※ 考生請注意，本試題 □可 ☑不可 使用計算機

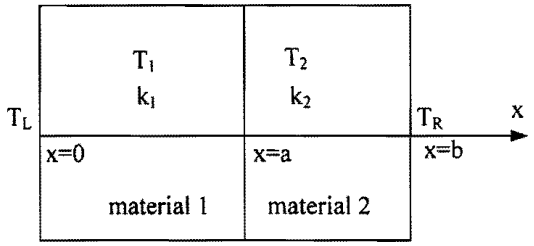
I. The one-dimensional heat conduction equation can be written as

$$\rho C\frac{\partial T}{\partial t} = k\frac{\partial^2 T}{\partial x^2} + q'''$$

(1) What are the effects of $\rho C\frac{\partial T}{\partial t}$, $k\frac{\partial^2 T}{\partial x^2}$ and q''' in the heat transfer? (6%)

(2) What is $k/(\rho C)$? What is its unit? (4%)

II. In the following figure, two materials with k_1 and k_2 thermal conductivities have perfect contact and their corresponding temperatures are T_1 and T_2.

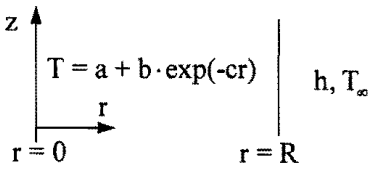


(1) Write down the boundary conditions at x=0, x=a and x=b. (6%)

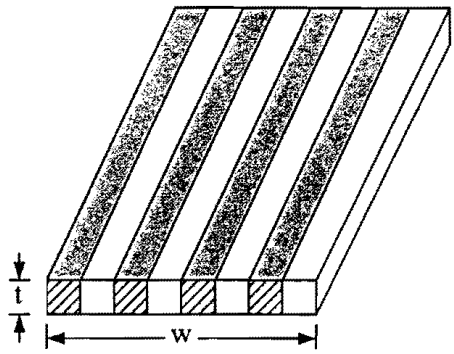
(2) Solve the T_1 and T_2 under the assumptions of 1-D steady state with no heat source and constant k_1 and k_2. (6%)

(3) If these two materials do not have perfect contact at their interface, what are the boundary conditions at x = a? (4%)

III. The temperature distribution of a 1-D steady-state problem (as shown in the following figure) is $T = a + b\cdot\exp(-cr)$, where a, b, and c are constants. At r = R, there is a convective boundary condition. Derive the expression of h, which is the convective heat transfer coefficient. T_∞ is the ambient temperature, and k is the thermal conductivity. Hint: Do not need to find a, b and c, since they are assumed to be known in this problem. (8%)



IV. A long and flat slab is made of n pairs of square bars of different thermal conductivities, k_A and k_B. Determine the effective thermal conductivity of the slab: (i) across the width (ii) through the thickness. (12%)



V. Explain the following terms: (24%)

(1) Bulk fluid temperature
(2) Blackbody
(3) Heat flux
(4) Thermal resistance
(5) Green house
(6) Fourier's law

VI. Answer the following questions: (30%)

(1) 請舉三個熱傳於工業上之應用例子。
(2) 請舉三個應用熱傳於日常生活的例子。
(3) In what conditions does convection heat transfer not occur?
(4) 在烈日之下，爲何在樹下比在遮雨棚下更涼爽？
(5) 在能源問題越來越嚴重時，熱傳有何重要性？
(6) What is the lumped-heat-capacity system?