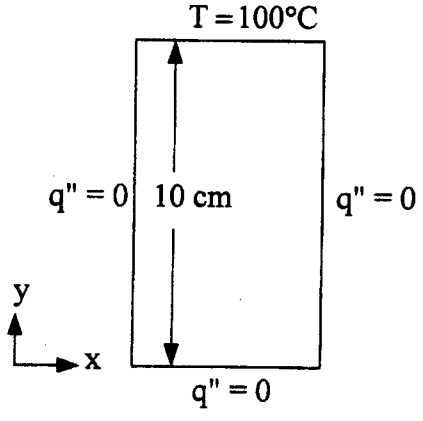
(2) Nusselt number

(3) Prandtl number

III. According to the following boundary conditions, draw the isotherms（等溫線）for the steady solutions or write down the solutions. (No calculation required) (10%)



(a)



(b)

IV. Answer the following questions: (36%)

(1) 如何做到絕熱（也就是如何盡量減少熱量之損耗）的效果？

(2) 為何無法做到百分之百的絕熱？

(3) 可以透氣的衣服，以熱傳觀點，有何作用？

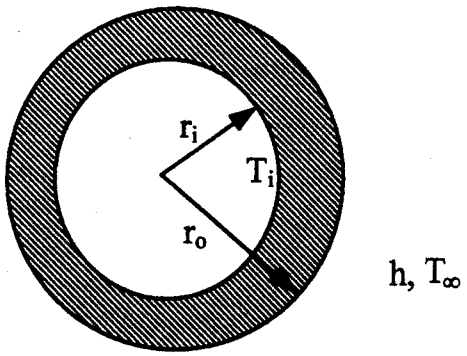
(4) 穿兩衣可以禦寒嗎？為什麼？

(5) LED 與電腦之散熱，有何異同？

(6) 刮大風時，天氣變冷，還是變熱？以熱傳觀點闡釋之。

V. (a) Consider a layer of insulation which is installed around a circular pipe (see the following figure). The outer radius of the pipe is r_i and the outer radius of the insulation is r_o. Prove that the critical radius of insulation is $r_o = k/h$ and it has maximum heat loss. (12%)

Hint: Critical radius of insulation here means that when $r_o = k/h$, it has the maximum or minimum heat loss.



(b) A pipe (12-cm-diameter) need insulating by using asbestos [k = 0.15 W/m°C]. The pipe will be exposed to room air at 20 °C with h = 3.0 W/(m^2·°C). What will you do to avoid the critical thickness of insulation? (5%)

VI. As shown in the following figure, T_1 = 22°C, T_2 = 27°C, T_3 = 32°C and T_∞ = 20°C. If the thermal conductivity of the metal is 1 W/(m·°C). What is the convective heat transfer coefficient h? (10%)