(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0043 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. VIII) EXAMINATION, 2006-07

OPEN CHANNEL FLOW

Time : 3 Hours] *[Total Marks : **100***

Note : *(1) Attempt **all** the questions. All questions carry **equal** marks.*

(2) Use illustrations, wherever needed.

(3) Assume missing data suitably, if any, and state the assumptions made.

1. Attempt any **four** parts of the following : **5×4 = 20**

(a) Differentiate between the following with neat sketches :

(i) Rapidly varied flow and spatially varied flow?

(ii) Prismatic and non-prismatic channels.

(b) **Figure – 1,** shows a free overfall in a horizontal frictionless rectangular channel. Assuming the flow to be horizontal at section 'O' and the pressure at the brink section 'e' to be atmospheric throughout the depth, show that

$$\frac{y_e}{y_0} = \frac{2f_0^2}{\left(2f_0^2 + 1\right)}$$

where $f_0^2 = \dfrac{q^2}{g y_0^3}$ and q = discharge per unit width.

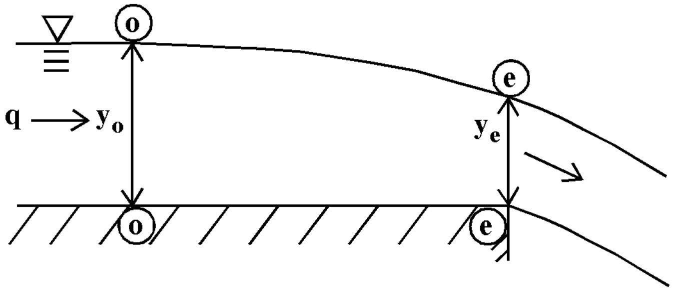

Fig. 1

(c) For a rectangular channel of width B=2.0 m, calculate the critical depth and the corresponding specific energy for a discharge of 6.0 m^3/s.

(d) A rectangular channel section is to have critical flow and at the same time the wetted perimeter is to be minimum. Show that these two conditions to occur simultaneously, the width of the channel must be equal to 8/9 times the minimum specific energy head.

(e) Prove that for a most economical section of a trapezoidal channel :

(i) Half of top width = length of one of sloping sides.

(ii) Hydraulic mean depth = half of depth of flow.

(f) A triangular channel with an apex angle of 60^{o} carries a flow of 1.2 m^3k at a depth of 0.80 m. If the bed slope is 0.009, find the roughness coefficient of the channel.

2. Attempt any **two** parts of the following : **10 × 2 = 20**

(a) Derive the differential equation of G.V.F. in a rectangular channel of variable width *B* with stating assumptions, in the following form :

$$\frac{dy}{dx} = \frac{s_o - s_f + \left(\frac{Q^2 y}{gA^3} \frac{dB}{dx}\right)}{1 - \frac{Q^2 B}{gA^3}}$$

And hence show that for a horizontal, frictionless rectangular channel of varying with B, it reduces to

$$\left(1 - f^2\right) \frac{dy}{dx} - f^2 \left(\frac{y}{B}\right) \frac{dB}{dx} = 0$$

where f = Froude number.

(b) Explain the graphical integration method for solving the G.V.F. equation for prismatic channels of irregular shape.

A rectangular channel 15.0 m wide and 10.0 km long has a slope of 10^{-4} and connects two lakes. The water depths at the upstream and downstream ends of the channel are 1.50 and 2.00 m. respectively. If $n = 0.015$ determine the type of G.V.F profile.

(c) Sketch the possible water surface profile in case of flow from a steep slope to a wild slope?

A rectangular channel 5.0 m wide carries water at a depth of 1.5 m. The bed slope is 10^{-4} and n=0.016. The channel ends in an abrupt drop. Find using Chow's method, how far upstream of the fall the depth of flow would be 1.4 m.

Given : first hydraulic exponent 'M'=3.0 and second hydraulic exponent 'M=3.0'.

3. Attempt any **two** parts of the following : **10×2 = 20**

(a) Derive the differential equation of spatially varied flow (S.V.F) with decreasing discharge. Clearly state the assumption made.

(b) A horizontal rectangular lateral spillway has a free overfull outlet. The inflow is uniformally distributed along the channel with a rate of q* per unit length of the channel. The channel length is 'L'. Prove that the equation of flow is :

$$\frac{dx^2}{dy} - \frac{x^2}{y} = \frac{-gb^2y^2}{q*^2}$$

Hence, show that for the condition of critical depth 'y_c' occurring at the outlet solution will be

$$\left(\frac{x}{L}\right)^2 = \frac{3}{2}\left(\frac{y}{y_c}\right) - \frac{1}{2}\left[\frac{y}{y_c}\right]^2$$

(c) Write short notes on any **two** of the following :

(i) Classification of different types of flows over bottom vacks (with neat sketch).

(ii) Classification of flow profiles for S.V.F with lateral inflows (Li's Classification)

(iii) Standard fourth-order Range–Kutta method for surface profile plotting.

4. Attempt any **four** parts of the following : **5×4 = 20**

(a) Show that in a hydraulic jump formed in a horizontal, frictionless rectangular channel. The energy loss relative to the critical depth 'y_c' can be expressed as

$$\left(\frac{E_L}{y_c}\right)^3 = \frac{(a-1)^9}{32(a+1)a^4}$$

where a = sequent depth ratio = $\frac{y_2}{y_1}$

(b) Give the classification of hydraulic jumps formed in horizontal rectangular channels with neat sketches, stating the relative energy loss.

(c) A hydraulic jump takes place in a horizontal triangular channel having side slopes of 1.5H : 1V. The depths before and after the jump are 0.40 m and 1.50 m respectively. Estimate the flow rate and Froude number at the beginning and end of the jump.

(d) Explain the use of hydraulic jump as an energy dissipator.

(e) A trapezoidal channel is 7.0 m wide at the bottom and the side slopes are 1 H: 1V carries a discharge of 20 cumes. Draw the specific force diagram for this channel.

(f) What is a submerged jump? Hence, detail the submergence factor.

5. Attempt any **two** parts of the following : **10×2 = 20**

(a) How you will determine that the culvert is hydraulically short or hydraulically long? Give the neat sketches of culvert with outlet unsubmerged condition.

(b) Discuss the design consideration for determining the shape of cross section at an open channel bend i.e. a channel of non-linear alignment under the supercritical flow condition.

(c) Write short notes on any **two** of the following :

(i) Characteristics of flow through channel junction.

(ii) Characteristics of flow through sudden transitions in subcritical flow.

(iii) Flow through an obstruction in open channel flow.