M.E. (Water Resources & Hydraulic Engg.) (6 Semester) Examination, 2025

(1st Semester-Supplementary Examination)

FREE SURFACE FLOW

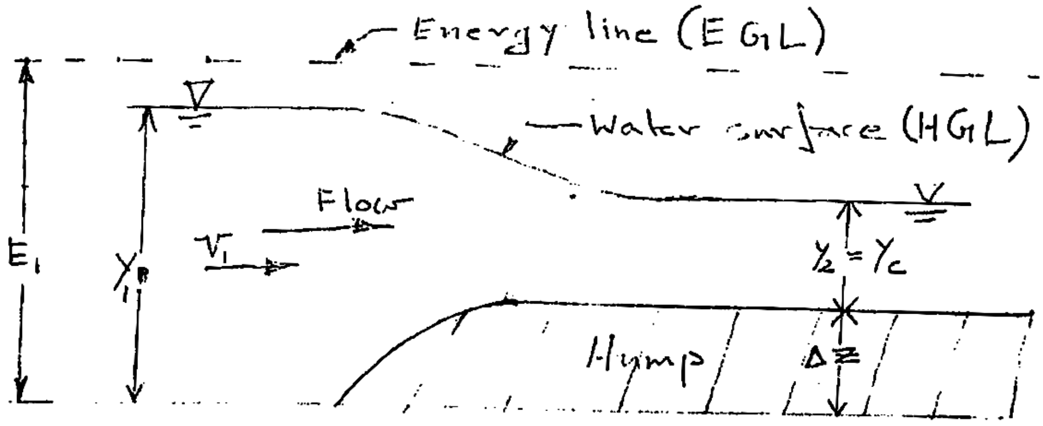
(Paper V)

Time: Three Hours | Full Marks :100

1. (a) What do you mean by (Choked condition) "Chocking" in case of free surface flow?

   (b) With the help of a specific energy curve only show the condition of chocking for a free surface flow over a hump.

   (c) A 2.25 m wide rectangular channel has a flow with a velocity of 1.4 m/s and a depth of 1.3 m. A small hump is to be built at a section to create critical flow conditions over the hump. Calculate (i) the minimum height of the hump required to achieve this and (ii) the resulting change in the water surface elevation.



3+7+12 = 20

2. (a) Deduce an expression of velocity distribution against shear velocity in the fully turbulent flow of hydraulically smooth and rough boundaries cone.

   (b) The bottom sediment of an open channel consists mainly of coarse sand with a medium grain size of 1mm and a specific gravity of 2.65. If the temperature is 20°C, estimate the permissible shear stress at the bottom of the channel.

10+10 = 20

3. (a) An earthen trapezoidal channel (n = 0.025) has a bottom width of 5.0 m, side slopes of 1.5 horizontal: 1 vertical and a uniform flow depth of 1.1 m. In an economic study to remedy excessive seepage from the canal two proposals, viz. (a) to line the sides only, and (b) to line the bed only are considered. If the lining is of smooth concrete (n = 0.012), determine the equivalent roughness in the above two cases.

   (b) Define the terms average velocity for the cross section and correction coefficient.

   (c) What is the principle of conservation of energy, and how does it apply to fluid mechanics?

10+5+5 = 20

[Turn over

4. (a) Water (ν=1.1× 10^{-6} m^2/s at 20^0C) flows in a channel (Ks=2.5 mm) of bottom width 5 m and side slope 1.50 H: 1 V at a depth of 1 m and a slope of 1.3×10^{-4}. Find the mean flow velocity and indicate whether the boundary is smooth, rough, or in transition.
   (b) Deduce an expression for the equivalent/composite roughness of an open channel section.

   12+8 = 20

5. (a) Derive the relationship required for the Standard Step Method from the differential energy equation of GVF
   (b) In a wide river, the depth of flow at a section is 3 m, bed slope is 1 in 10000 and the discharge intensity is 30 m^3/s per meter width. If the Chezy formula with C = 70 is used, estimate the slope of the water surface relative to the bed at that section of the river.

   14+6 = 20

6. (a) Find out the GVF differential equation by Direct Integration Method.
   (b) Find out the basic equation to calculate the water surface elevation in the case of GVF using the Direct Step Method.

   11+9 = 20

7. (a) Derive the basic differential equation of GVF.
   (b) Describe mild and steep type GVF profiles with neat sketches.

   10+10 = 20

8. (a) Establish a relationship between the depths of flow upstream and downstream of hydraulic jump in terms of upstream Froude number (F_1) in the case of a horizontal rectangular channel.
   (b) A hydraulic jump occurs in a rectangular channel and the depths of flow before and after the jump are 0.75 m and 2.25 m respectively. Calculate the critical depth of flow.
   (c) A sluice gate discharges water into a horizontal rectangular channel with a velocity of 10 m/s and a depth of flow of 1 m. Determine the depth of flow after the jump and consequent loss in total head.
   (d) A rectangular channel carrying a supercritical flow is to be provided with a hydraulic jump type of energy dissipator. Energy loss required in the hydraulic jump is 6.0 m and inlet Froude number is 10. Determine the sequent depths.

   6+5+4+5 = 20