

## 國立臺灣科技大學 106 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)

1. (15 points) Define the following dimensionless groups and also show the relationship between them. Please carefully indicate the meaning of each symbol you used.
  - (a) (3 points) Prandtl number
  - (b) (3 points) Nusselt number
  - (c) (3 points) Stanton number
  - (d) (3 points) Reynolds number
  - (e) (3 points) The relationship between the above dimensionless groups
  
2. (15 points) Derive the convective heat transfer flux in  $r$  direction ( $q_r$ ) from a solid sphere with radius  $R$  and surface temperature of  $T_0$  to an infinite medium with bulk temperature  $T_\infty$ . Assume that there is no bulk flow.  $r$  represents radial distance from the center of the sphere.
  
3. (20 points) A 100 kg batch of granular solids containing 30 per cent moisture is to be dried in a tray drier to 20 per cent of moisture by passing a current of air at 350 K tangentially across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is  $0.001 \text{ kg/s m}^2$  and the critical moisture content is 15 per cent, calculate the approximate drying time. Assume the drying surface to be  $0.03 \text{ m}^2/\text{kg dry mass}$ .
  
4. (36 points) A Newtonian and incompressible fluid is confined between two vertical plates (the  $xz$ -plane). The fluid density is  $\rho$  and fluid viscosity is  $\mu$ . The distance between two plates is  $B$ , and the length and width of plates are  $L$  and  $W$ , respectively. The left plate moves in the positive  $x$  direction with constant velocity  $v_0$ , while the right plate is stagnant. The pressure gradient along the flow direction,  $(\frac{\partial P}{\partial x})$ , between two plates is proportional to the fluid velocity with the constant of proportionality as  $-1$ .
  - (a) (7 points) Derive the governing equations and list the assumptions or conditions you use to simplify these equations.
  - (b) (4 points) List the boundary conditions.
  - (c) (12 points) Derive the velocity profile.
  - (d) (4 points) Find the average velocity.
  - (e) (9 points) Find the shear force on solid surfaces.
  
5. (14 points) Dimensional analysis is to be used to correlate data on bubble size with the properties of the liquid when gas bubbles are formed by a gas issuing from a small orifice below the liquid surface. Derive the dimensionless groups in the process of bubble formation. Assume that the significant variables are bubble diameter  $D$ , orifice diameter  $d$ , liquid density  $\rho$ , surface tension  $\sigma$ , liquid viscosity  $\mu$ , and gravitational acceleration  $g$ . Select  $d$ ,  $\rho$  and  $g$  as the core variables.

