

Course Name: Watershed Hydrology

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Week: 12

Lecture 58: Objectives on Watershed Hydrology

**SWAYAM NPTEL COURSE ON
WATERSHED HYDROLOGY**


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Module: 12
Lecture: 3 (Objectives on Watershed Hydrology)

Hello friends, welcome back to this online certification course on Watershed Hydrology. I am Rajendra Singh, a professor in the Department of Agriculture and Food Engineering at the Indian Institute of Technology, Kharagpur. We are in module 12, this is lecture number 3, where we will be focusing on objectives in watershed hydrology.

Module 12

- **Miscellaneous Focus**
 - Hydrological Model Demonstration
 - Important Topics Not Covered Earlier
 - Concept Revision Through GATE Multiple-Choice Questions
 - Doubt Clearing



So, basically, at the beginning of module 12, we said that this module will have a miscellaneous focus, and today's lecture will be on concept revision through multiple-choice questions. So, we will take multiple questions and then we will try to revise the concepts based on those questions.

Objectives: Module 1


Example 1

Precipitation consisting of droplets less than _____ in diameter is classified as drizzle

- a) 0.05 mm
- b) 0.5 mm
- c) 1 mm
- d) 1.5 mm

Solution:

- We defined drizzle as the "precipitation in the form of water droplets less than 0.5 mm in diameter and intensity less than 1 mm/h"
- Rainfall also occurs in liquid form, but drop sizes vary from 0.5 to 6.0 mm
- Light rain: < 2.5 mm/h; Moderate rain: 2.5–7.5 mm/h; Heavy rain: > 7.5 mm/h



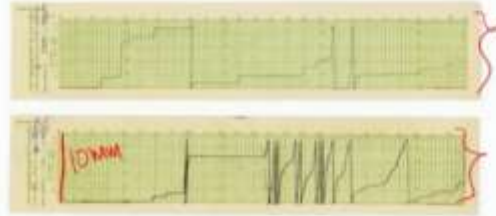
Let us begin with example number 1, which says that precipitation consisting of droplets less than _____ in diameter is classified as drizzle, and then we have been given 4 options: 0.05, 0.5, 1, 1.5 mm. Obviously, you must recall when we discussed in the beginning precipitation temperature that we defined drizzle as the precipitation in the form of water droplets less than 0.5 mm in diameter and intensity less than 1 millimetre per hour. We also defined that rainfall also occurs in liquid form, but drop sizes vary from 0.5 to 6 mm, and based on the intensity of

Objectives: Module 1

Example 3

A float and siphon type recording rain gauge measures maximum of 10 mm of rainfall at one time

- a) 5 mm
- b) 3 mm
- c) 7 mm
- d) 10 mm



Solution:

- A float/siphon type recording rain gauge has a specific design limitation that restricts the measurement to a maximum of 10 mm of rainfall at one time. After 10 mm of rainfall, siphoning takes place

d) 10 mm

Then we take up the next example, example 3: a float and siphon type rain recording rain gauge measures a maximum of this much millimetre of rainfall at one time. Options are given: 4 options are given. And if you recall, the float or siphon type of rain gauge recording rain gauge, we always say that there is a specific design limitation for each of the gauges. And in the case of float siphon type, if you remember, we showed this typical chart where the depth scale is 10 mm. So, what happens is that when the rainfall reaches 10 mm of depth, then siphoning occurs. So, basically, it has a maximum of 10 mm of rainfall at one time; after 10 mm of rainfall, siphoning takes place. So, that means the correct answer is 10 mm, and that is option D is the correct answer.

Objectives: Module 2

Example 4

The formula for estimation of evapotranspiration using only temperature and day length is known as

- a) Thornthwaite formula
- b) Penman formula
- c) Christiansen formula
- d) Blaney-Criddle formula

Solution:

Penman $E_{PET} = \frac{\lambda}{\lambda + \gamma} \left(\frac{R_n}{\lambda} + \frac{\gamma}{\lambda + \gamma} \frac{6.43(f_u)D}{\lambda} \right)$ Includes radiation, vapour pressure, wind speed etc.

Christiansen method includes radiation, air temperature, wind speed, relative humidity, sunshine percentage and elevation

Blaney-Criddle $ET_0 = p (0.46 T_{mean} + 8)$ T and p (mean daily percentage of annual daytime hours)

Thornthwaite $E_T = 2.54 KF$; $F = \sum \frac{P_h \bar{Y}_f}{100}$ Includes crop factor, besides T and P

(d) Blaney-Criddle formula

Then we take the next example: the formula for estimation of evapotranspiration using only temperature and day length is known as 4 methods are given: Thornthwaite, Penman, Christiansen, and Blaney Criddle.

We studied at least 3 of these methods, and we know that the Penman method is the most advanced, which includes radiation, vapor pressure, and wind speed. Another advanced version is the FAO 24 Penman, which is the standard ET equation, but modifications have been made to it. Then, Christiansen's method includes radiation, air temperature, wind speed, relative humidity, sunshine, and elevation. Blaney Criddle, if you take it, uses P and T mean, where T is the temperature and P is the mean daily percentage of annual daytime hours. Thornthwaite uses a crop factor besides T and P. So, from these descriptions, we can see that the Blaney Criddle formula is the one which uses only temperature and day length, thus option D is the correct answer.

Objectives: Module 2

Example 5

The initial infiltration rate is at capacity rate if the intensity of rainfall is

- Less than the average rate of infiltration
- Less than the infiltration capacity of soil
- Equal to or more than the average rate of infiltration
- Equal to or more than the infiltration capacity of soil

Solution:

- When the intensity of rainfall matches or exceeds the infiltration capacity, the soil is not able to absorb water as fast as it is being applied, leading to excess water on the soil surface. This excess water contributes to surface runoff

d) Equal to or more than the infiltration capacity of soil

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Then we move on to example 5, which talks about the initial infiltration rate. When the intensity of rainfall matches or exceeds the infiltration capacity, the soil is not able to absorb water as fast as it is being applied, leading to excess water on the soil surface. So, obviously, the initial infiltration capacity will be at capacity rate if the intensity of rainfall is equal to or more than the infiltration capacity of the soil. Option D is the correct answer.

Objectives: Module 2

Example 6

The infiltration capacity of a basin is described by the Horton's equation, $I = 2 + e^{-3t}$, where I is in cm/h and the duration, t is in h. If the duration of the storm event is 2 h, the depth of the infiltration in the last 1 h of the storm event in mm is

- a) 5.16 (b) 10.16
c) 20.16 (d) 25.16

Solution:

- Integrating I with respect to t , we get

$$\int_1^2 I dt = \int_1^2 (2 + e^{-3t}) dt = 2t - \frac{e^{-3t}}{3}$$

Thus, infiltration in the 2nd hour is

$$\left(2 \times 2 - \frac{e^{-3 \times 2}}{3}\right) - \left(2 \times 1 - \frac{e^{-3 \times 1}}{3}\right) = 2.016 \text{ cm} = 20.16 \text{ mm}$$

Next, in example 6, we have to find the depth of infiltration in the last 1 hour of a 2-hour storm event, given Horton's equation. Integrating between 1 and 2 hours, we find that the infiltration depth is 2.016 centimeters or 20.16 millimeters, so option C is the correct answer.

Objectives: Module 3

Example 7

Off-stream storage ponds are constructed

- a) Far away from a continuously flowing stream
b) Along the continuously flowing stream
c) Across the continuously flowing stream
d) Near the continuously flowing stream

Solution:

- Off-stream storage ponds, also known as off-channel or off-stream reservoirs, are constructed far away from a continuously flowing stream. They are built to store water during periods of excess availability, such as during the wet season or when streamflow is high.

- a) Far away from a continuously flowing stream

Example 7 is about upstream storage ponds, which are constructed far away from continuously flowing streams. They are built to store water during periods of excessive availability, away from the stream. Therefore, option A is the correct answer.

Objectives: Module 3

Example 8

Interception loss is

- a) More towards end of a storm
- b) More at the middle of the storm
- c) More at the beginning of the storm
- d) Uniform throughout the storm

Solution:

- At the onset of a storm, the vegetation may not be saturated. Thus, the canopy can capture a higher proportion of the incoming rainfall. As the storm progresses and the canopy becomes saturated, the interception capacity decreases.

- c) More at the beginning of the storm

Finally, in example 8, interception losses are highest at the beginning of the storm when the canopy can capture a higher proportion of the incoming rainfall. As the storm progresses and the canopy becomes saturated, the interception capacity decreases. So, the highest value of interception will be at the beginning of the storm.

Objectives: Module 3

Example 9

The dilution technique of flow measurement depends on which principle

- a) Continuity
- b) Momentum
- c) Continuity and momentum
- d) Concentration

Solution:

- The dilution technique of flow measurement is based on the principle of continuity or mass conservation.
- In the dilution method, a known quantity of a tracer substance is introduced into the flowing stream, and the resulting dilution of the tracer is used to estimate the flow rate of the water

- a) Continuity

In example 9, the dilution technique of flow measurement depends on which principle? The correct principle is continuity or mass conservation. In the dilution method, a known quantity of tracer substance is introduced into the flowing stream, and the resulting dilution of this tracer is used to estimate the flow rate of the water. Therefore, the correct answer is A, the principle of continuity.

Objectives: Module 4

Example 10

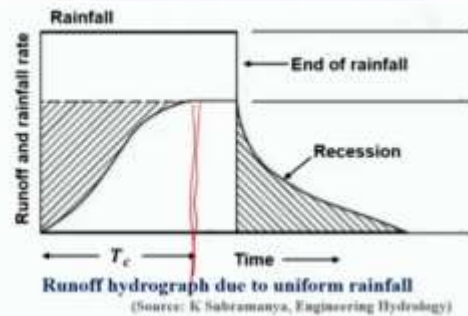
In the rational method of runoff prediction, rainfall occurs at uniform intensity for a duration at least equal to the _____ of the watershed

- Time lag
- Time of concentration
- Time to peak
- Storm duration

Solution:

- Rational method has the assumption of the uniform distribution of rainfall over the watershed for a duration equal to the time of concentration. This assumption implies that the entire watershed contributes runoff.

- Time of concentration



Moving on to example 10, in the rational method of runoff prediction, rainfall occurs at a uniform intensity for a duration at least equal to the dash of the watershed. The correct term here is "time of concentration." The rational method assumes a uniform distribution of rainfall over the watershed for a duration equal to the time of concentration, ensuring that the entire watershed contributes to runoff.

Objectives: Module 4

Example 11

A catchment has an area of 150 ha and a runoff/rainfall ratio of 0.4. If due to a 100 mm rainfall over the catchment, runoff at the catchment outlet lasts for 10 h, the average runoff in the period is

- 1.33 m³/s
- 16.7 m³/s
- 100 m³/min
- 6 × 10⁴ m³/h

Solution:

$$\text{Total rainfall volume generated over the catchment} = \frac{100}{1000} \times 150 \times 10^4 = 15 \times 10^4 \text{ m}^3$$

$$\text{Thus, total runoff generated} = 0.4 \times 15 \times 10^4 = 6 \times 10^4 \text{ m}^3$$

$$\text{Thus, average runoff} = (6 \times 10^4) / (10 \times 3600) = 1.67 \text{ m}^3/\text{s} = 100 \text{ m}^3/\text{min}$$

c) 100 m³/min

Example 11 involves calculating the average runoff rate given the catchment area, runoff rainfall ratio, and duration of runoff. After converting units appropriately, the average runoff rate is found to be 100 cubic meters per minute, making option C the correct answer.

Objectives: Module 4

Example 12

Cook's Method is used for the estimation of:

- Baseflow
- Peak rate of runoff
- Evapotranspiration
- Infiltration

Solution:

- Cook's Method is used for estimating the peak rate of runoff in small to medium-sized watersheds. The runoff characteristics of a watershed are carried under four categories: Relief, Soil infiltration, Vegetation cover, and Surface depression.

$$Q_p = PRFS$$

Where, Q_p = Peak runoff for specified geographical location and recurrence interval (m^3/s), P = Uncorrected peak runoff rate (m^3/s), R = Geographic rainfall factor (different for different regions), F = Frequency factor, and S = Shape factor

Finally, in example 12, Cook's method is used for the estimation of the peak rate of runoff in small to medium-sized watersheds.

Runoff characteristics of watersheds are analysed under four categories: relief, soil infiltration, vegetation cover, and surface preparation. Then, we use the relationship $Q=PRFS$ for calculating the peak runoff rate. So, basically, the answer is the peak rate of runoff, which is option B.

Objectives : Module 5

Example 13

The concept of "linearity" in unit hydrograph theory implies that:

- The hydrograph has a linear shape
- The unit hydrograph response is proportional to the amount of rainfall
- The watershed slope is constant
- The unit hydrograph is always a straight line



Solution:

- The concept of "linearity" in unit hydrograph theory implies that the hydrological response of a watershed to a unit depth of rainfall is assumed to be linear. It suggests that the response of the watershed to a complex storm can be estimated by superimposing or scaling the unit hydrograph response of a simpler unit storm

- The unit hydrograph response is proportional to the amount of rainfall

Moving on to example 13, the concept of linearity in unit hydrograph theory implies that the hydrograph has a linear shape. The correct interpretation is that the unit hydrograph responds in proportion to the amount of rainfall. It doesn't necessarily mean that the hydrograph is always

a straight line. This can be determined through an elimination process, as hydrographs typically exhibit curvilinear shapes rather than straight lines.

And the watershed slope does not come into the picture as far as the hydrograph is concerned. So, the only possible option is that the unit hydrograph response is proportional to the amount of rainfall. The explanation is that the concept of linearity in unit hydrograph theory implies that the hydrological response of a watershed to a unit depth of rainfall is assumed to be linear. This means that the response of the watershed to a complex storm can be estimated by superimposing or scaling the unit hydrograph response of a simpler unit storm. So, the correct option is option B, as I already mentioned through the process of elimination.

Objectives : Module 5

Example 14

If a 4-h UH of a catchment has a peak ordinate of $60 \text{ m}^3/\text{s}$, the peak ordinate of 8-h UH for the same catchment will be

a) $< 60 \text{ m}^3/\text{s}$

b) $> 60 \text{ m}^3/\text{s}$

c) $= 60 \text{ m}^3/\text{s}$

d) Data inadequate

Solution:

- A unit hydrograph is based on the principle of linearity and the principle of superposition. If a D-h unit hydrograph is available, a UH with other duration such as 2D, 3D, etc. can be obtained easily from the principle of superposition. As the duration of the unit hydrograph increases, the base period also increases, and consequently, the peak ordinate decreases.

a) $< 60 \text{ m}^3/\text{s}$

The diagram shows a hydrograph with a peak labeled '4h' and a longer, lower peak labeled '8h', illustrating that as duration increases, the peak ordinate decreases.

Moving on to example 14, a 4-hour unit hydrograph of a catchment has a peak ordinate of 60 cubic meters per second. The peak ordinate of an 8-hour unit hydrograph for the same catchment will be less than that. There are four options given, and of course, we know that if we are given a 4-hour unit hydrograph, then we can develop the 8-hour unit hydrograph.

So, if we have a 4-hour unit hydrograph given, then for developing an 8-hour unit hydrograph, we use the principle of superposition. That means, the two 4-hour unit hydrographs, because $n=2$, will be superimposed, each lagging the previous one by 4 hours. That is the concept we use, or that is the procedure we use. And of course, as you know, with a unit hydrograph, the base increases, and the peak decreases. So, the peak ordinate of an 8-hour unit hydrograph will always be less than 60 cubic meters per second. This means that the base period increases, so the peak ordinate will obviously decrease. Thus, option A, "less than 60 cubic meters per second," is the correct answer.

Objectives : Module 5

Example 15

For a catchment with an area of 400 km², the equivalent discharge of the S-curve obtained by summation of 4-h UH is

- a) 100 m³/s (b) 139 m³/s
c) 200 m³/s (d) 278 m³/s

Solution:

Equivalent discharge of the S-curve is given by,

$$Q_e = 2.78 \frac{A \text{ (km}^2\text{)}}{D \text{ (h)}}$$

Thus, for the given data, $Q_e = 2.78 \frac{400}{4} = 278 \text{ m}^3/\text{s}$

- d) 278 m³/s

Next, for a catchment with an area of 1400 square kilometers, the equivalent discharge of the S-curve obtained by summation of the 4-hour unit hydrograph can be calculated using the formula $Q_e = 2.78 \times A/D$, where A is in square kilometers and D is in hours. With the area given as 400 square kilometers and D given as 4 hours, plugging these values into the equation yields $Q_e = 278$ cubic meters per second, matching option D. So, option D is the correct answer for this question.

Objectives: Module 6

Example 16

A synthetic unit hydrograph can be developed for a basin

- a) Having a rain gauge network but no stream gauging station
b) In which the stream is being regularly gauged
c) Having no rain gauge network and stream gauging station
d) By taking the basin slope as an index

Solution:

- A synthetic unit hydrograph is developed for a basin when observed data, such as rainfall and streamflow records, are not available or are insufficient for hydrological analysis. Developing a synthetic unit hydrograph involves applying various methods that use basin characteristics and geomorphological parameters to estimate the hydrograph's shape and magnitude.

- c) Having no rain gauge network and stream gauging station

Then, in example 16, a synthetic unit hydrograph can be developed for a basin having a rain gauge network but no stream-gauging station. Conversely, it can also be developed for a basin with no rain gauge network or stream-gauging station, using basin slope as an index. So, we use a synthetic unit hydrograph when observed data such as rainfall and stream flow records

Objectives: Module 7

Example 18

The area of a watershed is 130 km². The distance and elevation difference between the outlet and the farthest point in the watershed are 20 km and 740 m, respectively. The total length of all order streams is 650 km. The drainage density of the watershed is

- a) 10 km km⁻²
- b) 5 km km⁻²
- c) 0.15 km km⁻²
- d) 0.01 km km⁻²

Solution:

Drainage density is defined as the length of drainage per unit area

$$D_d = \frac{L}{A} = \frac{650}{130} = 5 \text{ km km}^{-2}$$

b) 5 km km⁻²

Moving on to example 18, the area of the watershed is 130 square kilometers, and the distance and elevation difference between the outlet and the farthest point in the watershed are given as 20 kilometers and 740 meters, respectively. The total length of all-order streams is 650 kilometers. The drainage density (D_d) of the watershed, calculated as the length of drainage area per unit area, is $\frac{L}{A}$. Although additional data is given, such as elevation difference and distance, these are not needed. The D_d value comes out to be 5 kilometers per square kilometer. So, option B is the correct answer. This is just to demonstrate that additional data might be given to confuse you, testing your conceptual clarity.

Objectives : Module 7

Example 19

What does Integrated Watershed Management involve

- a) Focusing solely on agricultural practices
- b) Separating water quality management from land use planning
- c) Addressing the interdependence of land, water, vegetation, and people
- d) Ignoring the ecological aspects of watersheds

Solution:

- Integrated Watershed Management involves a holistic and collaborative approach that integrates the environmental, economic and social aspects. Thus, it addresses the interdependence of land, water, vegetation, and people

c) Addressing the interdependence of land, water, vegetation, and people



Next, in example 19, integrated watershed management involves a holistic and collaborative approach that integrates environmental, economic, and social aspects, addressing the

interdependence of land, water, vegetation, and people. Since integrated watershed management focuses on the environment, economy, and societies, option C, addressing the interdependence of land, water, vegetation, and people, is the correct answer.

Objectives: Module 8

Example 20


What does a Distributed Hydrological Model consider in its simulations

- Aggregated catchment properties
- Uniform precipitation patterns
- Homogeneous soil characteristics
- Spatial variability within a watershed

Solution:

- A Distributed Hydrological Model considers spatial variability within a watershed in its simulations, taking into account the heterogeneity of land surface characteristics, such as topography, land cover, soil types, and land use, across different locations within the watershed
- Here, options (a) – (c) refer to the lumped approach

d) Spatial variability within a watershed



Then, in example 20, a distributed hydrological model considers spatial variability within the watershed in its simulation, taking into account the heterogeneity of land surface characteristics such as topography, land cover, soil types, and land use across different locations within the watershed. Options A to C, which refer to aggregated catchment properties, uniform precipitation patterns, and homogeneous soil characteristics, belong to or refer to the lumped approach. Therefore, the only suitable option for a distributed hydrological model is D, especially variability within the watershed.

Objectives: Module 8

Example 21


Proxy Catchment Test involves

- Calibrating the model against data for one catchment and then running a validation test for the other catchment
- Calibrate for high flows and validate for low flows and vice-versa
- One period of observations is used in model calibration and one or more separate periods are used in model validation
- Only validation of datasets

Solution:

- The proxy catchment test uses data of two catchments to show that the model has even greater general validity. On the contrary, options (c) and (b) refer to split sample and differential split sample tests

a) Calibrating the model against data for one catchment and then running a validation test for the other catchment



Lastly, in example 21, proxy catchment tests involve...

Then, the proxy catchment test uses data from two catchments to show that the model has general validity. On the contrary, option C, which states that one period of observation is used for model calibration and another period for model variation, refers to split-sample testing. Option B, which suggests calibration for high flows and validation for low flows, and vice versa, represents a differential split-sample test. Therefore, in this case, since only validation data is used, it has nothing to do with calibration. Thus, option A, calibrating the model against data for one catchment and then conducting validation tests for the other catchment, is the correct answer to this question.

Objectives: Module 9

Example 22

How does urbanization typically impact flood in a watershed

- a) It reduces peak flows
- b) It increases time of concentration
- c) It increases peak flows
- d) It has no effect on flood routing

Solution:

- Urbanisation can increase the risk of flooding by reducing natural permeable surfaces, such as forests and wetlands, and increasing the amount of impervious surfaces, like roads and buildings

c) It increases peak flows

Moving on to example 22, urbanization typically impacts floods in a watershed by increasing the risk of flooding. This is due to the reduction of natural permeable surfaces such as forests and wetlands, leading to an increase in impervious surfaces like roads and buildings. Consequently, infiltration decreases, while flooding increases, resulting in an increase in peak flows. Therefore, option C, increases peak flows, is the correct answer.

Objectives: Module 9

Example 23

A soil conservation structure has an expected life of 10 years and is designed for a flood magnitude of return period 50 years. The risk of this hydrologic design in percentage is.

- a) 21.2 (b) 18.6
c) 18.3 (d) 21.3

Solution:

$$\text{The risk, } \bar{R} = 1 - \left(1 - \frac{1}{T}\right)^n$$

Here $n = 10$ years and $T = 50$ years

$$\bar{R} = 1 - \left(1 - \frac{1}{50}\right)^{10} = 0.183$$

- c) 18.3

Then, in example 23, a soil conservation structure with an expected life of 10 years is designed for a flood magnitude with a return period of 50 years. The risk of this hydrological design, expressed as a percentage, can be calculated using the formula $1 - \left(1 - \frac{1}{T}\right)^n$, where T is the return period (given as 50 years) and n is the expected life of the structure (given as 10 years). Substituting these values, we get a result of 18.3 percent, which matches option C.

Objectives: Module 9

Example 24

Which factor is a primary cause of riverine floods

- a) Excessive groundwater recharge
b) Intense rainfall and snowmelt
c) Limited vegetation cover
d) Low atmospheric pressure

Solution:

- Riverine floods are caused by overflow of rivers due to excessive rainfall, rapid snowmelt, or a combination of factors

- b) Intense rainfall and snowmelt

In example 24, the primary cause of riverine floods is intense rainfall and snowmelt, leading to the overflow of rivers. Therefore, option B, intense rainfall, and snowmelt, is the correct choice.

Objectives: Module 10

Example 25

The hydrologic reservoir routing methods use

- a) Bernoulli's equation only
- b) Hydrologic continuity equation only
- c) Muskingum equation only
- d) Both the hydraulic momentum and hydrologic continuity equations

Solution:

- The hydrologic flood routing methods use the equation of continuity, while the hydraulic routing methods use the equation of continuity and the equation of motion (momentum equation (Saint Venant Equation))

- b) Hydrologic continuity equation only

Lastly, in example 25, hydrological reservoir routing methods use the hydrological continuity equation. So, option B, which states that hydrological reservoir routing methods use the hydrological continuity equation, is correct.

Objectives: Module 10

Example 26

In the Muskingum method of channel routing, the routing equation is written as $Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$. If the storage-time constant $K = 12$ h, weighting factor $x = 0.15$ and the time step for routing $\Delta t = 4$ h, the coefficient C_0 is

- a) 0.016
- b) 0.048
- c) 0.328
- d) 0.656

Solution:

$$C_0 = \frac{(-Kx + 0.5 \Delta t)}{(K - Kx + 0.5 \Delta t)} = \frac{(-12 \times 0.15 + 0.5 \times 4)}{(12 - 12 \times 0.15 + 0.5 \times 4)} = 0.016$$

- a) 0.016

In the Muskingum method of channel routing, the routing equation is written as Q_2 , as given in the equation. If the storage time constant K is 12 hours and the weighing factor x is 0.15, the time for routing, Δt , is 4 hours, and the coefficient C_0 is. We have to remember this question and the formulae for C_1 , C_0 , and C_2 . Of course, we only have to calculate C_0 , and we know that C_0 is given by this equation: $C_0 = \frac{-Kx + 0.5 \Delta t}{K - Kx + 0.5 \Delta t}$. We have been given Kx and Δt values here. Kx and Δt are already given. So, putting these values, we calculate C_0 to be 0.016. So, that means, option A is the correct answer to this particular question.

Objectives: Module 10

Example 27

Kinematic Wave Celerity is given by

a) $c_k = \frac{1}{B} \frac{dQ}{dy}$ ✓

(b) $c_k = \frac{1}{B} \frac{dA}{dy}$

c) $c_k = \frac{1}{B} \frac{dH}{dy}$

(d) $c_k = \frac{1}{B} \frac{dQ^2}{dy}$

Solution:

- The kinematic wave celerity is expressed as

$$c_k = \frac{dQ}{dA} = \frac{1}{B} \frac{dQ}{dy} \quad \text{where,} \quad dA = B dy$$

a) $c_k = \frac{1}{B} \frac{dQ}{dy}$

Then we go to example number 27, which relates to kinetic wave celerity. Kinetic wave celerity, given by the equation, is provided. This means you have to remember the formula, and you know that we discussed kinetic wave celerity and derived the formula also. C_k is dQ/dA , or if we express it in terms of bed width, then we will get $\frac{1}{B} \times \frac{dQ}{dy}$, and this matches straight away with option A. So, option A is the correct answer to this particular question.

Objectives: Module 11

Example 28

Given the reflectance of red light of 0.06 and reflected near-infrared light of 0.65, the NDVI will be

a) 0.53

b) 0.83

c) 0.73

d) 0.33

Solution:

$$NDVI = \frac{(NIR - R)}{(NIR + R)} = \frac{(0.65 - 0.06)}{(0.65 + 0.06)} = 0.83$$

b) 0.83

Then we go to example number 28. Given the reflectance of red light of 0.06 and reflected near-infrared light of 0.65, the NDVI value will be. Options are given as 0.53, 0.83, 0.73. Obviously, you have to remember the formulae of NDVI and calculate the value, and we know that NDVI is given by this relationship: $\frac{(NIR - R)}{(NIR + R)}$, where NIR value is given as 0.65 and R value

is given as 0.06. Putting the values of NIR and R in the numerator and denominator, we get an NDVI value of 0.83, which matches option B. So, option B is the correct answer to this particular question.

Objectives: Module 11

Example 29

The most common chemicals used for cloud seeding is

- a) Silver iodide
- b) Dry Potassium
- c) Sodium iodide
- d) Ice

Solution:

- ✓ Cloud seeding is a type of weather modification that aims to change the amount or type of precipitation that falls from clouds by dispersing substances into the air that serve as cloud condensation or ice nuclei, which alter the microphysical processes within the cloud
- ✓ The most common chemicals used for cloud seeding include silver iodide, potassium iodide and dry ice (solid carbon dioxide) to aid in the formation of ice crystals

a) Silver iodide

The slide also features a small inset video of a man in a white shirt and dark vest, and several logos at the bottom left.

Then we take example 29. The most common chemical used for cloud seeding is silver iodide, dried potassium sodium iodide, ice. Of course, if you remember, you can easily pick the answer, but just to recall the concept, cloud seeding is a type of weather modification that aims to change the amount or types of precipitation that fall from clouds by dispersing substances into the air that serve as cloud condensation or ice nuclei, which alter the microphysical process within the cloud. So, basically, as we discussed, we artificially create hygroscopic materials through so that condensation could take place, and the most common chemicals used for cloud seeding include silver iodide, potassium iodide, and dry ice or solid carbon dioxide to aid in the formation of ice crystals. We also discussed that silver iodide is also naturally available in the atmosphere. So, obviously, the only possible answer to this question is silver iodide. So, option A is the correct answer. With this, we come to the end of this lecture. We have covered 29 different problems that appeared in GATE examinations in different years, and we also reviewed our concepts while solving these questions. Obviously, if you aim to pursue higher studies, you have to write the GATE examination, and of course, then you need to prepare for these questions. If you have any questions or doubts, please read the queries and also provide your feedback. Thank you very much.

