M.E. (Water Resources & Hydraulic Engg.) Examination (6 Semester), 2024

(4th Semester)

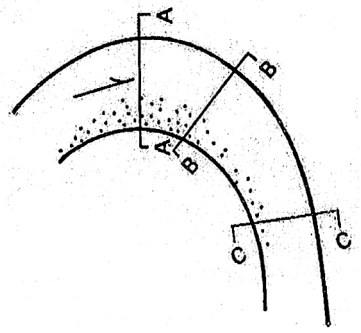
RIVER HYDRAULICS & ENGINEERING

(Paper – IX)

Time : Three Hours | Full Marks : 100

Answer any ***four*** questions.

1. a) The figure above shows a river reach and the arrow shows the flow of river. Draw the shape of the cross section at sections A, B and C and explain.



b) What are gabions? Write down the advantages and disadvantages of gabions?

c) Differentiate between dynamic wave, kinematic wave and diffusive wave with neat sketches.

d) Derive Saint Venant equations in the following form:

$$A\frac{\partial V}{\partial x}+V\frac{\partial A}{\partial x}+T\frac{\partial y}{\partial t}=0$$

3+6+11+5=25

2. a) During a flood flow the depth of water in a 10m wide rectangular channel was found to be 3.0 m and 2.9 m at two sections 200 m apart. The drop in the water-surface elevation was found to be 0.12 m. Assuming Manning's coefficient to be 0.025, estimate the flood discharge through the channel.

b) What are the guidelines for selecting the number of segments in case of the area-velocity method of stream flow measurement?

c) Describe briefly the sudden injection or gulp and constant rate injection-dilution method of flow measurement.

d) Describe in details the stream flow measurement by Electromagnetic method?

e) What are the advantages of ultrasonic method of streamflow measurement?

10+3+6+4+2=25

3. a) What is Fiber Mattress revetment and what are the advantages and disadvantages of Fiber Mattress revetment? Mention the common reasons for failure.

   b) What are the major problems associated with the disposal of dredged materials and where does the dredged materials are usually disposed

   c) Factors considered in developing a dredging operation?

   d) What is dredging sequence? Discuss.

   e) How dredged material can be used or recognized as a resource?

7+4+5+5+4=25

4. a) Derive the characteristic equations using MOC for a unit width, wide rectangular channel having gradually varied unsteady flow without lateral inflow. Also, explain the characteristics-grid method. Use the celerity of a small wave $C = \sqrt{gy}$.

   b) Explain the four point explicit finite-difference scheme to convert the St Venant equations into a set of algebraic equations in such a way that the unknown terms (V and y) at the end of a time step are expressed by known terms at the beginning of the time step.

   c) Consider a long channel carrying uniform flow at the upstream end of which a disturbance is introduced at the time T. Let V_0 and C_0 be the velocity and celerity prior to the introduction of the disturbance. Then prove that for a point C at x=0 having $t_c > T$:

$$\frac{dx}{dt} = \frac{3}{2}V_C - \frac{1}{2}V_0 + C_0$$

(7+7)+6+5 = 25

5. a) The equation of motion of GVUF differs from the differential equation of GVF by one essential term. This term is

   (i) $\frac{1}{g}\frac{\partial V}{\partial x}$ (ii) $\frac{\partial V}{\partial t}$ (iii) $\frac{1}{g}\frac{\partial V}{\partial t}$ (iv) $\frac{1}{g}\frac{\partial y}{\partial x}$ (v) $\frac{\partial y}{\partial x}$

   b) Prove the following relationship when a sluice gate in a horizontal channel suddenly raised to cause a quick change in the depth and hence a positive surge travelling downstream. Assume proper notations.

$$V_w = V_1 + \sqrt{g\frac{A_2}{A_1}\frac{\left(A_2\bar{y}_2 - A_1\bar{y}_1\right)}{\left(A_2 - A_1\right)}}$$

c) A rectangular channel 3.0 m wide has a flow of 3.65 m^3/s with a velocity of 0.85 m/s. if a sudden release of additional flow at the upstream end of the channel causes the depth to rise by 50 percent, determine the absolute velocity of the resulting surge and the new flow rate.

d) In a tidal bore river the depth and velocity of flow are 0.95 m and 1.24 m/s respectively. Due to tidal action a tidal bore of height 1.25 m is observed to travel upstream. Estimate the height and speed of the bore and the speed of flow after the passage of the bore.

2+10+6+7 = 25

6. a) What do you understand by celerity and stability of a surge?

b) Derive the following relationship between river velocity V_1, wave velocity V_w and depth before negative surge moving upstream section due to sudden release of control gate at a reservoir.

$$V_w = 3\sqrt{gy} - 2\sqrt{gy_1} - V_1$$

c) Prove the following relationship considering a negative surge produced in a horizontal frictionless channel due to the sudden raising of a sluice gate (x =0) at a downstream section. Prove that

$$y_{x=0} = \frac{4}{9}y_1$$

and

$$q_{x=0} = \frac{8}{27}\sqrt{gy_1^3}$$

where, $y_{x=0}$ is the depth of water at the gate x = 0, $q_{x=0}$ is the discharge per unit width at the sluice gate and y_1 is the depth at the upstream of the channel having no wave effect.

d) A sluice gate in a rectangular horizontal channel carrying a discharge of 15 m^3/s per meter width at a depth of 2.50 m partially closed to reduce the discharge by 55%. Calculate the height of the negative surge and the velocity of flow after the passage of the wave.

3+7+8+7 = 25