CEL734: Advanced Hydraulics
Major

Time: 2 Hours **Marks: 40**

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

Solve the following:

Q.1 (a) Derive the expression for discharge in laminar flow of Herschel-Bulkley fluid through pipeline. **[5]**

(b) Derive the correlation for concentration profile in the flow of multisized particles through pipeline considering diffusivity and fall velocity of particles as constant across the pipe cross-section describing all the intermediate steps. **[8]**

Q.2 Determine the pressure drop using Wasp model for the following sediment flowing through a smooth pipe of 25 cm diameter at flow velocity of 2.5 m/s :
Solids specific gravity = 2.65 (sand). Carrier fluid is water.
Solids size consist:

Mean diameter (cm)	Percent by weight	Fall velocity in water w_{jo} (m/s)	C_D
0.0400	40	0.0055	5
0.0100	20	0.0015	35
0.0020	40	0.0005	850

Slurry concentration = 20 % by volume. Static settled concentration = 55% by volume.
Make use of iterative procedure. **[8]**

Q.3 Derive the following expression for multisized particulate flow through open channel:

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

The notations have their usual meaning. **[3]**

Q.4 Find out the concentration of solids at the mid-depth in an open channel using the following data: Flow depth = 30 cm; Flow velocity = 2 m/s; Bed slope = 0.0015; Channel width = 20 cm; Solids specific gravity, Carrier fluid, PSD, Slurry concentration and Static settled concentration is similar to that in Q2. **[6]**

Q.5 Determine the bed load transportation rate by volume for the channel and bed material given in Q.4 using DuBuoy's and Meyer-Peter's equation. **[4]**

Q.6 Using Meyer-Peter equation, determine the bed slope of a wide alluvial channel from the following data:
Discharge = 50 m^3/s
Bed load concentration = 0.2 % by volume
d_{50} = 0.325 mm
Specific gravity of grains = 2.65
Manning's n = 0.0225
Width of the channel = 20 m.
Also, compute the sediment concentration and derive the formula used at 3 cm above channel bottom using fall velocity w_o = 0.045 m/s, β = 1, k = 0.4 and $\nu = 1.01 \times 10^{-6}$ m^2/s. **[6]**