I. Explain the following terms: (20%)

(1) Fourier's law of heat conduction (2) Boussinesq approximation
(3) Nusselt number (4) film temperature (5) mixed convection

II. Answer the following questions: (25%)

1. 請寫出三種熱傳之應用實例。
2. 如果我們要製作一液態氦之儲存容器，如何製作絕熱（也就是如何減少熱量之損耗）之設備？
3. 為何絕熱之設備不易達到百分之百的絕熱條件？
4. 以熱傳觀點，為何冰箱需要除霜？
5. 請簡述如何以實驗方式獲得一材料之熱傳導係數？

III. A 5-cm layer of loosely packed asbestos is placed between two plates at 100 and 200°C. Calculate the heat transfer across the layer (i.e., the heat flux across the layer). The conductivity of the layer is 0.161 W/(m·°C). (5%)

IV. One side of a plane wall is maintained at 100°C, while the other side is exposed to a convection environment having T = 10°C and h = 10 W/(m^2·°C). The wall has k = 1.6 W/(m·°C) and is 40 cm thick. Calculate the heat flux through the wall. (10%)

V. Derive an expression for the temperature distribution in a plane wall having uniformly distributed heat sources $\dot{q}$ and one face maintained at a temperature T_1 while the other face is maintained at a temperature T_2. The thickness of the wall may be taken as 2L. (10%)

VI. Consider a steady-state heat conduction problem in a rectangular plate. Its boundary conditions are shown in Fig. 6. Find the temperature solution of the plate. (15%)

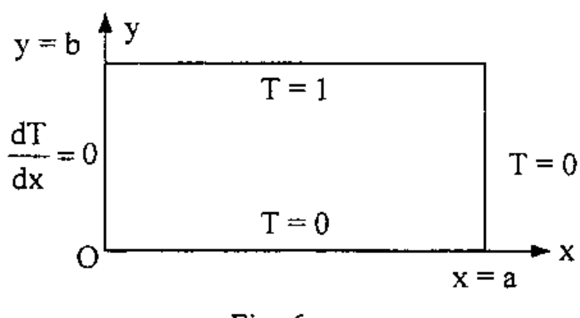

Fig. 6

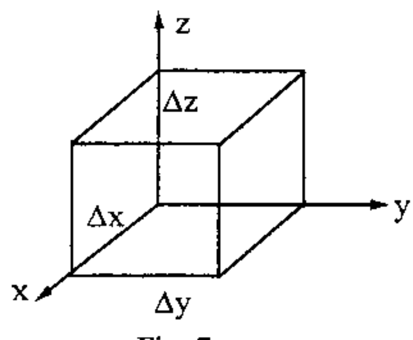

Fig. 7

VII. For a one-dimensional problem of heat convection, derive the expression of the energy equation in the steady-state condition. To derive this equation, consider a small control volume as shown in Fig 7. The temperature is only function of y, i.e., T = T(y). Only the velocity in the y direction exists, i.e. $u = 0,\ \ v = v(y),\ w = 0$. (15%)

Hint: the energy equation is $\rho Cp \cdot v\frac{\partial T}{\partial y} = \frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right)$, where ρ is density, Cp is heat capacity and k is thermal conductivity.