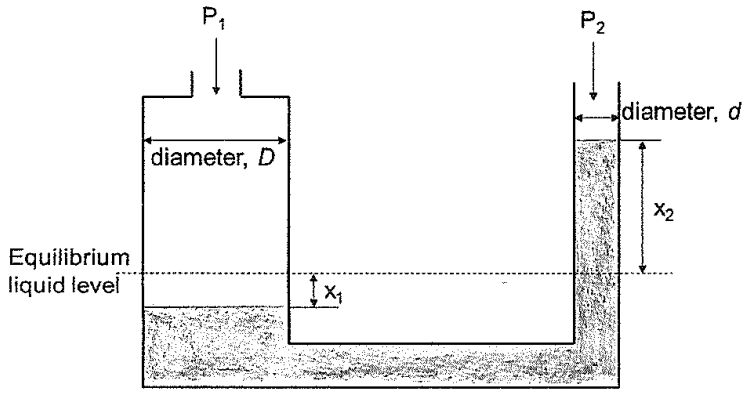
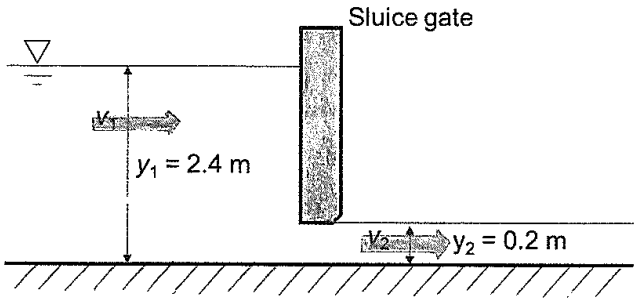
1. Explain the following terms:
(a) Navier-Stoke equation (5 %)
(b) Euler's equation (5 %)
(c) Newtonian fluid (5 %)

2. (a) A reservoir manometer is built with tube diameter of ***d*** and a reservoir diameter of ***D***. The density of liquid through the manometer is ρ. Derive an equation for the pressure difference (P_1 - P_2) in terms of (ρ, g, x_2, d, D). (8 %)
(b) If the manometer liquid is oil with specific gravity of 0.8, d = 10 mm, and D = 30 mm, calculate the pressure difference in unit of SI. (5 %)



3. Water flows under a sluice gate on a horizontal bed at the inlet to a flume as shown. The water depth of the upstream and the downstream of the gate is 2.4 m and 0.2 m, respectively. The flow may be considered to be frictionless, uniform at each section. Calculate the flow speed, upstream and downstream of the gate. (10 %)



4. Water flows in an open channel of a trapezoidal shape at a normal depth of 1.6 m. The bottom width is 3.2 m and the sides slope at 1:1 (45°). The flow rate is 8.2 m^3/sec. The channel wall is smooth, uniform earth with a Manning roughness coefficient (n) of 0.022. Find the bed slope. (12 %)

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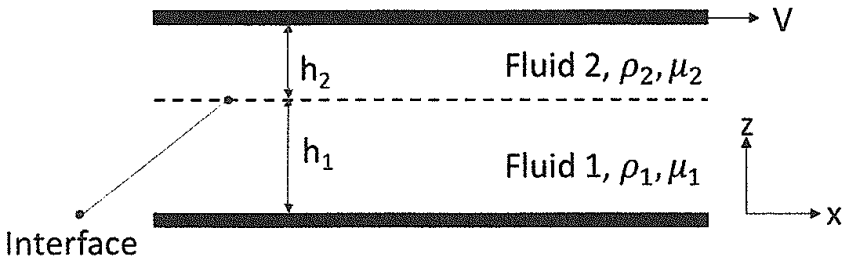
5. (a) The viscous torque produced on a disc rotating in a liquid depends upon the characteristic dimension D, the speed of rotation n, the density ρ and the dynamic viscosity μ. Show the dimensionless equation linking these quantities. (10%)
(b) In order to predict the torque on a disc 0.5 m diameter which rotates in oil at 200 rpm, a model is made to a scale of 1/5. The model is rotated in water. Calculate the speed of rotation for the model which produces dynamic similarity. (Oil's density and dynamic viscosity are 750 kg/m^3 and 0.2 N·s/m^2, respectively; water's density and dynamic viscosity are 1000 kg/m^3 and 0.001 N·s/m^2, respectively) (10%)
(c) When the model is tested at 18.75 rpm the torque was 0.02 N·m. Predict the torque on the full-size disc at 200 rpm. (5%)

6. Consider a modified form of Couette flow in which there are two immiscible fluids sandwiched between two infinitely long and wide, parallel flat plates. The flow is steady, incompressible, parallel, and laminar. The top plate moves at velocity V to the right, and the bottom plate is stationary. Gravity acts in the -z direction (downward). There is no forced pressure gradient pushing the fluids through the channel—the flow is set up solely by viscous effects created by the moving upper plate. You may ignore surface tension effects and assume that the interface is horizontal. The pressure at the bottom of the flow (z = 0) is equal to P_0. (a) Solve for the velocity field. (b) Solve for the pressure field. (15%)



7. In a certain steady, incompressible, inviscid, two-dimensional flow field ($w = 0$, and all variables independent of z) the x component of velocity is given by $u = x^2 - y$. Will the corresponding pressure gradient in the horizontal x direction be a function only of x, only of y, or of both x and y? Please Justify your answer. (10%)

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