

※ 考生請注意: 本試題 可 不可 使用計算機 (不可使用電子字典)

(You may write your answers in either Chinese or English or both)

- (20%) Air passes an obstacle in a circular tunnel of diameter 2m and exits as a free jet as shown in Figure 1. At upstream, the velocity is uniform with the gage pressure of 50 Kpa, while the velocity at exit is non-uniform as indicated. Neglect the shear effects along the pipe wall and determine (a) the momentum and energy coefficients at exit; (b) the mass, momentum and kinetic energy fluxes at both upstream and exit. Also, calculate (c) the force on the obstacle; (d) the head loss through the obstacle. (每題 5分)

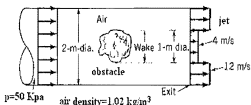


Figure 1

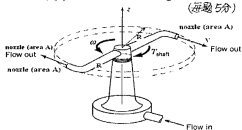


Figure 2

- (15%) The garden sprinkler (in Figure 2) rotates at an angular velocity $\omega=800$ rpm when the water (of density 1000 kg/m^3) leaves from nozzle exits at the velocity $V=15 \text{ m/sec}$. The radii of nozzle arms are $R=20 \text{ cm}$ and the nozzle sectional areas are $A=30 \text{ mm}^2$. Please calculate (a) the jet velocity at the nozzle; (b) the volume flow rate Q ; (c) the shaft torque T_{shan} ; (d) the shaft power W_{shan} . (每題 3分, 共 4分)
- (15%) Hele-Shaw flow between two parallel plates is described by the flow stream function $\psi = Axy$ where A is a positive constant and (x, y) are the Cartesian coordinates of fluid particle. If we consider the pure water in this flow and put an additional mass source of another immiscible fluid at the origin of strength m , please determine the location of stagnation points and build up the expression for interface shape as $y=h(x)$ of these two fluids by using A and m .
- (20%) For a fully developed flow, consider the laminar fluid flow of dynamic viscosity μ and density ρ in a long circular pipe of diameter D and length L . (a) Please derive velocity profile $u(r)$ at a point of radius r as the function of pressure drop Δp . (b) What is the shear stress on pipe wall? (c) If we replace by another fluid of density ρ_1 and density μ_1 , the results above are changed accordingly. However, why they are not affected by the density ρ_1 ? (d) What is acceleration in the pipe? (每題 5分)
- (18%) Write down the dimensions of following quantities in (F, L, T) system on your answer sheets (a) shaft power; (b) rate of shear strain; (c) dynamic viscosity; (d) surface tension (coefficient); (e) fluid density; (f) rate of heat transfer; (g) flow pressure; (h) velocity head; (i) Reynolds number. (每題 2分)
- (12%) Explain shortly the following terms on your answer sheet. (Note they are not for translation.) (a) pressure drag and viscous drag; (b) displacement thickness; (c) Archimedes principle of buoyancy; (d) centripetal acceleration; (e) Eulerian and Lagrangian descriptions; (f) Reynolds similarity law. (每題 2分)