CEL459: River Mechanics
Minor I

Time: One Hour **Marks: 20**

Solve the following. Assume the missing data suitably.

Q.1 (a) Describe different flow regimes in slurry flow through a pipeline. **[2]**

(b) Describe the basic slurry pipeline transportation system. **[2]**

Q.2 Derive the equation for sediment concentration profile considering particle diffusivity ε as (a) constant (b) variable. **[4]**

Q.3 Plot shear stress vs. shear rate curves for different type of fluids: **[4]**

Q.4 Determine the type of flow and the pressure drop per meter of pipe length for the following data:

Flow Rate (Q)	m^3/hr	800
Pipe Inside Diameter (D)	mm	250
Bingham Yield Stress (τ_{YB})	Pa	6.0
Plastic viscosity (η_P)	Pa.s	0.03
Slurry Density (ρ)	kg/m^3	1250
Wall Shear Stress (τ_w)	Pa	9.0

[4]

Q.5 Derive the expression for discharge in laminar flow of Herschel-Bulkley fluid through pipeline. **[4]**

Bingham Plastic – Laminar Friction Factor:

$$R_{BP} = \frac{DV\rho}{\eta_P} \text{ and } He = \frac{D^2\tau_{YB}\rho}{\eta_P^2} \text{ and } f_{fL} = \frac{16}{R_{BP}}\left[1 + \frac{He}{6R_{BP}} + \frac{He^4}{3f_f^3 R_{BP}^7}\right]$$

Bingham Plastic – Turbulent Friction Factor:

$$f_{fT} = 10^a R_{BP}^b \quad where \quad a = -1.47\left[1 + 0.146\exp(-2.9\times10^{-5}He)\right] and\ b = -0.193$$

Bingham Plastic – Combined Friction Factor:

$$f_f = (f_{fL}^m + f_{fT}^m)^{1/m} \quad where \quad m = 1.7 + \frac{40000}{R_{BP}}$$

Hints:

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

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

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