

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

(1) Please explain following terms

- (a) Boundary layer thickness (5%)
- (b) Drag coefficient (5%)
- (c) Friction coefficient (5%)
- (d) Flow separation (5%)
- (e) Kármán vortex trail (5%)
- (f) Boussinesq eddy viscosity (5%)

(2) The hydraulic radius ( $R=A/P$ ) is defined as the ratio of the cross-sectional area ( $A$ ) to the wetted perimeter of the conduit ( $P$ )

- (a) Explain the physical meaning of  $R$  (10%)
- (b) Use Bernoulli equation and momentum equation to prove that  $R=D/4$  for an incompressible, fully-developed, pressurized pipe flow with pipe diameter  $D$  (15%)

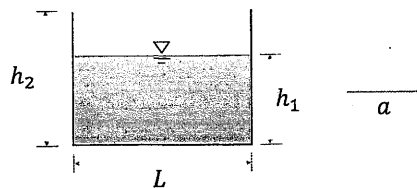
(3) Considering two dimensional, incompressible, steady flow condition. The x-direction Navier-Stoke equation can be expressed as:

$$u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = -\frac{1}{\rho} \frac{\partial P}{\partial x} + \frac{\mu}{\rho} \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right)$$

- (a) Let  $l$  denotes the boundary layer thickness,  $u_\infty$  denotes the velocity not affected by boundary. Please use  $l$  and  $u_\infty$  to non-dimensionalize the equation above (15%)
- (b) Please discuss the criteria when the viscosity force can be neglected (10%)

(4) A rectangular tank has  $L$  in length,  $h_2$  in high, and water level  $h_1$  when steady.

- (a) Under the condition that the water in tank does not spill out, determine the maximum allowable acceleration  $a$  in the following figure (10%)



- (b) If the water surface is covered by a lid, determine the pressure distribution the water acting upon the lid under the accelerations  $a$  and  $b$  in the following figure (10%)

