國立臺灣科技大學
115學年度碩士班招生

試題

系所組別：0600化學工程系碩士班

科　　　目：工程數學與輸送現象

<<506001>>

國立臺灣科技大學115學年度碩士班招生試題

系所組別： 化學工程系碩士班

科　　目： 工程數學與輸送現象

（總分為100分；所有試題務必於答案卷內頁依序作答）

1. **(15 %)** Find the solution of $y' = \dfrac{y(x-1)^2}{y+3}$, $\quad y(3) = -1$

2. **(15 %)** Solve for the general solution of $y'' - 2y' + 2y = 2e^x \cos x$.

3. **(20%)** Solve the following partial differential equation (a, b, and T_0 are constants):

$$\nabla^2 T = 0$$
$$T(x,0) = T(x,b) = 0$$
$$T(0,y) = 0$$
$$T(a,y) = T_0$$

4. **(15%)** A Newtonian fluid with density of ρ flows through a horizontal circular pipe with a fully developed situation. Assume that the flow has reached a steady-state condition.

   (1) **(7%)** Using the shell momentum balance approach, derive the differential equation corresponding to the fluid flow behavior in the pipe.

   (2) **(3%)** What is the fundamental physical meaning of the derived differential equation.

   (3) **(5%)** A fluid with a density of 1 g/cm³ and a viscosity of 1 cP flows through a horizontal circular pipe with a diameter of 10 cm. The velocity distribution of the fluid is given by

   $v = 10\left[1 - \left(\dfrac{r}{0.1}\right)^2\right]$ (m/s). Determine whether the flow behavior of this fluid corresponds

   to *laminar flow* or *turbulent flow*.
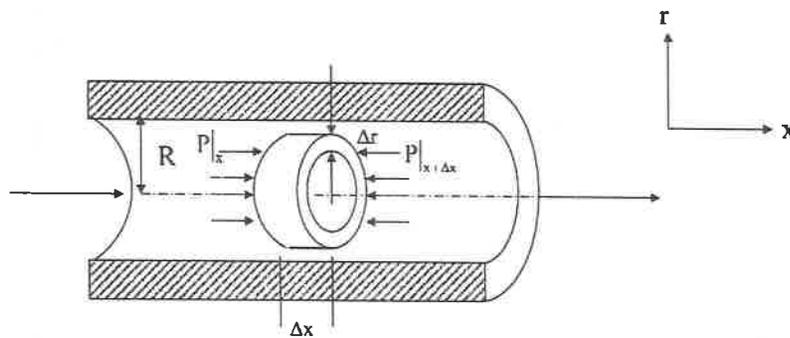
5. **(15%)** An object has cylindrical fins with radius of R attached to its surface for enhancing heat transfer. The figure below shows a local enlarged view. The surface temperature of the object is T_0, the ambient environment temperature is T_∞, and the thermal conductivity of the fin and the convective heat transfer coefficient with the ambient environment are k (W/m·K) and h (W/m²·K), respectively. Assume the heat transfer is in steady-state.

(1) **(9%)** Based on the parameters described above and the coordinate system given in the following figure, establish the governing differential equation for the temperature distribution in this cylindrical fin.

(2) **(3%)** If the tip of this cylindrical fin is adiabatic, provide the boundary condition at z=L.

(3) **(3%)** If the tip of this cylindrical fin can exchange heat with the ambient environment through convection, provide the boundary condition at z=L.
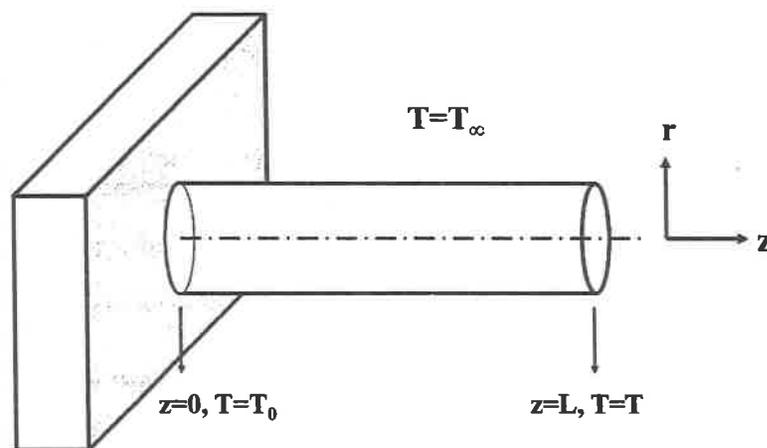
6. **(20%)** In a binary component mass transfer system, the molar concentration and component velocity of component A are C_A and v_A, respectively, while those of component B are C_B and v_B. The molar average velocity of the mass transfer system is V.

(1) **(10%)** Please derive the relationship between the mass transfer flux representing component A, namely N_A and J_A.

(2) **(10%)** If the mass transfer in this binary component system can be regarded as equimolar counter diffusion, with the partial pressure of component A being 1 atm at x=0 m and 0.1 atm at x=0.1 m, the temperature is 298 K, the diffusion coefficient of component A is 2.41×10^{-5} cm²/s, and the gas constant is 0.08205 m³·atm/kgmol·K. What is the value of the mass transfer flux N_A for component A ?