系所組別： 工程科學系在職專班乙組
考試科目： 熱傳學（專班）　　　　　　　　　　　　　考試日期：0307，節次：3

※ 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

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

(1) What are $\rho C \dfrac{\partial T}{\partial t}$ and $k \dfrac{\partial^2 T}{\partial x^2}$ ? (6%)

(2) What are the units（單位）of $\rho$, C and k? (6%)

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

II. Prove that the heat flux ($q''$) is equal to constant for the one-dimensional steady conduction with constant thermal conductivity in a Cartesian coordinate. (15%)

Hint: This is to prove that $q'' = \text{cons}\tan t$. The following two equations are used.

(1) $\rho C \dfrac{\partial T}{\partial t} = k \dfrac{\partial^2 T}{\partial x^2}$, (2) $q'' = -k \dfrac{\partial T}{\partial x}$

III. Explain the following terms: (24%)
(1) Thermal diffusivity
(2) Thermal resistance
(3) Prandtl number
(4) Steady state
(5) Radiation shape factor
(6) Fourier's law

IV. Answer the following questions: ( 30%)
(1) 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/m³) | 1.1774 | 1005.7 |
| c (kJ/kg°C) | 1.0057 | 2.2 |
| $\rho$c (kJ/m³°C) | 1.2 | 2200 |
| $v$ (m²/s) | 15.69 | 0.93 |

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

(2) What is convection heat transfer? Give three examples.

(3) What is radiation heat transfer? Give three examples.

(4) 頂樓夏天會很熱，以熱傳觀點，如何改善？

(5) 冰箱要除霜，是將冷凍庫之結冰去除，冷凍庫之結冰不是可幫助維持冰箱之冷度？為何冰箱要除霜？

V. Consider a plate with the thickness of 0.5 cm. The cross-sectional area is 300 cm² and its thermal conductivity is 15 W/m·°C. One surface of the plate is subjected to uniform heat flux, whose total heat transfer rate is 1200 W. The other surface loses heat to the surroundings at $T_\infty$ by convection, as shown in the following figure. The convection heat transfer coefficient (h) is 80 W/m². Evaluate the temperatures at these two surfaces (i.e., T(0) and T(L)). (16%)