CEL459: River Mechanics

Major

Marks: 40

Time: 2 Hours

Assume missing data suitably. Equation hints are given at end.

Solve the following:

Q.1 Derive the correlation for concentration profile in the flow of multisized particles through pipeline with all the intermediate steps. [6]

Q.2 Derive the following expression for multisized particulate flow through open channel:

$$G_j = \frac{\overline{v_j}}{\left[1 - e^{-K_j H}\right]} H K_j$$

The notations have their usual meaning. [4]

Q.3 Find out the concentration of solids at 20cm above bottom in an open channel using the following data: Flow depth = 25 cm; Flow velocity = 2.5 m/s; Bed slope = 0.001; Channel width = 20 cm; Solids specific gravity = 2.65 (sand). Carrier fluid is water. Solids size consist:

Mean diameter (cm)	Percent by weight	Fall velocity w_{jo} (m/s)
0.00300	40	0.0055
0.00100	20	0.0025
0.00025	40	0.0015

Slurry concentration = 12 % by volume. Static settled concentration = 55% by volume. [6]

Q.4 (a) Explain the experimental method with equations involved in the determination of static settled concentration. [3]

(b) Plot shear stress vs. shear rate curves for thixotropic and rheopectic fluids. [3]

Q.5 (a) Derive the expression for friction factor in laminar flow of Newtonian and Power-law fluid through pipeline. [6]

(b) Derive the expression for discharge in laminar flow of Bingham-Plastic and Herschel-Bulkley fluid through pipeline. [6]

Q.6 Determine the type of flow (laminar or turbulent) for the following data: [6]

Flow Rate (Q)	m^3/hr	600
Pipe Inside Diameter (D)	mm	250
Herschel-Bulkley Yield Stress (τ_{YH})	Pa	6.0
K	Pa.s	0.035
n	-	0.95
Slurry Density (ρ)	kg/m^3	1160
Wall Shear Stress (τ_w)	Pa	9.2

$\epsilon_s = 0.1 H u_*$ $\beta = 1.0 + 0.125\, e^{4.22 C_v / C_{vs}}$

$$\frac{8\rho V_m^2}{\tau_{yH} + K\left(\frac{8V_m}{D_{inner}}\right)^n} \quad ; \quad \pi R^3 n \left(\frac{\tau_w}{K}\right)^{1/n} (1-\phi)^{(n+1)/n} \left\{\frac{(1-\phi)^2}{3n+1} + \frac{2\phi(1-\phi)}{2n+1} + \frac{\phi^2}{n+1}\right\}$$

$$\frac{nR}{(n+1)}\left(\frac{\tau_w}{K}\right)^{1/n} (1-\phi)^{(n+1)/n}$$