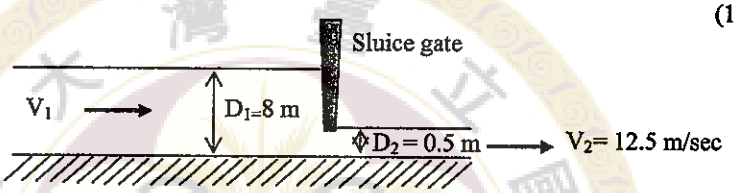
1. Explain the following terms:
   (a) Ideal fluid (5 points)
   (b) Newtonian fluid (5 points)

2. Write the Navier-Stoke equation describing an incompressible viscous flow, and explain the meaning of each term in the equation.

   (10 points)

3. Water flows under a sluice gate on a horizontal, rectangular channel. Flow is frictionless and uniform. The depth of the upstream is 8 m. Water discharges with a flow velocity of 12.5 m/sec under the sluice gate in a 0.5 m deep flow. Use the Bernoulli equation to determine the velocity of the upstream.

   (15 points)



4. Water flows in a rectangular channel on a bed slope of 0.0005. The flow rate is 200 m^3/sec and n is 0.022. Determine the required dimensions of the best hydraulic cross section (The normal depth should be one-half the width of the channel bottom).

   (15 points)

5. A Newtonian fluid with viscosity μ flows in one dimension with horizontal (x direction) velocity u which varies vertically (y direction).
   (a) Write an expression (equation) describing the shear stress τ exerted in the x-direction on a fluid surface at y is.
   (b) Also give the units of μ, u and τ.

   (10 points)

6. A Newtonian fluid of density ρ and viscosity μ flows downward (z-direction) in cylindrical pipe of radius R. At vertical upstream position z = 0 and downstream position z = L, the static pressures are p_0 and p_L, respectively. The gradient of laminar flow velocity (u_z) in z-direction with respect to radius direction r can be describe as
   $du_z/dr = -[(p_0 + \rho gL) - p_L]r/(2\mu L)$
   (a) Obtain the velocity distribution of u_z at various r.
   (b) Calculate the maximum velocity $u_{z,max}$.
   (c) Compute the average velocity $u_{z,avg}$.
   (d) Calculate the volume rate of flow Q.
   (e) Compute the force of the fluid on the wetted surface of the pipe F_z.
   (f) Define a proper Reynolds number of the pipe flow system.

   (30 points)

7. A sphere solid with radius R and density ρ_s is allowed to fall from rest in a viscous fluid with density ρ and viscosity μ and accelerate until it reaches a constant (terminal) velocity u_t.
   (a) Make a force balance on the sphere solid if the drag force F_d can be describe by the Stokes's law with $F_d = 6\pi\mu R u_t$. .
   (b) Compute the μ.

   (10 points)

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