Major Exam: CEL251 (Hydraulics and Hydrology) Max^m Marks : 50

Part A All questions carry equal marks

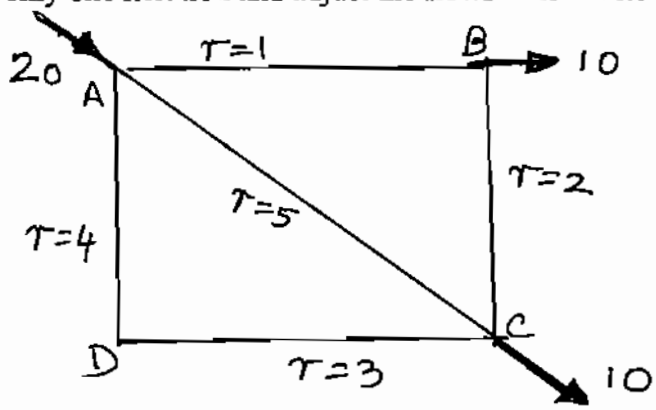
Q(1). Assume the shear stress ζ varies linearly in a laminar boundary layer such that $\zeta = \zeta_0 (1 - y/\delta)$, where ζ_0 is the shear stress at y=0. Show that the average drag coefficient on a flat plate of unit width and length L is $C_d = C/(Re_L)^n$, where $Re_L = UL\rho/\mu$. Determine the values of the constants C and n. Take dP/dx=0.

Q(2)

(a) At a section in a wide rectangular channel, the depth is 1.0 m and the velocity is 3.6 m/s. If a hydraulic jump occurs, would it be upstream or downstream of this section? Explain

(b) Water flows 2.4 m deep in a rectangular channel 3.6 m wide at a rate of 62 m^3/s. At what other depth could the water flow with the same speeific force?

Q(3) Determine the flow through all the pipes in the network shown below by the Hardy Cross Method. Do only one iteration and adjust the flows after the iteration.



Q(4) A rectangular channel 2 m wide has a flow of 2.4 m^3/s at a depth of 1.0 m. A hump of height 20 cm is installed across the channel bed at a location where the channel width is reduced to 1.7 m. Determine if critical depth occurs at the hump. Neglect the head losses at the hump and constriction caused by friction, expansion and contraction.

Q(5) Direct measurements indicate that for fully developed turbulent flow in a circular tube of relative roughness of 0.0018 and a smooth tube at Re=82000, the average velocity 'V' corresponds to the actual velocity '$\bar{u}$ at y/R = 0.25.

At what value of y/R is the actual velocity '$\bar{u}$' equal to the average veloeity 'V' for the power-law velocity profile $\bar{u}/U_m = (y/R)^{1/7}$

Formulas:

$d\theta/dx + (2\theta + \delta^*)(1/U)(dU/dx) = \tau_0 / \rho U^2$

$y_2/y_1 = (1/2)((1+8\,Fr_1^2)^{0.5} - 1)$

~~$Q = r h_L^2$~~, $\Delta Q = -\sum h_L / \sum(2 r Q_0)$

$h_L = rQ^2$

Major CEL251 Part B: Hydrology

Max. Marks 30

Q. 1 A coefficient of variation = 0.3 was observed in the rainfall data of 16 stations in a catchment. Determine % error within which the existing raingauges are sufficient to estimate the average rainfall in the catchment. Also find the number of surplus or deficit raingauges in the catchment if permissible error in the estimation of the mean rainfall is limited within 9%. (**2** Marks)

Q. 2 Estimate the vapour pressure at a place at which temperature and relative humidity were recorded as 35° C and 35% respectively. [$x = 610.78\exp(17.27\, y/(237.3 + y))$] (**2** Marks)

Q. 3 Derive the following Green-Ampt equation for flow through unsaturated porous media: $F(t) = Kt + \psi\Delta\theta \ln\left(1 + F(t)/\psi\Delta\theta\right)$. Also deduce corresponding relation for infiltration rate f and compute its value after 34 minutes of infiltration into a soil having suction head = 16.7 cm, K = 0.65 cm/h, porosity = 60% and initial moisture content = 16%. (**6** Marks)

Q. 4 The 10-minute triangular unit hydrograph from a catchment has a peak discharge of 100 $m^3/s.cm$ at 40 min and a total duration of 140 min. Calculate the streamflow hydrograph from this catchment for a storm in which 2 cm of rain falls in the first 10 minutes and 1 cm in the second 10 minutes, assuming that the loss rate is φ = 3.0 cm/hr and the baseflow rate is 20 m^3/s. What is the watershed area? (**10** Marks)

Q. 5 What are the basic differences between the Pul's and Goodrich's methods of reservoir routing? Route a triangular flood hydrograph (peak discharge of 360 m^3/s at 60 min and a total duration of 150 min) through a reservoir having relation between O and $O + 2S/\Delta t$ as shown in graph.
Initially the reservoir was empty. (**10** Marks)