CEL459: River Mechanics
Minor II

Time: 1 Hour **Marks: 20**

Assume suitably if some data are missing.

Solve the following:

Q.1 (a) Define the bed load and draw different bed forms. [3]

(b) 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. [3]

Q.2 Find out the concentration of solids at 8 cm above bottom in an open channel using the following data: Flow depth = 20 cm; Flow velocity = 2.0 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)
0.00400	40	0.0065
0.00100	20	0.0025
0.00020	40	0.001

Slurry concentration = 10 % by volume;

Static settled concentration = 50% by volume. [6]

Q.3 Using Meyer-Peter equation, determine the bed slope of a wide alluvial channel from the following data:

Discharge = 40 m^3/s

Bed load concentration = 0.05 % by volume

d_{50} = 0.35 mm

Specific gravity of grains = 2.65

Manning's n = 0.0225

Width of the channel = 30 m.

Also, compute the sediment concentration at 2 cm above channel bottom using fall velocity $w_o = 0.05$ m/s, $\beta = 1$, $k = 0.4$ and $\nu = 1.01 \times 10^{-6}$ m^2/s. [3]

Q.4 Determine the bed form geometry and its classification for an alluvial river flow depth of 2.5 m, bed slope of 7.0 cm/km, average flow velocity 0.95 m/s, sediment sizes d_{50} = 0.3 mm and d_{90} = 1.5 mm. Also determine the bed form shear stress (τ_o''). [5]

$$\tau_c = 0.155 + \frac{0.409 d_{50}^{2}}{\sqrt{1+0.177 d_{50}^{2}}} N/m^2; d_{50}(mm).$$

$$n' = \frac{1}{24} d_{50}^{1/6};$$ d_{50} is in m

$$g_b = 0.417(\tau_o' - \tau_c)^{3/2}; \quad C_{2d} = \frac{q_b}{23.2 V^{*'} d_{50}};$$

$$\frac{C}{C_a} = \left[\frac{a(H-y)}{y(H-a)}\right]^{\frac{w_0}{\beta \kappa V_*}}$$

$$\frac{\Delta}{H} = 0.11\left(\frac{d_{50}}{H}\right)^{0.3}(1-e^{-0.5T})(25-T); \quad x = 7.3H;$$

$$d_* = d_{50}\left[\frac{(G-1)g}{\nu^2}\right]^{1/3}$$

$$T = \frac{\tau_o'}{\tau_c} - 1; \quad K_s = 3d_{90} + 1.1\Delta(1-e^{-25\Delta/x});$$

$$C = \sqrt{\frac{8g}{f}} = 5.75\sqrt{g}\log_{10}\left(\frac{12R}{K_s}\right)$$

$$n = \frac{1}{C} R^{1/6}$$

$d_* \le 10$ & $T \le 3$: Ripples;

$T \le 15$: Dunes;

T= 15 to 25: Wash out dunes or transition

T is more than 25: Upper regime

$$\varepsilon_l = 0.4 u_* y(1 - \frac{y}{H}) \text{ for } 0 \le \frac{y}{H} \le 0.5$$

$$\varepsilon_l = 0.1 H u_* \text{ for } 0.5 \le \frac{y}{H} \le 1.0$$

$$\beta = 1.0 + 0.125\ e^{4.22 C_{vf}/C_{vss}}$$