7. Derive the differential equation of GVF and also write the basic assumptions involved in the analysis of it.

8. Water from a low dam is released through a sluice gate on a horizontal rectangular channel. The depth of water upstream of the sluice gate is 16·0 m above the channel bed and the gate opening is 1·5 m. The sluice gate can be assumed to be sharp-edged. If a free hydraulic jump is formed just downstream of the gate, find the sequent depth and the percentage of the initial energy lost in the jump.

9. Write short notes on any *three* of the following :

   (a) Boundary-layer thickness

   (b) Specific energy

   (c) Hydraulically efficient channel

   (d) Causes of unsteady flow

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B.Tech. 4th Semester Exam., 2015

HYDRAULICS AND OPEN CHANNEL FLOW

Time : 3 hours *Full Marks* : 70

Instructions :

(i) All questions carry equal marks.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any *seven* questions from the following :

   (a) The boundary layer exists in which of the following?

      (i) Flow of real fluids

      (ii) Flow of ideal fluids

      (iii) Flow over flat surfaces only

      (iv) Pipe-flow only

(b) When the fluid flows along the solid boundary, more and more fluid gets retarded in the vicinity of the boundary; this deceleration is due to

(i) high velocity of the fluid

(ii) high velocity flow outside the boundary layer

(iii) high velocity gradients which exist at and near the boundary

(iv) None of the above

(c) Piezometric head is the sum of

(i) pressure head, datum head and velocity head

(ii) datum head and velocity head

(iii) pressure head and velocity head

(iv) pressure head and datum head

(d) In the uniform flow in a channel of small bed slope, the hydraulic grade line

(i) coincides with the bed

(ii) is considerably below the free surface

(iii) is considerably above the free surface

(iv) essentially coincides with the free surface

(e) The term alternate depths is used in open channel flow to denote the depths

(i) having the same kinetic energy for a given discharge

(ii) having the same specific force for a given discharge

(iii) having the same specific energy for a given discharge

(iv) having the same total energy for a given discharge

(f) In a parabolic channel ($x^2 = 4ay$), the value of E_c / y_c is

(i) 1·5

(ii) 2·0

(iii) 3·33

(iv) 1·25

(g) The dimensions of Manning's n are

(i) $L^{\frac{1}{6}}$

(ii) $L^{\frac{1}{2}}T^{-1}$

(iii) $L^{-\frac{1}{3}}T$

(iv) $L^{-\frac{1}{3}}T^{-1}$

(h) The hydraulic jump is a phenomenon

(i) in which the water surface connects the alternate depths

(ii) which occurs only in frictionless channels

(iii) which occurs only in rectangular channels

(iv) None of the above

(i) The standard-step method aims to solve

(i) the differential equation of GVF

(ii) the Bernoulli equation

(iii) the differential energy equation of GVF

(iv) the momentum equation

(j) If the Froude number of a hydraulic jump is 5·50, it can be classified as

(i) an oscillating jump

(ii) a weak jump

(iii) a strong jump

(iv) a steady jump

2. If velocity distribution in laminar boundary layer over a flat plate is assumed to be given by second-order polynomial $u = a + by + cy^2$, determine its form using the necessary boundary conditions. 14

3. An expansion in a horizontal rectangular channel takes place from a width of 2·0 m to 3·0 m. The depths of flow for a discharge of 7·2 m^3/s are 1·2 m and 1·4 m in the narrower and wider sections respectively. Estimate the energy loss in the transition. Assume the kinetic energy correction coefficient α to have values of 1·05 and 1·15 at the inlet and outlet of the transition, respectively.

4. Explain critical-flow condition and define critical depth. A parabolic channel has its profile given by $x^2 = 4ay$. Obtain an expression for the relative specific energy at the critical flow, E_c / y_c for this channel.

5. Derive the Chezy resistance formula. Discuss the resistance formula for practical use. What are the factors that affect the Manning's roughness coefficient, n?

6. The specific energy in a 2·0 m wide rectangular channel is not to exceed 1·2 m. What maximum discharge can be carried in such a channel? What longitudinal slope is required to sustain such a flow? Assume, Manning's $n = 0·015$.