FLOODS UNIT-4

Introduction:-

Floods:- Floods are Natural occurences where an area of land that is normally dry abruptly becomes submerged in water. In simple term, flood can be defined as an overflow of large quantities of water onto a normally dry land. Flooding happens in many ways due to overflow of streams, river, lakes & oceans & as a result of Excessive rain.

→ whenever flooding takes place, there is the possibility of loss of life, hardship to people, and Extensive damage to property. this is because flooding can carry bridges, cars, houses, and Even people. Flooding also destroys crops and can wipe away trees and other important structures on land. some floods occur abruptly and recede quickly whereas others take several days & Even months to form and to recede because of Variation in size, duration, and the area affected.

* "European union Floods Directive" defines a flood as a covering by water of land not normally covered by water. In the sense of "flowing water", the word may also be applied to the inflow of the tide".

* Causes of flooding:-

→ Many conditions Result in flooding. Hurricanes, clogged drianages, and rainfall are some of the conditions that have led to flooding in various Regions across the globe. Here are the leading causes of flooding.

1.> Rain:-

→ Rain is the leading contributor to most of the flooding cases witnessed across the world. Too much rain causes water to flow overland contributing to flooding. In particular, It is due to high rainfall intensity over a prolonged period.

→ Depending on the rainfall distribution, the amount of rain, and soil Moisture content, short rainfall period can also result in flooding. Light rains for longer periods - several days & weeks, can also result in floods. the rain water Erosive force can weaken the foundations of buildings, causing tumbles and cracks.

(1)

2. River overflows:-

→ Rivers or streams can overflow their banks. this happens when the river or stream holds more water upstream than usual, and it flows downstream to the neighbouring low-lying areas, typically referred to as the flood plains. As a consequence, this creates a sudden discharge of water in to the adjacent lands leading to flooding.

Dams in rivers may also at times overwhelm rivers when the carriage capacity is exceeded, causing the water to burst and get in to the flood plains. Flood caused by river overflow has the potential of sweeping everything in its path downstream.

3. Lakes and coastal flooding:-

→ Lake and coastal flooding occurs when large storms or tsunamis causes the water body to surge inland. these overflows have destructive power since they can destroy ill-equipped structures to withstand water's strength such as bridges, houses and cars.

In the coastal areas, strong and massive winds and hurricanes drive water on to the dry coastal lands and give rise to flooding. the situation is even worsened. when the winds blowing from the ocean carry rains in them. sea waters from the tsunami or hurricane can cause widespread damage.

4. Dam Breakage:-

→ Dams are man-made structures used to hold water from flowing down from a raised ground. the potential energy stored in the dam water is used to generate electricity. At times, the walls can become weak and break because of overwhelming carriage capacity. Due to this reason, breakage of the dam can cause extensive flooding in the adjacent areas.

Flooding occurs when the embankments built along the sides of the river to stop high water from flowing onto the land breaks. sometimes, the excess water from the dam is deliberately released from the dam to prevent it from breaking thereby causing floods.

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5. Melting of the Glacier and Mountain tops:-

→ In the cold regions, ice and snows build up during the winters. when the temperature rises in summer, the accumulated (shows) snows and ice are subjected to melting resulting in vast (moments) movements of water into lands that are normally dry. Regions with Mountains that have ice on top of them also (provided) Experience the same outcome when the atmospheric temperature rises. this type of flooding is usually termed as snowmelt flood.

6. Clogged drainage:-

→ Flooding also takes place when snowmelt(or) rainfall runoff cannot be channeled appropriately into the drainage systems forcing the water to flow overland. clogged(or) lack of proper drainage system is usually the cause of this type of flooding.

* the areas remain flooded until the storm water systems or waterways are rectified. Instances where the systems or waterways are not rectified, the areas remain flooded until the excess water Evaporates or is transpired into the atmosphere by plants.

* Effects of flooding:-

→ primary Effects:-

> the primary Effects of flooding include loss of life and damage to buildings and other structures, including bridges, sewerage systems, roadways and canals

> floods also frequently damage power transmission and sometimes power generation, which then has knock-on Effects caused by the loss of power.

> This includes loss of drinking water treatment and water supply, which may result in loss of drinking water (or) severe water contamination.

> It may also cause the loss of sewage disposal facilities.

> Lack of clean water combined with human sewage in the flood waters raises the risk of waterborne diseases, which can include typhoid, giardia, cryptosporidium, cholera and many other diseases depending upon the location of flood.

> Damage to road and transport Infrastructure may make it difficult to mobilize aid to those affected or to provide Emergency health treatment.

(3)

➢ Flood water typically inundate (film) farm land, making the land unworkable and preventing crops from being planted & harvested, which can lead to shortages of food both for humans and farm animals. Entire harvests for a country can be lost in Extreme flood circumstances. Some tree species may not survive prolonged flooding of their root systems.

→ Secondary and long-term Effects :-

> Economic hardship due to a temporary decline in tourism, rebuilding costs, & food shortages leading to price increases is a common after-effect of severe flooding. The impact on those affected may cause psychological damage to those affected, in particular where deaths, serious injuries and loss of property occur.

> Urban flooding can cause chronically wet houses, leading to the growth of indoor mold and resulting in adverse health Effects, particularly respiratory symptoms.

> Urban flooding also has significant Economic implications for affected neighbourhoods

- In the united states, industry Experts Estimate the wet basements can lower property values by 10-25% and are cited among the top reasons for not purchasing a home.
- According to the U.S. Federal Emergency Management Agency (FEMA), almost 40% of small businesses never reopen their doors following a flooding disaster.
- In the united states, Insurance is available against flood damage to both homes and businesses.

* Benefits :-

> Floods can also bring many benefits, such as recharging ground water, making soil more fertile and increasing Nutrients in some soils.

> Flood water provide much needed water resources in arid and semi-arid regions where precipitation can be very unevenly distributed throughout the year and kills pests in the farming land.

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> Freshwater floods particularly play an important role in maintaining Ecosystems in river corridors and are a key factor in maintaining flood plain biodiversity.

> flooding can spread Nutrients to lakes and rivers, which can lead to increased biomass and improved fisheries for a few years.

(> for some fish species, are endangered)

> periodic flooding was Essential to the well-being of ancient communities along the Tigris - Euphrates River, the Nile River, the Indus River, the Ganges and the Yellow River among others. the viability of hydropower, a renewable source of Energy, is also higher in flood prone regions

* Flood Frequency Studies:-

→ Flood frequency :- It denotes the likely hood of a flood being Equal(or) Exceeded.

→ Reccurance Interval (T_R) :- Denotes the no. of years in which a given flood can be Expected once.

$$T_R = \frac{100}{F}$$

→ calculation of R.I :-

1. California Method :- $T_R = \frac{N}{M}$

2. Hazen's Method :- $T_R = \frac{2N}{2m-1}$

3. Weibull's Method :- $T_R = \frac{N+1}{m}$

4. Gumbel's Method :- $T_R = \frac{N}{m+C-1}$

C → Gumbel's correction

* depends on $\frac{M}{N}$ ratio.

* Gumbel's correction :-

$\frac{M}{N}$	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.08	0.04
C	1	0.95	0.88	0.845	0.78	0.73	0.66	0.59	0.52	0.4	0.38	0.28

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→ probability of occurance (p):-

> the probability of Event being Equal & Exceeded in any one year is the probability of occurance (p) has for a period of T_r years.

$$p = \frac{1}{T_r}$$

* the probability that the flood will not occur in an year is known as probability of Non occurance.

$$q = 1 - p$$

Examples:

* the following flood discharge data is available at a catchment. Estimate 'T_r' for a flood of 6000 m^3/sec - use all formulae.

Year	flood discharge(m^3/s)	data in order	Rank
1991	10,200	11,640	1
92	6000	10,200	2
93	7200	9600	3
94	2500	8270	4
95	9600	7200	5
96	5400	6000	6
97	3600	5400	7
98	4950	4950	8
99	8270	3600	9
2000	11,640	2500	10

i) California Method, $T_r = \frac{N}{m}$

$$T_r = \frac{10}{6} = 1.67 \simeq 2 \text{ years}$$

ii) Hazen's Method, $T_r = \frac{N+1}{m}$

$$T_r = \frac{11}{(2-1)} = \frac{11}{11} = 1 \text{ year}$$

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iii) Weibull's Method, $T_r = \frac{11}{6}$

$T_r = 1.83$ years.

iv) Gumbel's Method, $\frac{M}{N} = \frac{6}{10} = 0.6 \Rightarrow C = 0.78$

$$T_r = \frac{10}{6+0.78-1}$$

$T_r = 1.73$ years

* Rational formula:-

$Q = KAR$ (or) $Q = CIR$

$Q = F_u KAR$

$F_u \rightarrow$ Factor depending on units taken.

'K' varies for different regions

$$K_{eff} = \frac{K_1A_1 + K_2A_2 + \cdots + K_NA_N}{A_1 + A_2 + \cdots + A_N}$$

* Estimation of flood discharge:-

→ Design flood:- It is the flood discharge adopted for the design of a hydraulic structure after careful consideration of hydrological aspects and design aspects.

→ Standard project flood:- (SPF)

> the flood obtained by severe combination of Meteorological and hydrological factors. Extreme combinations are not considered.

→ Probable Maximum flood:-

> Here Extreme flood physically on a given catchment is considered.

Most severe combinations of hydrological and Meteorological factors are considered. Rare combinations are also considered.

Methods of Estimation of flood as follows. they are,

1) By physical indicators of past flood.
2) By using Empirical formulae – flood discharge formulae.
3) Flood frequency service.

4) By unit graph Method

5) By rational Method.

* By physical indicators of past flood:-

→ Marks / identification on surrounding areas

→ Investigation of surrounding people.

→ From cls dimension of rivers, Mean velocity discharge can be calculated.

* Empirical formulae:-

→ the Equations of the form, $Q = KA^n$

K → flood discharge coefficients.

Dicker's formulas-

$$Q = CA^{3/4}$$

used for North central and Eastern India.

'C' depends on catchment location.

Central India:- 13.9 – 19.5

Eastern India:- 22.2 – 25

Northern India:- 11.4

Ryve's formula:-

$$Q = CA^{2/3}$$

used for Madras catchment.

'C' depends on location

Area with in 24km from the coast – 6.45

Area with in 24–161 Km from coast – 8.45

Limited area near hills – 10.1

Inglis formula:-

$$Q = \frac{123A}{\sqrt{A+10.4}} \simeq 123\sqrt{A} \text{ (approx)}$$

– these are applicable for former Bombay presidency.

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Nawab Jung Bahadur formula:-

$$Q = CA(0.993 - \frac{1}{14}\log A)$$

'C' value ranges from 40–60

applicable to old hyderabad catchments.

Fanning's formula:-

(F.P.S)

$$Q = CA^{5/6}$$

applicable for American catchments.

$C = 2.54$.

Fuller's formula:-

$$Q = CA^{0.8}(1+0.8\log T)(1+2.67A^{-0.3})$$

$T \rightarrow$ No. of years after width which such a flood is to reoccur.

$Q \rightarrow$ Max discharge (M^3/s)

$C \rightarrow$ (0.185 to 1.3)

$A \rightarrow$ Area of catchment in Km^2.

* Methods used to control floods:-

→ floods can cause many problems and in serious cases, lives may be taken as well. this is why it is important to take preventive measures to stop the floods from happening in the first place. flood control is referred to as measures taken to prevent floods from happening.

* flooding has many negative impacts, from damaging property to even taking lives. flooding also transports other sediments to other places. this pollutes the habitats that wildlife may reside in. If the floods are to make their way into urban areas then it may cause disruption to traffic, interfere with drainage and electrical systems - this causes millions of dollars in damage. Thus, it would be less costly and safe to prevent the flood from happening in the first place.

* Methods used to prevent floods:- Structural Methods :-

→ "Dams" are one way that can be used for flood control. Dams are barriers that control the flow of water from a big water source such as a river or reservoir. unlike other barriers, damns are used to retain water. the advantage with dams is that they are able to generate Electricity through hydropower.

→ Another type of method of flood control that can be used would be "flood gates". flood gates are systems that have adjustable gates to control the flow rate of a river. the water can either be stored or routed depending on the situation. Also, flood gates can also lower the water levels from canal channels or the main river channel. this allows more water to flow into a storage area if a flood is being predicted.

→ the next method that can be used for flood control would be a "flood wall". similar to dams, flood walls are serve the purpose of containing water of rivers or other water channels. However, flood walls are only temporary. they are used in areas where there is limited space or if a construction of other barriers would interfere with the surrounding Environment. flood walls are made out of fabricated concrete materials. these flood walls may sometimes have flood gates which allow people and vehicles to pass through. they are only closed in case of a flood.

→ In Asian countries, "flood diversion" is used to divert the flood away from more populated cities.

→ To control coastal flooding, there are some methods such as sea walls, beach nourishment and barrier islands that can be built along to coast to prevent flooding from the ocean.

> Sea walls may corrode over time and collapse.

> Beach nourishment is the addition of sand to the Existing coast so that the tides will not reach the populated areas that quickly. However, it is a costly method that takes a considerable amount of time to complete.

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→ Water Shed Management:-

> Land treatment and watershed Management in the basin aims to cutting down and delaying the runoff before it gets into the river. watershed Management Measure includes developing the Vegetative and soil cover in conjuction with land.

> Treatment works like check dams, contour bunding, terraces Etc. these treatment cause. increase in infiltration, increase in Evapotranspiration and reduction in soil Erosion. these all treatments lead to Moderation of peak flows and increasing of dry weather flows.

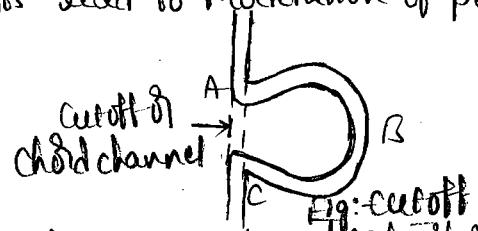


Fig: cutoff

* Non-Structural method:-

(a) Flood plain zoning:- when the channel discharges are very high, it is to be Expected that the channel will overflow its banks and spill into the flood plains. flood plain Management identifies the flood prone areas of a river and regulates the land use so that it restricts the damage due to flood.

Zone	flood Return period	Example of uses
1	100 years	Residential houses, offices, factories Etc.
2	25 years	parks
3	Forever	NO construction/ Encroachments.

(b) Flood Forecasting and warning: Forecasting of floods should be done in advance, so that it Enables us to give warning to the affected people and take appropriate precautionary Measures. these techniques can be divided on the basis of time of forecasting

(i) Short-Range Forecasts:- this method gives advance warning 12-90 hours for flood.

(ii) Medium-Range Forecast:- this method gives advance warning of 2-5 days for floods, by using rainfall-runoff Relationship.

(iii) Long-Range Forecasts:- using Radar and Meteorological satellite data, time of occurance of Event are predicted well in advance.

(c) Evacuation and Relocation

(d) Flood Insurance: Flood insurance provides a Mechanism to modify the impact of loss by burden.

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* Types of flood:-

→ Large area flood

→ Small area flood.

(i) large area flood:-

→ this type of flood occur due to storm of low intensity having a duration of a few days to several weeks. sometimes, snow melt may also be a reason to cause large area floods. the time period of maximum total precipitation do not necessarily coincide with the time of occurence of large area floods.

ii) Small Area flood:-

→ storms of high intensity and duration of one day or less causes small area floods. such flows cause good damage to agricultural land in the form of Excessive soil Erosion. this is the major cause of sedimentation in reservoir and river. In this type, the total flood volume is not much but such floods causes serious local area damage.

→ The importance of structure and Economic development of surrounding area. dictate the design criteria for choosing the flood magnitude.

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* Flood routing:-

→ Flood routing is a process of determining peak discharge & stage of outflow hydrograph, corresponding to a known inflow hydrograph.

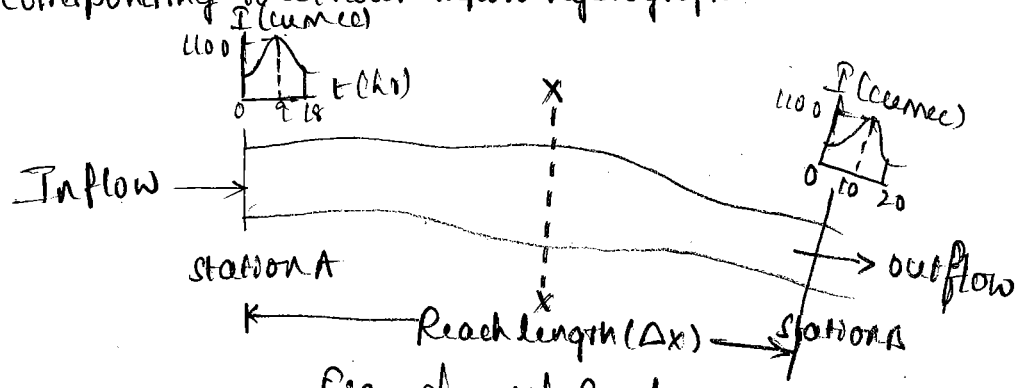


Fig: Channel Reach

* Uses of flood routing:-

→ In Estimation of design flood.

→ In designing of reservoir.

→ In designs of flood control structure.

→ In determining adequacy of spillway

→ In study of flood wave.

* Flood wave:-

→ Flood wave in open channels are also recognised as long progressive waves with the only difference that the movement of water in downstream direction, is also associated with the movement of waves in open channel & reservoir.

→ By associating flood wave with water movement gives two type of flood waves:

> the wave which travel downstream is known as primary wave.

> the wave which travel upstream is known as secondary wave.

* Types of flood routing:-

→ on the basis of application, flood Routing can be classified as

(i) Reservoir Routing

(ii) channel Routing

(i) Reservoir Routing:-

→ In reservoir routing the Effect of a flood wave Entering a reservoir is studied to predict the variations of reservoir Elevation and outflow discharge with time.

- this form of routing is used:

(a) In the design of capacity of spillways and other reservoir outlet structure

(b) In locating and sizing of the capacity of reservoir to meet specific requirements

(ii) Channel Routing:-

→ In channel routing the change in the shape of a hydrograph as it travel down a channel is studied to predict the flood hydrograph at various section of the reach.

* Various Method of Reservoir Routing:-

→ Modified puls method:-

> the Equation used before is rearranged as

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

At the starting of flood routing; the initial storage and outflow discharge are known, which means all the terms of left hand side are known.

> the various steps are to be taken:

(i) for the 1st time interval Δt, $\left(\frac{I_1+I_2}{2}\right)\Delta t$ and $\left(S_1 - \frac{Q_1\Delta t}{2}\right)$ are known and hence.

$\left(S_2 + \frac{Q_2\Delta t}{2}\right)$ is determined.

(ii) the water surface Elevation corresponding to $\left(S_2 + \frac{Q_2\Delta t}{2}\right)$ is found by using curve of storage - Elevation and discharge Elevation. the outflow discharge Q_2 at the End of time step Δt is found from the curve outflow discharge - Elevation

(iii) Deducting $Q_2\Delta t$ from $\left(S_2 + \frac{Q_2\Delta t}{2}\right)$ gives $\left(S - \frac{Q\Delta t}{2}\right)$ for the beginning of the next time step

(iv) the procedure is repeated till Entire inflow hydrograph is routed.

* Hydrological channel Routing:

→ In channel routing the storage is a function of both outflow and inflow discharge.

$$S = f(I, Q)$$

→ the water surface in a channel reach is not only unparallel to the channel bottom but also varies with time. the flow in a channel during a flood is spatially varied unsteady flow.

→ the total volume stores in a channel reach can be considered under two categories.

(i) prism storage

(ii) wedge storage.

* prism storage:-

→ It is the volume formed by an imaginary plane parallel to channel bed, drawn upstream from the outflow section to the inflow section.

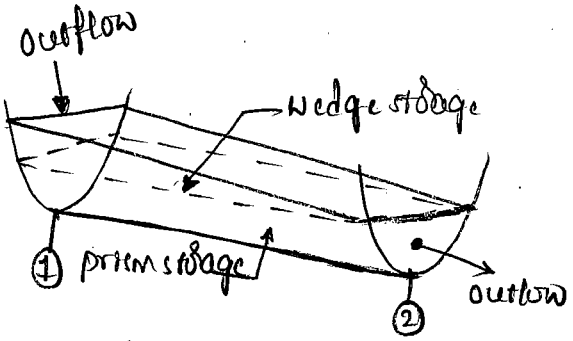


Fig:- storage in a channel reach.

* wedge storage:-

→ It is the triangular volume Enclosed between the actual water surface profile and the top surface of the prism storage.

→ At fixed depth at a downstream section of a river reach, the prism storage is constant while the wedge storage changes from a positive value at an advancing flood (in this case depth increases) to a negative value during receding flood (in this case depth decreases).

→ the prism storage is steady so it is similar to reservoir and Expressed as $S_p = f(I)$ the wedge storage can be Expressed as $S_w = f(I)$

→ the total storage.

$$S = K[xI^m + (1-x)Q^m]$$

* Muskingum Equation:

→ Considering the above Equation of total storage:

> M is taken as 1, as found for natural river,

$$S = K[xI + (1-x)Q]$$

K = a coefficient parameter

m = a constant Exponent

x = weightage constant.

Now the storage have linear relationship with inflow and outflow.

> x is a dimensionless weighing factor between inflow and outflow, its value Varies between to 0 to 0.5. for nature river 0.1 to 0.3.

> when x=0.5, inflow will not cause any influence on storage, and storage will become a function of outflow only, now called a linear storage of linear reservoir.

> K is known as storage-time constant. It is approximately Equal to the time of travel of a flood wave through the channel reach.

-the muskingum Equation can be write down as

$$Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$$

Here $$C_0 = \frac{-Kx + 0.5\Delta t}{K(1-x) + 0.5\Delta t}$$

$$C_1 = \frac{Kx + 0.5\Delta t}{K(1-x) + 0.5\Delta t}$$

$$C_2 = \frac{K(1-x) - 0.5\Delta t}{K(1-x) + 0.5\Delta t}$$

NOTE:- $C_0 + C_1 + C_2 = 1$

Examples:

→ The storage in a stream reach has been studied and x and K have been identified as 0.28 and 1.6 days. If the inflow hydrograph in the stream reach, as the flood starts coming in and passes, is given by the following table, compute the outflow hydrograph (plotting is not needed).

Hours	0	6	45	18	24	30
I (m³/sec)	35	55	92	130	160	140

A. Given, $K = 1.6$ days

$= 1.6 \times 24h = 38.4h$

$x = 0.28$

Coefficients:-

$$C_0 = -\left[\frac{38.4 \times 0.28 - 0.5 \times 6}{38.4 - 38.4 \times 0.28 + 0.5 \times 6}\right] = \frac{-7.752}{30.648} = -0.253$$

$$C_1 = \frac{38.4 \times 0.28 + 0.5 \times 6}{38.4 - 38.4 \times 0.28 + 0.5 \times 6} = \frac{13.752}{30.648} = 0.449.$$

$$C_2 = \frac{38.4 - 38.4 \times 0.28 - 0.5 \times 6}{38.4 - 38.4 \times 0.28 + 0.5 \times 6} = \frac{24.648}{30.648} = 0.804.$$

Check:- $C_0 + C_1 + C_2 = -0.253 + 0.4479 + 0.804 = 1.0$

The outflow O_2 at the End of Each interval by using the Muskingum Equation May be calculated from the Equation

$$O_2 = C_0 I_2 + C_1 I_1 + C_2 O_1$$

The calculations are carried out in table.

Time (1)	Inflow (cumecs) (2)	$C_0 I_2$ $= (-) 0.253 I_2$ (3)	$C_1 I_1$ $= 0.4479 I_1$ (4)	$C_2 O_1$ $= 0.804 O_1$ (5)	O in cumecs (3)+(4)+(5) (6)
0	35	—	—	—	35.00*
6	55	$-0.253 \times 55 = -33.915$	$0.4479 \times 35 = 15.715$	$0.804 \times 35 = 28.14$	29.94*
12	92	$-0.253 \times 92 = -23.276$	$0.4479 \times 55 = 24.695$	$0.804 \times 29.94 = 24.072$	25.49**

18	130	$-0.253 \times 130 = 32.89$	$0.449 \times 92 = 41.308$	$0.806 \times 25.49 = 20.496$	28.91**
24	160	$-0.253 \times 160 = -40.48$	$0.449 \times 130 = 58.37$	$0.806 \times 28.91 = 23.266$	41.13
30	140	$-0.253 \times 140 = -35.42$	$0.449 \times 160 = 71.84$	$0.806 \times 41.13 = 33.068$	69.49

the outflow hydrograph ordinates are thus, obtained in col.(6) wrt. time in col.(1)

2nd sum:-

→ Route the following flood through a river reach for which the Muskingum coefficients K and x are 22h and 0.25, respectively. At time t=0, the outflow discharge is $40 m^3/s$.

Hours	0	12	24	36	48	60	72
Inflow (m^3/s)	40	65	165	250	240	205	170

plotting the hydrograph is not needed.

A. using Muskingum's Equations, we have

$$C_0 = \frac{-Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t}$$

$$C_1 = \frac{Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t}$$

$$C_2 = \frac{K - Kx - 0.5\Delta t}{K - Kx + 0.5\Delta t}$$

$C_0 + C_1 + C_2 = 1$ (for verification)

and

Here, in the given Equation

$K = 22h$

$x = 0.25$

$\Delta t = 12h$ (time interval)

$$C_0 = \frac{(-)(22 \times 0.25 - 0.5 \times 12)}{22.5} = 0.022$$

$$C_1 = \frac{(22 \times 0.25 + 0.5 \times 12)}{22.5} = 0.511$$

$$C_2 = \frac{(22 - 22 \times 0.25 - 0.5 \times 12)}{22.5} = 0.467$$

Check: $C_0 + C_1 + C_2 = 1.0$ (which is correct).

Now, the outflow coordinates are worked out in col.(6) of table using $Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$, assuming the initial value of outflow = 40 m³/s as given the table is otherwise self Explanatory.

NOTE:- I_2 stands for inflow at the End of the interval and I_1 at the start of Interval.

Time from start (h) (1)	Inflow in cumecs (2)	$C_0 I_2 = 0.022 I_2$ (3)	$C_1 I_1 = 0.511 I_1$ (4)	$C_2 Q_1 = 0.467 Q_1$ (5)	Q in cumecs (3)+(4)+(5) (6)
0	40	–	–	–	40* (given)
12	65	$-0.022 \times 65 = 1.43$	$0.511 \times 40 = 20.44$	$0.467 \times 40 = 18.68$	40.55
24	165	$0.022 \times 165 = 3.63$	$0.511 \times 65 = 33.32$	$0.467 \times 40.55 = 18.94$	55.79
36	250	5.5	84.32	26.05	115.87
48	240	5.28	127.75	54.11	187.14
60	205	4.51	122.64	87.39	214.54* (peak)
72	170	3.74	104.76	100.19	208.69

NOTE:- the above routing shows that the peak which occured at $t = 36$ hr at upstream point of river reach, now occurs at $t = 60$ hr at downstream point, i.e., at a lag of 24 hr - the peak discharge also reduces from 250 cumecs to 214.54 cumecs.