UNIT 3
RAPIDLY VARIED FLOW

1 Whatis rapidly variedflow?   **Part A**

It isdefinedasthat flow in which depth of flowchangesabruptlyover a small length of thechannel.

2 Define Hydraulicjump

A hydraulicjump is a phenomenon in the scienceof hydraulics which is frequently observed in open channel flow such as rivers and spillways. When liquid at high velocity discharges into azoneoflower velocity, arather abrupt rise occurs in the liquid surface.

3. Statetheusesofhydraulicjump. [Nov'06, Nov'07 &May'10]

The kinetic energy of flow after the hydraulic jump is greatly reduced, which may prevent erosion of the channel boundariesofdownstream side.

4. Explain the classification of hydraulic jumps. [May'10]

Based on Froude number (F), hydraulic jump can be classified into 5types.

a. Undulation jump: The Froude number F ranges from 1 to1.7and the liquid surface does not rise shortly but having undulations o radically decreasing size.

b. Weak jump: The Froude number F rangesfrom1.7 to 2.5 and the liquid surface remains smooth.

c. Oscillating jump: The Froude number F ranges from 2.5 to 4.5and thereisan oscillatingjet which enters the jump bottom and oscillating to the surface.

d. Steady jump: The Froude number Frangesfrom4.5 to9 and energy loss due to steady jump in between 45 and 70%.

e. Strong jump: The Froude number greater than 9 and the downstream water surface is rough. Energy loss due to strong jump may be up to 85%.

5. Define surges.

> When the flow properties, such as discharge or depth varies suddenly is called surge.

> Example: suddenclosureof gate.

6. What is meant by positive and negative surges? [Nov'07]

1. Positive surge– a surge producing increase in depth

2. Negative surge– a surge producing decrease in depth.

7. What is TRANSITION state?

If the Re lies between **500to 2000**, the flow is considered to be in transition state.

8. Give a brief note on Froude number, Sub-critical, Critical, Super critical flow.

Fe =V/√ (gD)

Critical:

The flow in open channel is said to be critical if the Froude number is1.

Sub-critical,:

The flow in open channel is said to be super critical if the Froude number is less than one.

Super critical flow:

The flow in open channel is said to be super critical if the Froude number is greater than

9. Give the formula relating to velocity and discharge in chezy's formula.

Velocity = C √mi

Discharge Q= AC√(mi)

10. GivetheBAZIN, GANGUILLET-KUTTER, MANNINGSformulasforchezy'sconstant.

a) Bazinformula

$$C = \frac{157.6}{1.81 + \dfrac{K}{\sqrt{m}}}$$

b)Ganguillet-kutter formula

$$C = \frac{23 + \dfrac{0.00155}{i} + \dfrac{1}{N}}{1 + (23 + \dfrac{0.00155}{i}) \dfrac{N}{\sqrt{m}}}$$

c) Manning'sformula

$$C = \frac{1}{N} m^{\frac{1}{6}}$$

11. Give the formula for total energy

$$\text{TOTAL ENERGY} = z + h + \frac{V^2}{2g}$$

12. Define specific energy.

It is defined as energy per unit weight of the liquid with respect to the bottom of the channel.

PARTB

1. *Inthe flow through a sluice in a large reservoir, the velocity y downstream is 5.33 m/s while the flow depth is0.0563m.***Determine the downstream conditions if a hydraulic jump** *takes place downstream. Calculate the energy dissipated by eddies in the jump.*

y2 = 0.5436m
dissipation= 62.82 %,

2. A venture flume is formed in a horizontal channel of 2mwidthbyconstructing the widthto1.3m and raising floor level in the constrictedsectionby0.2m above that of the channel. If the difference in level between the throat and downstream is 25mmandboth upstream and downstream depths are 0.6m, ***determine the rate of flow***.

Q =0.3736m3/s

*3.   A rectangular channel of5mwidthdischargeswaterat the rate of 1.5 m3/s intoa5 m wide apron with 1/3000slope at a velocity of5m/s.***Determine the height of the hydraulic jump** *and energy loss.*

Height of hydraulic jump =0.4638m
Energy loss=0.7937mheadofwater.

*4.)   A   Wide   channel   of   uniform   rectangular   section   with   a   slopeof1/95has   a   flow   rate   of 3.75m3/s/m.TheManningconstantis0.013.Suddenlythe slope changes to1/1420.***Determinethenormaldepthsfor** *each case. Show that a hydraulic jump has to occur and calculate the downstream flow height.*

Normal Depthy2 = 1.4404 m
the downstream flow height Y2=1.8208 m

*5) A rectangular channel of 6m width has a flowrateof22.5m3/s when the depth is 3m   .***Determine the alternate depth and the critical depth.**
y2= 0.5302m,
yc=1.1275 m

6) Show that for a hydraulic jump in a rectangular channel, the Froude numbers upstream and downstream are related by

$$F_{r2}^2 = \frac{8F_{r1}^2}{[(1+8F_{r1}^2)^{1/2} - 1]^3} \cdot$$

7

In a trapezoidal channel of 2.4 m bottom width and 45° side slope the flow rate is 7.1 m³/s. with normal depth of flow of 1.2 m. Determine the bed slope. N = 0.022   (1.98/1000)

8) A rectangular channel of 5m width carries water at the rate of 15m3/s. Calculate the critical depth and velocity. **(hc = 0.972 m, Vc =3.69m/s).**