

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

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

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

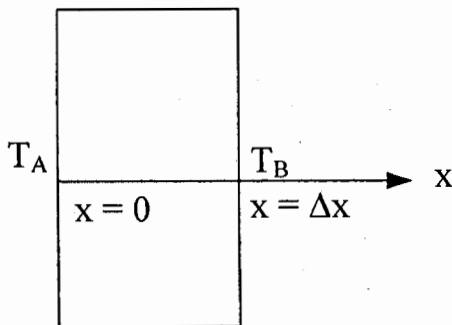
(1) What are the physical meanings of  $\rho C \frac{\partial T}{\partial t}$

and  $k \frac{\partial^2 T}{\partial x^2}$ ? (6%)

(2) What are the units (單位) of  $\rho C \frac{\partial T}{\partial t}$ ? (3%)

(3) In deriving this equation, what is the principle used? (3%)

II. Consider a one-dimensional steady heat flow through a plane wall without heat source, as shown in the following figure.



- (1) Solve the temperature distribution of the problem. (5%)
- (2) Derive the thermal resistance for the heat flow through the plane wall. (5%)

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

$$\rho C \frac{\partial T}{\partial t} = \frac{\partial}{\partial x} \left( k \frac{\partial T}{\partial x} \right) + \dot{q}$$

where  $\rho$ ,  $C$ ,  $k$  and  $\dot{q}$  are the density, specific heat, thermal conductivity and heat source.

Prove that the heat flux along the  $x$  direction is equal to constant with the extra assumptions of steady state and no heat source. (10%)

IV. Explain the following terms: (30%)

(1) Heat conduction

(2) Fourier's Law

(3) Natural convection

(4) Thermal resistance

(5) Lumped-Heat-Capacity System

(6) Black body

V. Answer the following questions: (30%)

(1) 銅與木材，那一個熱傳效果較好？如何以實驗方式驗證？

(2) 以熱傳觀點，來闡釋棉被的保暖效果？

(3) The thermal properties of water and air are shown in the following table.

Properties	AIR	WATER
$k$ (W/m°C)	0.024	0.556
$\rho$ (kg/m <sup>3</sup> )	1.1774	1005.7
$C$ (kJ/kg°C)	1.0057	2.2
$\rho C$ (kJ/m <sup>3</sup> °C)	1.2	2200
$\nu$ (m <sup>2</sup> /s)	15.69	0.93

Which one has the stronger convective heat transfer, air or water? Why?

- (4) 請舉三個熱傳實際應用例子。
- (5) 在烈日之下，為何在大樹下比在遮雨棚下更涼爽？

VI. A solid body has a very high thermal conductivity, whose volume and surface area are  $V$  and  $A$ . It is put in a fluid, whose temperature is  $T_\infty$  and the convective heat transfer coefficient is  $h$ . The initial temperature of the solid body is  $T_0$  and its thermal conductivity, density and specific heat are  $k$ ,  $\rho$  and  $C$ . Derive the temperature expression of the body in terms of time. (8%)

