th dec,
HURSDAY

09. FLOOD ROUTING

Flood Routing is the method of generating flood hydrograph on d/s side by using the flood data available on the upstream side.

- Flood routing is carried out by two methods:

(i) Hydraulic Flood Routing
(ii) Hydrologic Flood Routing

* Hydraulic Flood Routing:

- This method is very complex but accurate.
- It require high speed digital computer with advanced programming language.
- This method uses
  - (i) Continuity Equation.
  - (ii) St. Venant's equation of motion of unsteady gradually varied flow.

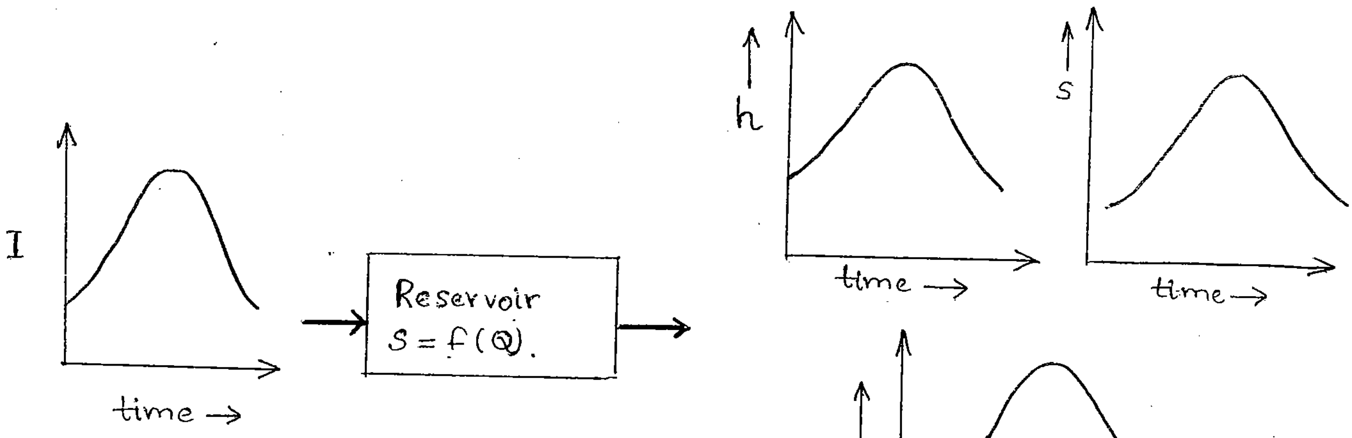
* Hydrologic Flood Routing:

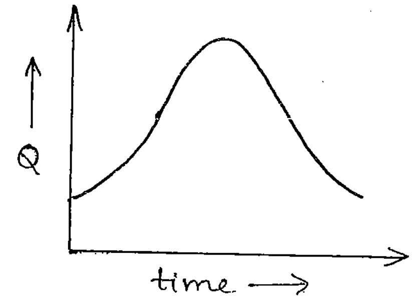
- This method is simple but approximate.
- This method uses only continuity equation.

$$\boxed{I - Q = \frac{ds}{dt}}$$

- Hydrologic flood routing is applied :-
  - (i) for channels with reservoir b/w u/s & d/s, known as 'Hydrologic Reservoir Routing'.
  - (ii) for channels without reservoir b/w u/s & d/s, known as 'Hydrologic Channel Routing'.

→ Hydrologic Reservoir Routing





- Reservoir storage is a function of outflow only (Q)

  h → depth of flow.

  S → storage.

$$I - Q = \frac{ds}{dt}.$$

$$\frac{I_1 + I_2}{2} - \frac{Q_1 + Q_2}{2} = \frac{\Delta S}{\Delta t}.$$

$$\frac{I_1 + I_2}{2} - \frac{Q_1 + Q_2}{2} = \frac{S_2 - S_1}{\Delta t}.$$

- To find out flow from the above equation :-

  (i) Modified Puls Method.

  (ii) Good rich method

anyone is used.

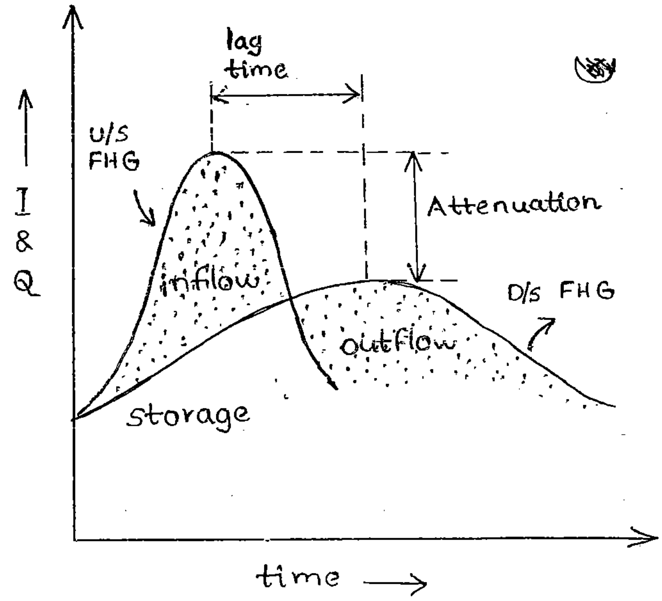
* Modified Puls Equation

$$\left(\frac{I_1 + I_2}{2}\right)\Delta t + \left(S_1 - \frac{Q_1}{2}\Delta t\right) = \overbrace{S_2 + \frac{Q_2}{2}\Delta t}^{\text{unknowns}}.$$

* Good rich method.

$$(I_1 + I_2) + \left(\frac{2S_1}{\Delta t} - Q_1\right) = \frac{2S_2}{\Delta t} + Q_2$$

Overlapped area b/w inflow curve and outflow curve represents storage.



→ Hydrologic Channel Routing

The effect of floodwave while passing from u/s to d/s is evaluated assuming that there is no lateral addition of flow by:

* Muskinghum Method

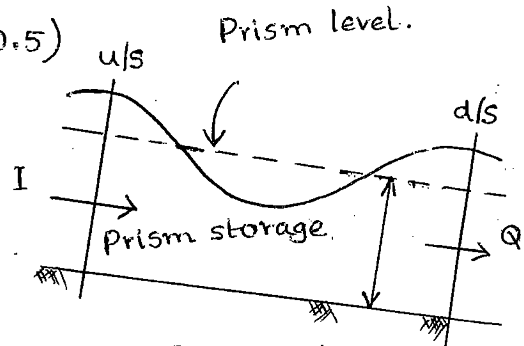
$$\text{Storage}, S = k\left(xI + (1-x)Q\right)$$

where $K \rightarrow$ storage time constant.

$x \rightarrow$ weightage factor (0 to 0.5)

$I \rightarrow$ inflow (u/s)

$Q \rightarrow$ outflow (d/s)



$$I - Q = \frac{dS}{dt}$$

– Solution to Muskingham equation for outflow, Q

$$Q_n = C_0 I_n + C_1 I_{n-1} + C_2 Q_{n-1}$$

where C_0, C_1 & C_2 are Muskingham constants.

$$C_0 + C_1 + C_2 = 1$$

time	u/s FHG (I)	d/s FHG (Q)
t_{n-1} } Δt	I_{n-1} →	Q_{n-1}
t_n	I_n ←	Q_n
t_{n+1}	I_{n+1}	Q_{n+1}

$$C_0 = \frac{-Kx + 0.5\,\Delta t}{K - Kx + 0.5\,\Delta t} \quad ; \quad C_1 = \frac{Kx + 0.5\,\Delta t}{K - Kx + 0.5\,\Delta t}$$

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3.

time	$I\,(m^3/s)$	$Q\,(m^3/s)$
3rd	18	15
4th	42	$Q_4 = ?$

$C_0 = 0.042$

$C_1 = 0.538$

$C_2 = 1 - (0.042 + 0.538) = 0.42.$

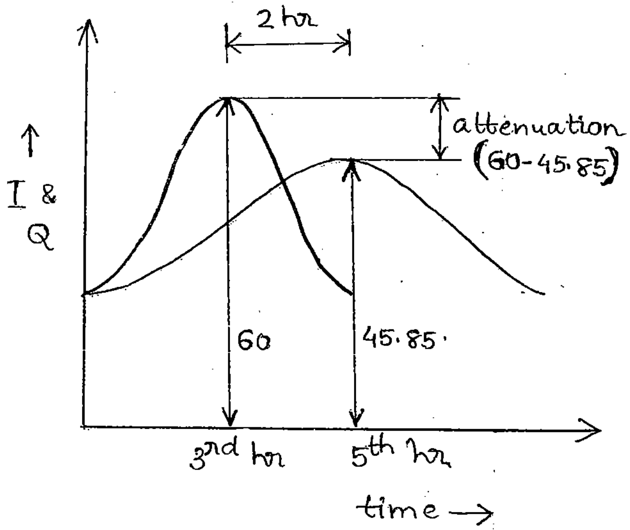
$$Q_4 = 0.042 \times 42 + 0.538 \times 18 + 0.42 \times 15 = \underline{17.748}\ m^3/s$$

5. / 4. $C_0 = 0.048$

$C_1 = 0.429$

$C_2 = 0.523$

time	u/s FHG (I) (m^3/s)	d/s FHG (Q) (m^3/s)
0	10	10
1	20	10.48
2	40	15.98
3	60	28.39
4	50	42.98
5	40	45.85
6	30	42.37



$Q_1 = 0.048 \times 20 + 0.429 \times 10 + 0.523 \times 10 = 10.48\ m^3/s$

$Q_2 = 0.048 \times 40 + 0.0429 \times 20 + 0.523 \times 10.48 = 15.98\ m^3/s$

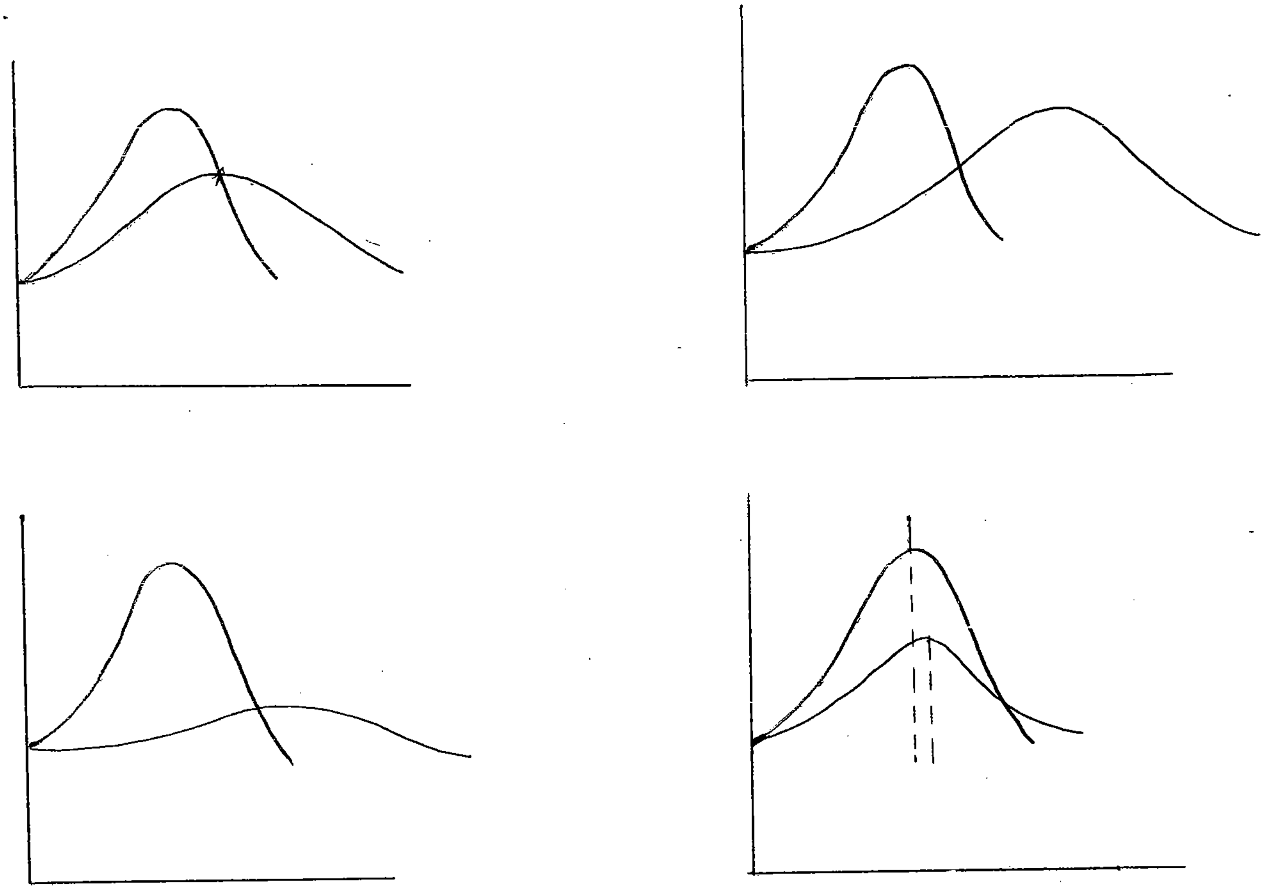
$Q_3 = 0.048 \times 60 + 0.429 \times 40 + 0.523 \times 15.98 = 28.39\ m^3/s$

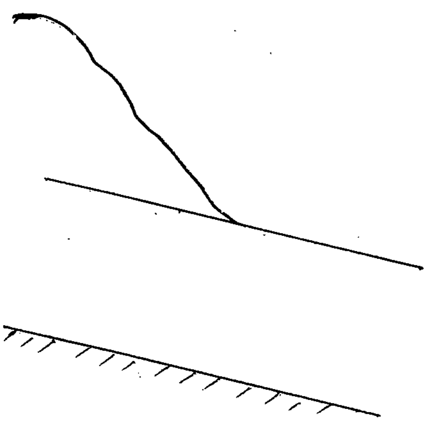
$Q_4 = 0.048 \times 50 + 0.429 \times 60 + 0.523 \times 28.39 = 42.98\ m^3/s$

$Q_5 = 0.048 \times 40 + 0.429 \times 50 + 0.523 \times 42.98 = 45.85\ m^3/s$

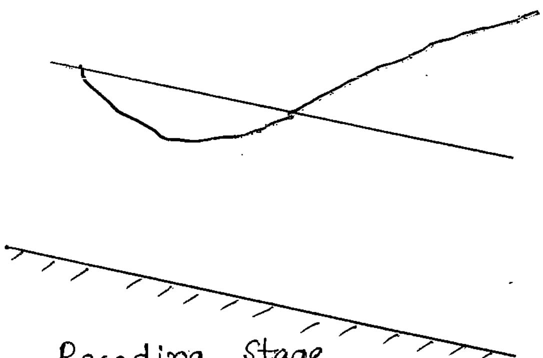
$Q_6 = 0.048 \times 30 + 0.429 \times 40 + 0.523 \times 45.85 = 42.37\ m^3/s$

Peak flood discharge on d/s $= \underline{45.85\ m^3/s}$





Rising Phase
(Advancing stage)



Receding Stage
(falling phase of flood).