1. A sphere solid with radius R and density ρ_s is moving through a viscous fluid with a relative velocity V_r. The fluid has density ρ and viscosity μ. (15%)
a. Find the drag force F_d on the solid if the system obeys the Stokes's law.
b. Obtain the drag coefficient C_d.

2. Consider a sphere solid carried by a fluid with density ρ and viscosity μ entering into a horizontal parallel plates duct with vertical height of H and length of L. The flow in the duct is laminar flow with bulk velocity of V_0. The solid enters from the entrance at a position (x, y) with distance y = h above the bottom plate in vertical y-axis and x = 0 in horizontal x-axis. The solid is assumed to have a constant vertical settling velocity U_y. (20 %)
a. Obtain the horizontal velocity (V_x) and vertical velocity (V_y) of the fluid.
b. Find the horizontal velocity (U_x) of the solid.
c. Derive an equation describing the trajectory (position) of solid in the duct during its moving.
d. What is the criterion or limitation of h/H for assuring the collection of solid before it flows out the duct?

3. An open cylinder tank of height H and radius R is initially entirely filled with a fluid. At time t = 0 the fluid is allowed to drain out through a small hole of radius R_0 at the bottom of the tank. (15 %)
a. Find the efflux velocity (the velocity of fluid drained out at the small hole) which is related to the instantaneous height of the fluid.
b. Find the efflux time to completely drain out the fluid by using the unsteady-state mass balance.

4. The sum of the depth of flow and the velocity head is defined as the specific energy for open-channel flow. If one rectangular canal has 10 M width and 10 CMS flowrate, (1) Draw the specific energy curve (depth vs. specific energy), (2) Explain the critical depth and alternate depths. (20%)

5. The pipe-flow relationship of the pipe network can be expressed by $h_L = kQ^n$, where k, n are constants, Q is the flowrate, and h_L is the head loss. (1) Write down two requirements of the basic relations of continuity and energy for analysis of flow in a pipe network, (2) Explain the Hardy Cross method. (20%)

6. A steady velocity field can be expressed in the form:

$$\vec{V} = x^2\hat{i} + xy\hat{j} \ ,$$

and $\hat{i}, \hat{j}$ are the unit vectors of a rectangular coordinates, what is the fluid acceleration at point $x = 1,\ y = -1$? (10%)

試題隨卷繳回