CEL459: River Mechanics
Major

Time: 2 Hours **Marks: 40**

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

$\varepsilon_j = 0.1\,Hu_*$ $\qquad \beta = 1.0 + 0.125\ e^{4.22 C_{vf}/C_{vss}}$

$$\frac{8\rho V_{ann}^2}{\tau_{jH} + K\left(\frac{8V_{ann}}{D_{shear}}\right)^n}$$

;

$$\pi R^3 n \left(\frac{\tau_w}{K}\right)^{1/n} (1-\phi)^{(n+1)\cdot n} \left\{\frac{(1-\phi)^2}{3n+1} + \frac{2\phi(1-\phi)}{2n+1} + \frac{\phi^2}{n+1}\right\}$$

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