M.E. (Water Resources & Hydraulic Engg.) Examination (6 Semester), 2019

(4th Semester)

RIVER HYDRAULICS & ENGINEERING

(Paper – IX)

Time : Three Hours | Full Marks : 100

Answer any ***four*** questions.

1. a) What do you mean by roll wave and monoclonal wave?
   b) Prove the following relation for river flood waves:

$$\frac{\partial y}{\partial x} = \frac{S_0 - S_f}{1 - (\beta - 1)^2 \, \mathrm{Fr}^2}$$

   c) An observer measures the flow depth in a 600 m wide rectangular river inclined at a bed slope of 0.0025 with Manning coefficient 0.016. Initially, the flow depth is 10 m and the water level rises at a rate of 1 m/h. Calculate (i) the initial discharge at a distance of 1.1 km downstream, (ii) relative magnitude of the acceleration terms in the St. Venant equation and (iii) determine whether the flood wave attenuates as it propagates downstream.

3+11+11 = 25

2. a) Draw and explain the characteristic lines for subcritical and supercritical flow using MOC.
   b) Water flows at a depth of 2.5 m and a velocity of 1.2 m/s in a rectangular channel into a large lake. The level of water in the lake is initially the same as that in the river but suddenly starts falling and the velocity at the junction with the lake starts increasing at the rate of 0.25 m/s per hour for a period of 6 hours. Determine how long it takes for the velocity in the river at a distance of 2 km upstream of the lake to increase to 1.825 m/s. How far upstream of the lake is the flow velocity affected at this moment? Assume $S_0 = S_f = 0$.
   c) Differentiate between dynamic wave, kinematic wave and diffusive wave.

4+9+12 = 25

3. 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.
   b) A rectangular channel 4.5 m wide carries a discharge of 12 m^3/s at a depth of 2.0 m. calculate the height and velocity of a surge produced when the flow is suddenly stopped completely by the full closure of a sluice gate at the downstream end.
   c) Find out the differential equation of a monoclonal rising wave in the following form:

$$S_f = S_0 + \frac{\partial y}{\partial x}\left[1 - \frac{Q_r^2 T}{gA^3}\right]$$

where Q_r is termed as overrun.

12+8+5= 25

4. a) 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.

b) Assume a sluice gate in a horizontal frictionless channel suddenly raised to cause a positive surge travelling down the channel having unit width. Derive the following equation using proper notations:

$$\frac{(V_w - V_1)^2}{gy_1} = \frac{1}{2}\frac{y_2}{y_1}\left(\frac{y_2}{y_1} + 1\right)$$

c) A rectangular channel carries a flow with a velocity of 0.65 m/s and depth of 1.40 m. If the discharge is abruptly increased threefold by a sudden lifting of a gate on the upstream, estimate the velocity and the height of the resulting surge.

9+9+7 = 25

5. a) 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.

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

b) Prove the following relationship considering a negative surge produced in a horizontal frictionless channel due to sudden raising of a sluice gate at a downstream section.

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

where $q_{x=0}$ 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.

c) A sluice gate in a rectangular horizontal channel carrying a discharge of 10 m^3/s per meter width at a depth of 2.50 m partially closed to reduce the discharge by 65%. Calculate the height of the negative surge and the velocity of flow after the passage of the wave.

10+8+7 = 25