M.E. (Water Resources & Hydraulic Engineering) Examination, 2019

(2nd Semester)

RIVER HYDRAULICS & ENGINEERING

(Paper – VIII)

Time : Three Hours

Full Marks : 100

Answer any ***five*** questions.

1. a) Define unsteady flow.

   b) Explain terms GVUF and RVUF. Give examples and differentiate between them.

   c) Derive the Saint Venant equation in the form

$$\frac{\partial h}{\partial x}+\frac{V}{g}\frac{\partial V}{\partial x}+\frac{1}{g}\frac{\partial y}{\partial t}=2S_0-S_f$$

2+5+13 = 20

2. a) Prove the following relation for river flood waves:

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

   b) An observer measures the flow depth in a 600 m wide rectangular river inclined at a bed slope of 0.0025 with Manning coefficient 0.02. 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 1.2 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.

10+10 = 20

3. a) Show that the momentum equation of St. Venant equations can be written with discharge as the primary variable as

$$\frac{1}{Ag}\frac{\partial Q}{\partial t}+\frac{2Q}{A^2g}\frac{\partial Q}{\partial x}+\left(1-F^2\right)\frac{\partial y}{\partial x}=S_0-S_f$$

   b) Explain terms (i) Diffusing Scheme, (ii) Leap frog scheme and (iii) four point implicit scheme.

11+13 = 20

4. a) Derive the characteristic equations using Method of Characteristics (MOC) for a unit width, wide rectangular channel having gradually varied unsteady flow without lateral inflow.

   b) Explain the characteristics-grid method to determine coordinate, velocity, celerity and time at a new point assuming the values for two known points.

c) Explain the Diffusing 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.

8+6+6= 20

5. a) Explain the following rapidly varied unsteady flow phenomena in a river with neat sketches.

(i) Flow conditions after sudden lifting of a gate

(ii) Flow conditions after sudden full closing of the gate.

(iii) Tidal bore moving upstream of the river

(iv) Tidal bore hitting a fully closed gate located at the upstream of a river

(v) Tidal bore passing through a partially opened gate

4×5 = 20

6. a) Sketch and differentiate between "region of constant state" and "simple wave region".

b) Consider a sluice gate in a horizontal frictionless channel suddenly raised to cause a quick change in the depth. Based on this condition, derive the following equation assuming 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.

3+10+7 = 20

7. a) Explain the celerity, stability and stretching of positive and negative surges with neat sketch.

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) In a tidal river the depth and velocity of flow are 0.9 m and 1.25 m/s respectively. Due to tidal action a tidal bore of height 1.2 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.

7+6+7 = 20