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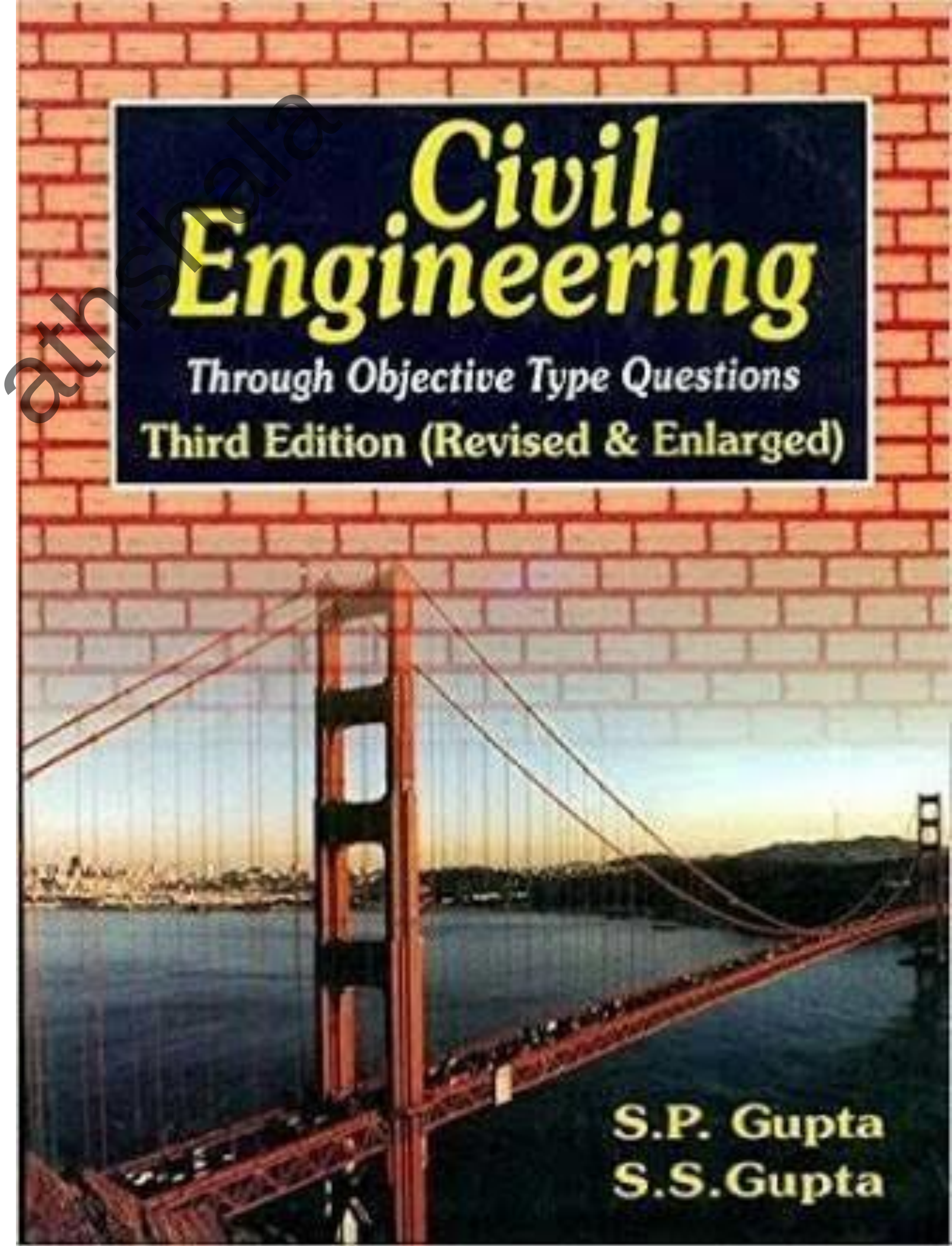
Objective Questions (01 to 15)

Irrigation & Hydrology



Q. 1) Which of the following methods of applying water may be used on rolling land

A. Boarder flooding
B. Check flooding
C. Furrow flooding
D. Free flooding

Answer A

Boarder flooding: - The land is divided into a number of strips, separated by low levees called boardes.

Q. 2) If the electrical conductivity of water is in between 250 to 750 micro mhos/cm at 25 °C, then it is classified as

A. Low salinity water
B. Medium salinity water
C. High salinity water
D. Very high salinity water

Answer B

Classification of irrigation water based on salt concentration

S. No.	Type of water	Suitability for irrigation
1.	**Low salinity water (C1)** Conductivity between 100 to 250 micromhos/cm at 25°C	Suitable for all types of crops and all kinds of soils. Permissible under normal irrigation practices except in soils of extremely low permeability.
2.	**Medium salinity water (C2)** Conductivity between 250 to 750 micromhos/cm at 25°C	Can be used, if a moderate amount of leaching occurs. Normal salt tolerant plants can be grown without much salinity control.
3.	**High salinity water (C3)** Conductivity between 750 to 2250 micromhos/cm at 25°C	Unsuitable for soil with restricted drainage. Only high-salt tolerant plants can be grown.
4.	**Very high salinity (C4)** Conductivity more than 2250 micromhos/cm at 25°C	Unsuitable for irrigation.

3. Sodium Absorption Ratio (SAR) is defined as

a) $$\frac{Na^{+}}{\sqrt{Ca^{++} + Mg^{++}}}$$

b) $$\frac{Na^{+}}{2\sqrt{Ca^{++} + Mg^{++}}}$$

c) $$\frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

d) $$\frac{2\,Na^{+}}{\sqrt{Ca^{++} + Mg^{++}}}$$

Answer C

Q. 4) The value of sodium absorption ratio for high sodium water lies between

A. 0 to 10
B. 10 to 18
C. 18 to 26
D. 26 to 34

Answer C

Classification of Irrigation water based on Sodium Absorption Ratio

S. No.	*Types of water*	*Suitability for irrigation*
1.	**Low sodium water (S1)** SAR : 0 to 10	Suitable for all types of crops and all types of soils, except for those crops which are highly sensitive to sodium.
2.	**Medium sodium water (S2)** SAR : 10 to 18	Suitable for coarse textured or organic soil with good permeability. Relatively unsuitable in fine textured soils.
3.	**High sodium water (S3)** SAR : 18 to 26	Harmful for almost all types of soils ; Requires good drainage, high leaching, gypsum addition.
4.	**Very high sodium water (S4)** SAR : above 26	Unsuitable for irrigation.

Q. 5) Optimum depth of kor watering for rice is

A. 135 mm
B. 165 mm
C. 190 mm
D. 215 mm

Answer C

The first watering is known as kor watering and the depth applied is known as kor depth.

The kor depth for rice is 190 mm.

Q. 6) Irrigation water having the concentration of Na^{++}, Ca^{++} and Mg^{++} as 20, 3 and 1 milli equivalent per litre respectively will be classified as

A. Low sodium water
B. Medium sodium water
C. High sodium water
D. Very high sodium water

Answer B

Sodium Absorption Ratio (SAR)

$$= \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

$$= \frac{20}{\sqrt{\frac{3+1}{2}}} = \frac{20}{\sqrt{2}} = 14.14$$

Medium sodium water (10 - 18)

Q. 7) The relation between duty D in hectares/cumec, depth of water Δ in metres and base period B in days is given by

A. $\Delta = 1.98B/D$
B. $\Delta = 8.64B/D$
C. $\Delta = 5.68B/D$
D. $\Delta = 8.64D/B$

Answer B

Duty (D) : - duty is defined as the area of land expressed in hectares that can be irrigated with unit discharge, that is, 1 cumec flowing throughout the base period, expressed in days.

Delta (Δ) : - Delta is the total depth of water required by a crop during entire period the crop is in the field.

Base Period (B) : - when irrigation water is first issued for preparation of the ground for planting the crop to, its last watering before harvesting.

If we take a field of area D hectares, water supplied to the field corresponding to the water depth Δ metres will be

$$= \Delta \times D \text{ hectare-metres}$$

$$= D \times \Delta \times 10^4 \text{ m}^3 \ldots\ldots\ldots\ldots\ldots (1)$$

Again for the same field of D hectares, one cumec of water is required to flow during the entire base period. Hence water supplied to this field

$$= 1 \times (\, B \times \times 24 \times 60 \times 60) \text{ m}^3 \ldots\ldots\ldots\ldots\ldots (2)$$

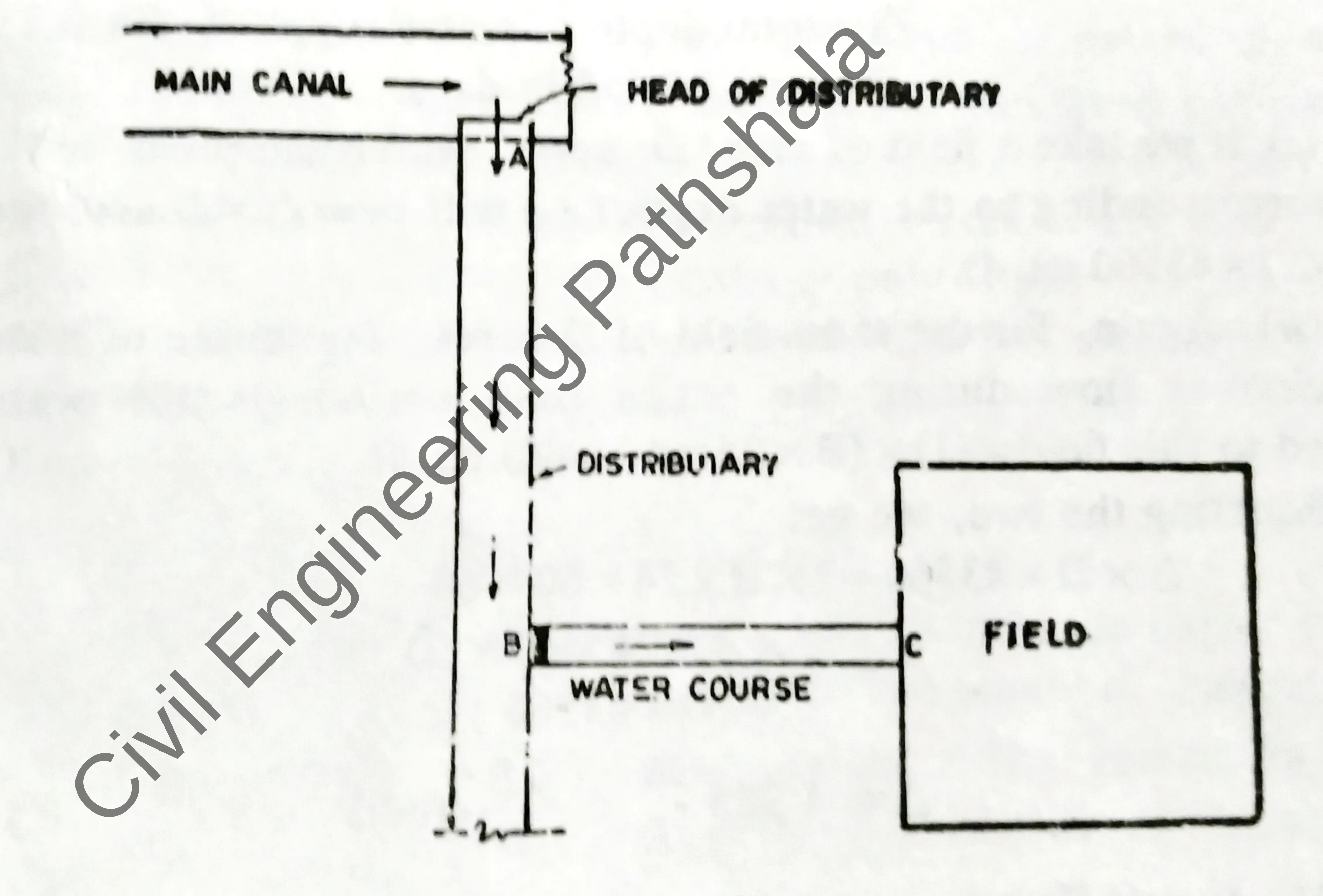
equating equations (1) and (2), we get

$$D\,\Delta = 8.64\,B$$

Q. 8) The duty is largest

A. At the head of water course
B. On the field
C. At the head of main canal
D. Same at all places

Answer B



MAIN CANAL
HEAD OF DISTRIBUTARY
A
DISTRIBUTARY
B
C
FIELD
WATER COURSE

Q. 9) The “outlet discharge factor” is the duty at the head of

A. Main canal
B. Branch canal
C. Watercourse
D. Distributory

Answer C

Q. 10) The kor depth for rice is 190 mm and kor periods is 14 days. The outlet factor for this will be

A. 637 hectares/m^3/sec
B. 837 hectares/m^3/sec
C. 972 hectares/m^3/sec
D. 1172 hectares/m^3/sec

Answer A

outlet factor – duty at the outlet

$$\Delta D = 8.64 B$$

Where,

D = duty in hectares/cumec

Δ = delta or total depth of water in m.

B = Base period in days.

$$\frac{190}{1000} \times D = 8.64 \times 14$$

$$D = 637 \text{ hectares/m}^3\text{/sec}$$

Q. 11) For supplying water to Rabi crop, kharif crop and sugarcane, the channel is designed for a capacity equal to the greater of water requirement of

A. Rabi or kharif
B. Rabi and kharif or sugarcane
C. Rabi and sugarcane or kharif and sugarcane
D. Rabi or kharif or sugarcane

Answer C

Q. 12) The ratio of the quantity of water stored in the root zone of the crops to the quantity of water actually delivered in the field is known as

A. Water conveyance efficiency
B. Water application efficiency
C. Water use efficiency
D. None of the above

Answer B

In general, efficiency is the ratio of the water output to input.

1. Water conveyance efficiency: - Ratio of Water delivered to farm or irrigation plot to water supplied from river or reservoir.

2. Water application efficiency: - Ratio of water stored in root zone to water delivered to the farm.

3. Water use efficiency: - Ratio of water used consumptively to water delivered.

Q. 13) The water utilizable by plants is available in soils mainly in the form of

A. Gravity water
B. Capillary water
C. Hydroscopic water
D. Chemical water

Answer B

Water present in the soil may classified

1. Hygroscopic water: - When an oven dried sample is kept open in the atmosphere, it absorbs some amount of water from the atmosphere. This is known as hygroscopic water

2. Capillary water: - Excess of hygroscopic water which exists in the pore space of soil by molecular attraction.

3. Gravity water: - Excess of hygroscopic and capillary water which will move out of soil.

Q. 14) The amount of irrigation water required to meet the evapotranspiration needs of the crop during its full growth is called

A. Effective rainfall
B. Consumptive use
C. Consumptive to irrigation requirement
D. Net irrigation requirement

Answer C

Evapotranspiration rate is the amount of water that is lost to the atmosphere through the leaves of the plant, as well as the soil surface.

Q. 15) With the increase in the quantity of water supplied, the yield of most crops

A. Increases continuously
B. Decreases continuously
C. Increases upto a certain limit and then becomes constant
D. Increases upto a certain limit and then decreases

Answer D

The plant growth may be retarded if the soil moisture is either deficient or excessive.

1. If the soil moisture is only slightly more than the wilting coefficient, the plant must extend extra energy to obtain it, and the plant will not grow healthy
Wilting coefficient- That water content at which plants no longer extract sufficient water from the soil for its growth.

2. Similarly, excessive flooding fills the soil pores with water, thus driving out air. Since air is essential to satisfactory plant growth, excessive water supply retard plant growth.

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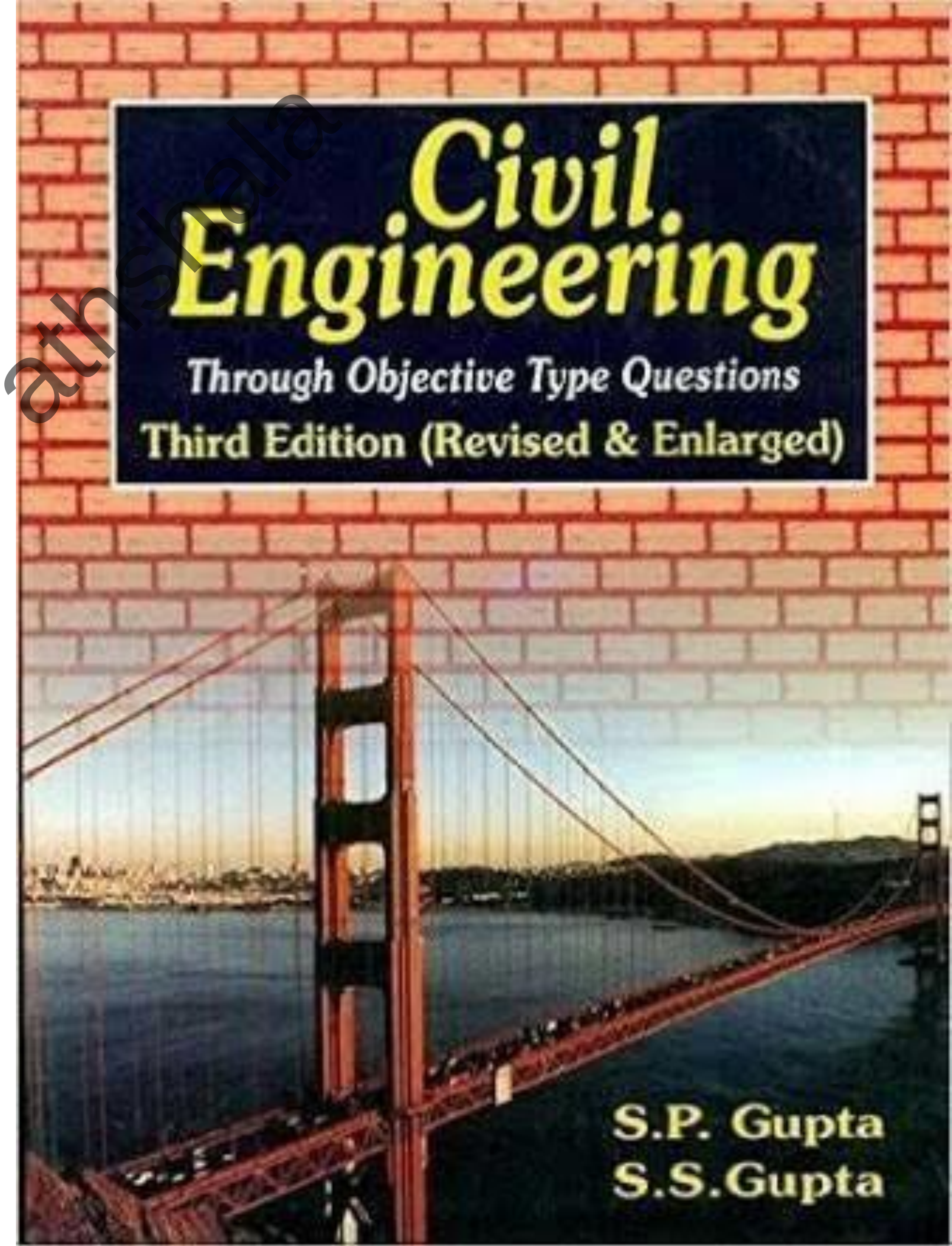
Objective Questions
(16 to 30)

Irrigation & Hydrology



Q. 16) Hydrograph is the graphical representation of

A. Runoff and time
B. Surface runoff and time
C. Ground waterflow and time
D. Rainfall and time

Answer A

Runoff is that portion of precipitation that is not evaporated. Which ultimately runs to the ocean through surface or sub surface streams.

1. Surface runoff:- Water flows to land and is first to reach streams and rivers, which ultimately discharge the water to the sea.

2. Interflow or sub surface runoff: - A portion of precipitation infiltrates into surface soil and depending upon the geology of the basin runs as sub surface runoff and reaches the streams and rivers.

3. Ground water flow or base flow: - It is that portion of precipitation, which after infiltration, percolates down and join the ground water Reservoir which is ultimately connected to the ocean.

Q. 17) Infiltration rate is always

A. More than the infiltration capacity
B. Less than the infiltration capacity
C. Equal to or less than the infiltration capacity
D. Equal to or more than the infiltration capacity

Answer C

Infiltration: - Water moving through a soil surface.

Infiltration rate: - That rate at which infiltration occurs, measured in mm/hour or a similar unit

Infiltration capacity: -Maximum rate at which infiltration will occur.

Q. 18) The depth of water required to bring the soil moisture content of given soil upto it’s field capacity is called

A. Hydroscopic water
B. Equivalent moisture
C. Soil moisture deficiency
D. Pellicular water

Answer C

Soil moisture deficiency:-

The difference between the amount of water actually in the soil and the amount of water that the soil can hold.

The amount of water the soil can hold is generally called field capacity.

Q. 19) infiltration capacity

A. Is a constant factor
B. Changes with time
C. Changes with location
D. Changes with both time and location

Answer D

Q. 20) Infiltration is the

A. Movement of water through the soil
B. Absorption of water by soil surface
C. Both A and B
D. None of the above

Answer A

Permeability

The ability of the ground surface to absorb water.

Q. 21) If the intensity of rainfall is more than the infiltration capacity of soil, then the infiltration rate will be

A. Equal to rate of rainfall
B. Equal to infiltration capacity
C. More than rate of rainfall
D. More than infiltration capacity

Answer B

Q. 22) Cyclonic precipitation is caused by lifting of an air mass due to

A. Pressure difference
B. Temperature difference
C. Natural topographical barriers
D. All of the above

Answer A

Precipitation is general term for all forms of moisture emanating from the clouds and falling to the ground.

Types of precipitation

1. **Cyclonic precipitation: -** lifting of air masses converging into low Pressure area or cyclone.

2. **Convective precipitation: -** Temperature difference may result from unequal heating at the surface, unequal cooling at the top of the air layer.

3. **Orographic precipitation: -** Due to natural topographical barriers such as mountains.

Q. 23) Which of the following is a non-recording raingauge

A. Tipping bucket type raingauge
B. Simon’s raingauge
C. Steven’s weighing type raingauge
D. Floating type raingauge

Answer B

Raingauge:- A device for collecting and measuring the amount of rain which falls.

1. Non recording raingauge: -
a) Simon’s raingauge

2. Recording raingauge: -
a) Weighing bucket raingauge
b) Tipping bucket raingauge
c) Float type raingauge

Q. 24) A raingauge should be preferably be fixed

A. Near the building
B. Under the tree
C. In an open space
D. In a closed space

Answer C

Selection the site for a raingauge station.

1. The site where a raingauge is setup should be an open place.

2. Distance between the raingauge and nearest object should be at least twice the height of the object.

3. The raingauge should never be situated on the side or top of a hill if the suitable site on the level ground can be found.

4. In The Hills situated where wind does not cause eddies.

5. Protect the gauge from cattle etc.

Q. 25) If allowable percentage error in the estimate of basic rainfall is E and coefficient of variation of rainfall is C, then the optimum number of raingauge is given by

A. C_v/E
B. $\sqrt{(C_v/E)}$
C. $(C_v/E)^2$
D. $(C_v/E)^{(3/2)}$

Answer C

Q. 26) Which of the following types of raingauge is used for measuring rain in remote hilly inaccessible areas

A. Tipping bucket type
B. Weighing type
C. Floating type
D. Simon's raingauge

Answer A

Q. 27) Rate of evaporation from a water surface increases if
i) difference of vapour pressure between water and air is increased
ii) velocity of wind is decreased
iii) concentration of soluble solids in water is decreased

The correct answer is
A. (i) and (ii)
B. (i) and (iii)
C. (ii) and (iii)
D. (i), (ii) and (iii)

Answer B

Factors affecting the evaporation are

1. Temperature: - ↑
2. Surface area: - ↑
3. Density: - ↓
4. Wind velocity: - ↑

Q. 28) A 70% index of wetness means

A. Rain excess of 30%
B. Rain deficiency of 30%
C. Rain deficiency of 70%
D. None of the above

Answer B

Q. 29) Under the same conditions, which of the following shapes of water surface will give the highest rate of evaporation

A. Flat water surface
B. Convex water surface
C. Concave water surface
D. Independent of shape of water surface

Answer B

Q. 30) Assertion A: To estimate the rainfall over a catchment, the number of raingauge required per unit area is large for hilly areas

Reason R: Rainfall gradient system

Select your correct answer according to the coding system given below

A. Both A and R are true and R is the correct explanation of A
B. Both A and R are true but R is not the correct explanation of A
C. A is true but R is false
D. A is false but R is true

Answer A

The broad guide lines set up for the required network of rain-gauge stations as per World Meteorological Organisation (WMO) is as follows:

For plain areas of the basin 1 rain-gauge for every 500 km^2.
For hilly areas of the basin: 1 rain-gauge for every 150 km^2.

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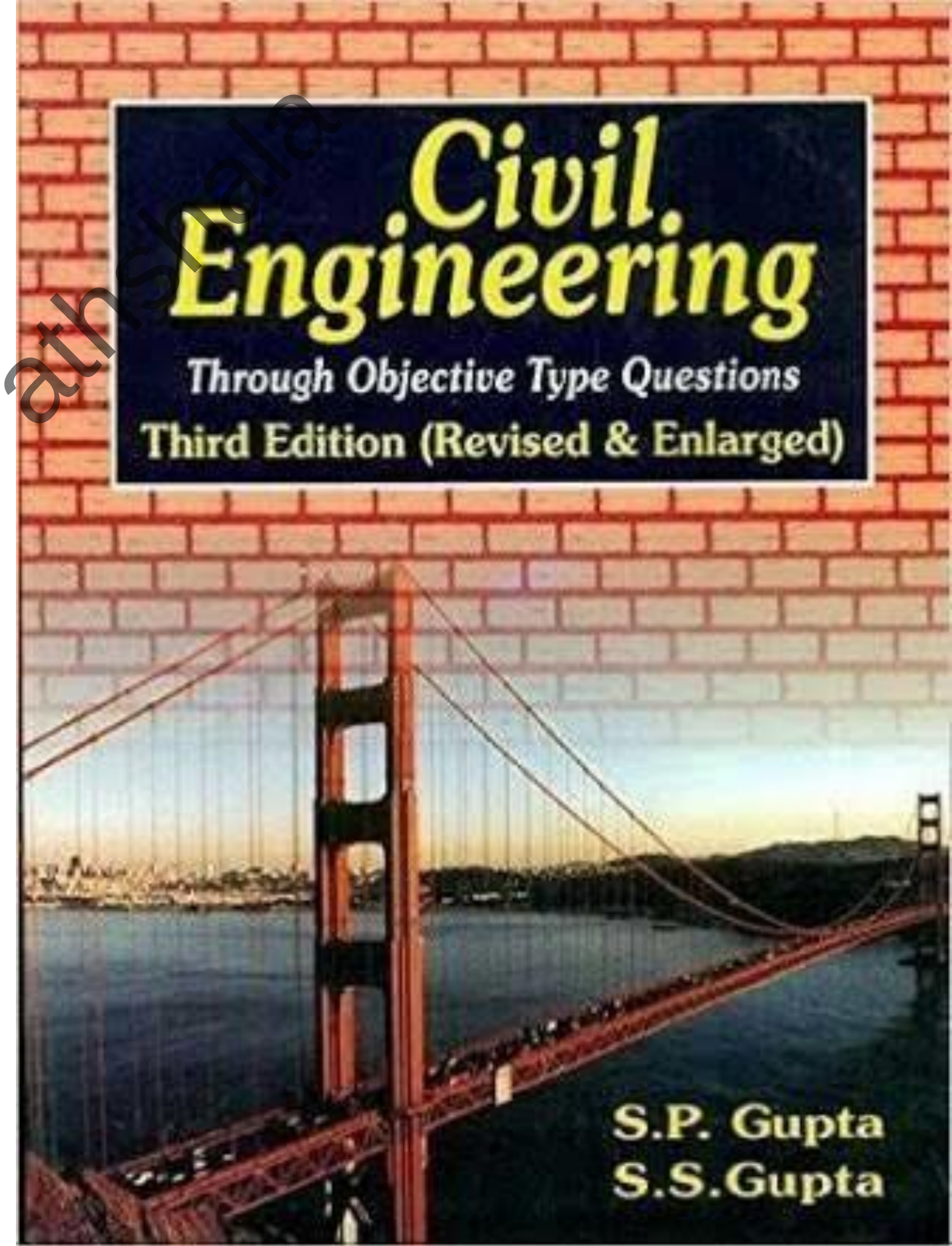
Objective Questions
(31 to 45)

Irrigation & Hydrology



Q. 31) When surface of transpiration is submerged under water, then potential evapotranspiration is

A. Much more than evapotranspiration
B. Much less than evapotranspiration
C. Equal to evapotranspiration
D. Equal to or less than evapotranspiration

Answer A

Evaporation:- The water from the surface of ocean, rivers, lakes and also from moist soil evaporates.

Transpiration:- Is the process of water being lost from the leaves of the plants.

Evapotranspiration = Evaporation + Transpiration

Potential evapotranspiration (PET):- Is defined as the amount of evaporation that would occur if a sufficient water source were available.

32. Coefficient of variation is given by

a) $\dfrac{\text{standard deviation}}{\text{mean}} \times 100$

b) $\dfrac{\text{variance}}{\text{mean}} \times 100$

c) $\dfrac{\text{mean}}{\text{standard deviation}} \times 100$

d) $\dfrac{\text{mean}}{\text{variance}} \times 100$

Answer A

The coefficient of variation represents the ratio of the standard deviation to the mean.

It is a useful for comparing the degree of variation from one data series to another.

Q. 33) Unit of runoff in M.K.S. System is

A. Cubic metre/sec
B. Metre/sec
C. Cubic metre
D. Square metre

<u>**Answer A**</u>

Runoff would be expressed in the same units as stream flow, cubic meter per second

Q. 34) The runoff Increases with

A. Increase in intensity of rain
B. Increase in infiltration capacity
C. Increase in permeability of soil
D. All of the above

Answer A

Runoff → The part of the water cycle that flows over land.

1. Amount of Rainfall:- The amount of rainfall directly affects the amount of runoff. As expected, if more rainfall hits the ground, more rainfall will turn into runoff.

2. Permeability: - The ability of the ground surface to absorb water will affect how much surface runoff occurs.

The less water the ground can absorb, the more runoff on the surface there will be.

3. Vegetation: - Vegetation needs water to survive, and a plant's root system is designed to absorb water from the soil. There is less runoff in highly vegetated areas.

4. Slope: - The steeper a surface is, the faster it will flow down the slope. A flat surface will allow the water time to absorb.

Q. 35) The area between the isohyets 45 cm and 55 cm is 100 square km and between 55 cm and 65 cm is 150 square km. The average depth of annual precipitation over the basin of 250 square km will be

A. 50 cm
B. 55 cm
C. 56 cm
D. 60 cm

Answer C

Isohyet :-

A line on a map or chart connecting areas of equal rainfall.

Computation of average rainfall or Precipitation

1. Arithmetic average method

$$P_{avg} = \frac{P_1 + P_2 + P_3 \ldots\ldots + P_n}{n} = \frac{\Sigma P}{n}$$

2. Thiessen Polygon method

$$P_{avg} = \frac{P_1A_1 + P_2A_2 + \ldots\ldots + P_nA_n}{A_1 + A_2 + \ldots + A_n} = \frac{\Sigma (A \times P)}{\Sigma A}$$

3. Isohyteal method

$$P_{avg} = \frac{\Sigma \left[A \times \left(\frac{P_1 + P_2}{2}\right)\right]}{\Sigma A}$$

$$P_{avg} = \frac{100\left(\frac{45+55}{2}\right) + 150\left(\frac{55+65}{2}\right)}{100 + 150}$$

$$\boxed{P_{avg} = 56\ cm}$$

Q. 36) A current metre is used to measure the

A. Velocity of flow of water
B. Depth of flow of water
C. Discharge
D. None of the above

<u>Answer A</u>

Current meter → Instrument for measuring the velocity of flow of a fluid (Water) in a stream.

Q. 37) If it rains between 2 p.m. And 3 p.m. And the entire basin are just starts contributing water at 3:00 p.m. To the outlet, then time of concentration will be

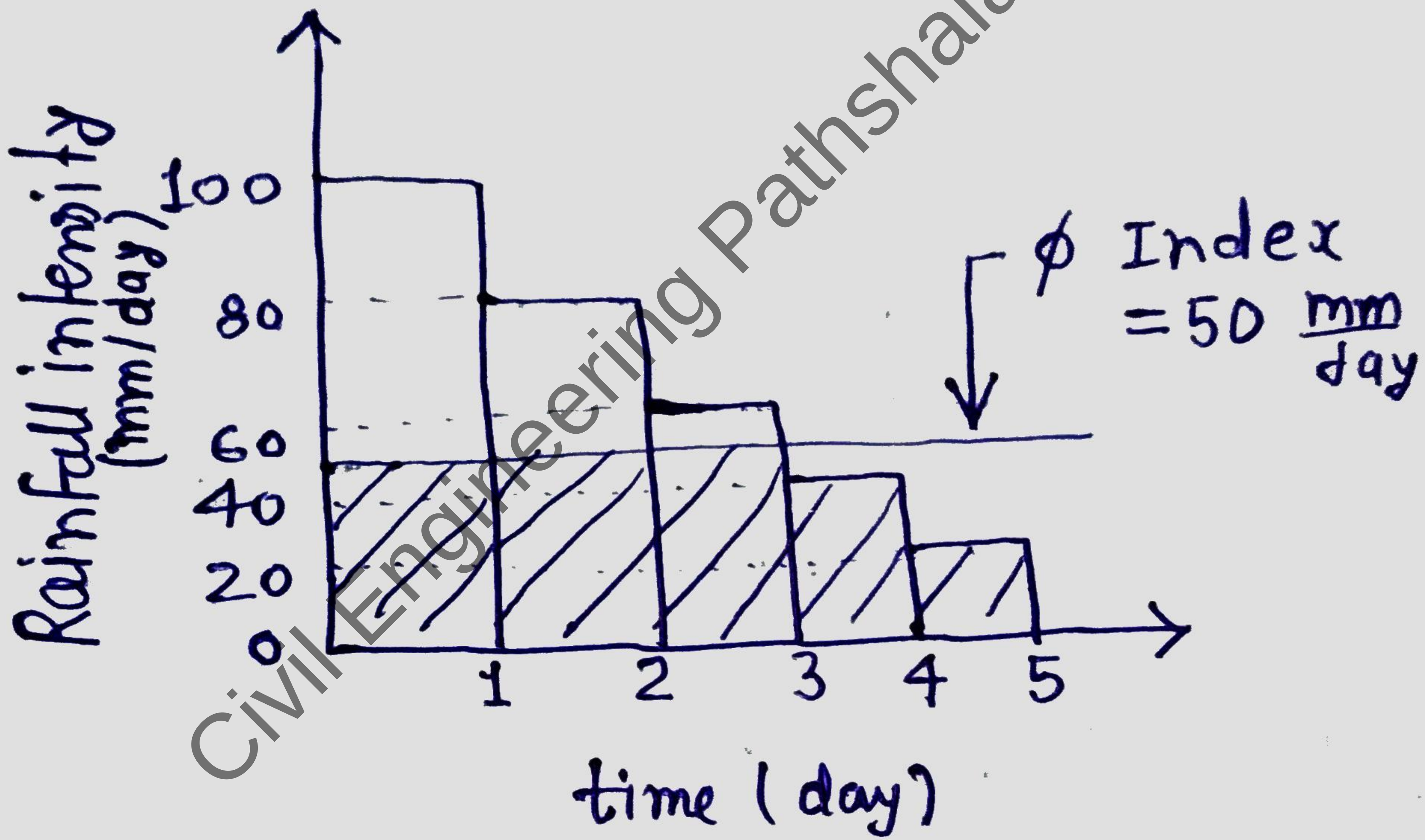
A. 15 minutes
B. 20 minutes
C. 30 minutes
D. 60 minutes

Answer D

Time of Concentration:- Time taken by rain water that falls at the farthest point to reach the outlet of a catchment.

Q. 38) The rainfall on five successive days were measured as 100 mm, 80 mm, 60 mm, 40 mm and 20 mm respectively. If the infiltration index or the storm loss rate for the catchment area is earlier estimated is 50 mm/day, the total surface runoff will be

A. 50 mm
B. 60 mm
C. 90 mm
D. 140 mm



Rainfall intensity (mm/day)
100
80
60
40
20
0
1
2
3
4
5
time (day)
φ Index = 50 mm/day
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Answer C

Infiltration Index or ϕ- Index

$$\phi \text{ Index} = \frac{P - R}{t}$$

$$50 = \frac{100+80+60 - R}{3}$$

$$150 = 240 - R$$

$$\boxed{R = 90 \text{ mm}}$$

Q. 39) The normal annual precipitation at stations X, A, B and C are 700 mm, 1000 mm, 900 mm and 800 mm respectively. If the storm precipitation at three station A, B and C were 100 mm, 90 mm and 80 mm respectively, then the storm precipitation for station X will be

A. 70 mm
B. 80 mm
C. 90 mm
D. 105 mm

Answer A

Normal precipitation: - An average of the precipitation values over a 30-year period.

Storm Precipitation at station X

$$\frac{P_x}{N_x} = \frac{\left(\frac{P_A}{N_A} + \frac{P_B}{N_B} + \frac{P_c}{N_c}\right)}{3}$$

$$\frac{P_x}{700} = \frac{1}{3}\left(\frac{100}{1000} + \frac{90}{900} + \frac{80}{800}\right)$$

$$P_x = \frac{700}{3}\left(\frac{1}{10} + \frac{1}{10} + \frac{1}{10}\right) = \frac{700}{3}\left(\frac{3}{10}\right)$$

$$\boxed{P_x = 70mm}$$

Q.40)The best unit duration of storm for a unit hydrograph

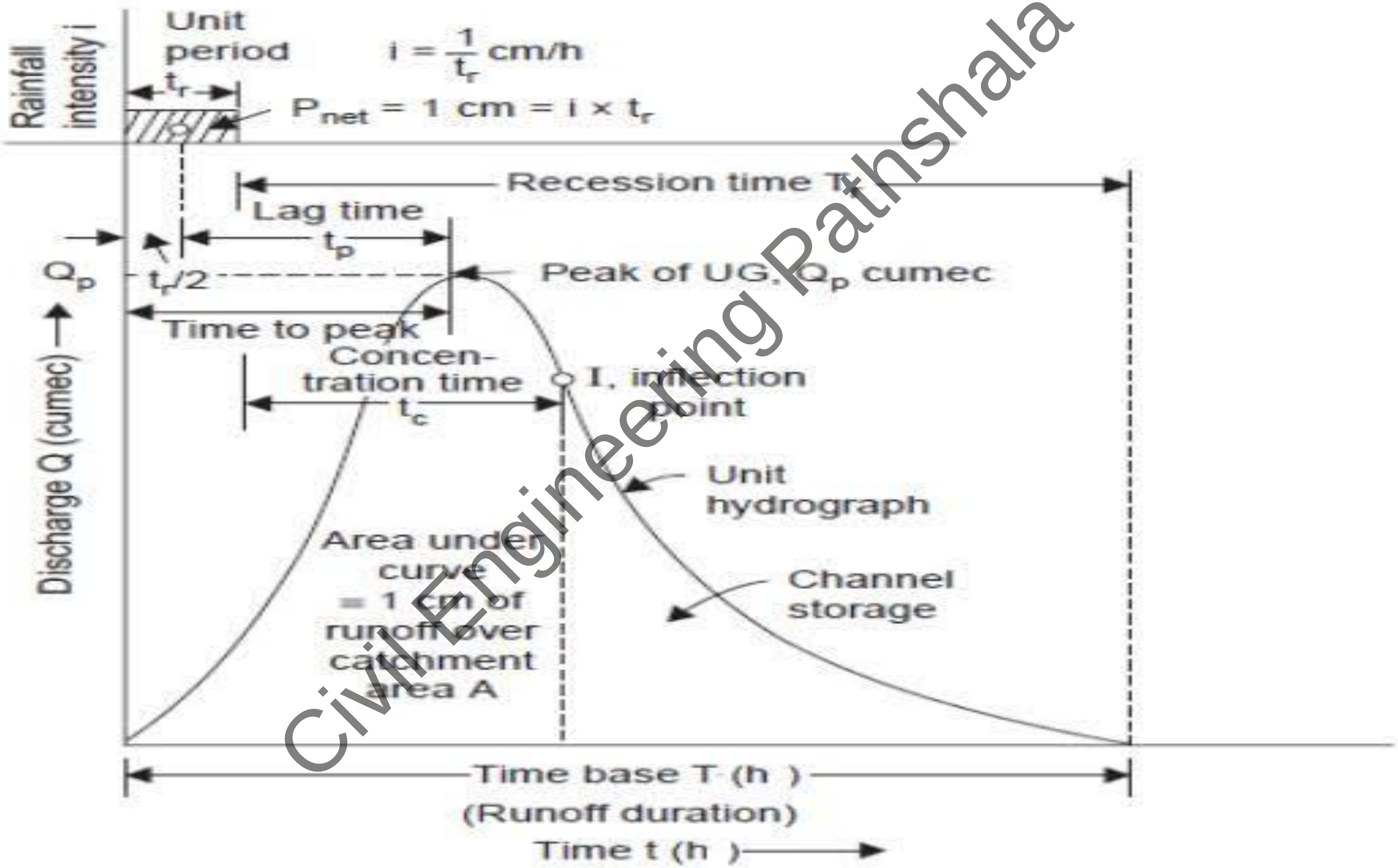
A. 1 hour
B. One-fourth of basin lag
C. One-half of basin lag
D. Equal to basin lag

Answer B

Unit hydrograph is a direct runoff hydrograph resulting from one unit (one inch or one cm) of constant intensity uniform rainfall occurring over the entire watershed/basin/catchment.

The concept of unit hydrograph is based on linear systems theory and follow the principles of superposition and proportionality.

Experience has shown that the best unit duration is about one-fourth of the basin lag, the time from the centre of mass of rainfall to the peak of the hydrograph.



Rainfall intensity i
Unit period
t_r
$i = \frac{1}{t_r}$ cm/h
P_{net} = 1 cm = $i \times t_r$
Recession time T_r
Lag time
t_p
Q_p
$t_r/2$
Peak of UG, Q_p cumec
Time to peak
Concen-tration time
t_c
I, inflection point
Unit hydrograph
Discharge Q (cumec)
Area under curve = 1 cm of runoff over catchment area A
Channel storage
Time base T (h)
(Runoff duration)
Time t (h)
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Q. 41) The unit hydrograph due to the storm may be obtained by dividing the ordinates of the direct runoff hydrograph by

A. Direct runoff volume
B. Period of storm
C. Total rainfall
D. None of the above

Answer A

Q. 42) The unit hydrograph of a specified duration can be used to evaluate the hydrograph of Storms of

A. Same duration only
B. Same and shorter duration
C. Same and longer duration
D. Any duration

Answer D

Q. 43) S-hydrograph is used to obtain unit hydrograph of

A. Shorter duration from longer duration
B. Longer duration from shorter duration
C. Both A and B
D. None of the above

Answer C

The technique of constructing a S-hydrograph is very useful in deriving unit hydrographs shorter duration from unit hydrograph of longer duration and vice versa

Q. 44) If two 4-hour unit hydrographs are staggered by 4 hours and added graphically, the resulting hydrograph will be

A. 4-hour unit hydrograph
B. 4-hour hydrograph with 20 mm runoff
C. 8-hour unit hydrograph
D. 8-hour hydrograph with20 mm runoff

Answer D

Q. 45) According to Dicken's formula for estimating floods, the peak discharge is proportional to

A. A
B. $A^{1/2}$
C. $A^{2/3}$
D. $A^{3/4}$

Where A is catchment area in square kilometres

Answer D

The design of structures on a river, such as dams, spillways, earthen embankments, flood control reservoirs, etc., requires information about the maximum (peak) flood discharge in the river.

In 1985, Dickens made an empirical formula for determining the maximum flood discharge Q (m^3/sec) in a river.

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

Where, A is the area of catchment in sq. Km

C is a constant whose value

between 2.8 to 5.6 for catchments in plains

and 14 to 28 for catchments in hills

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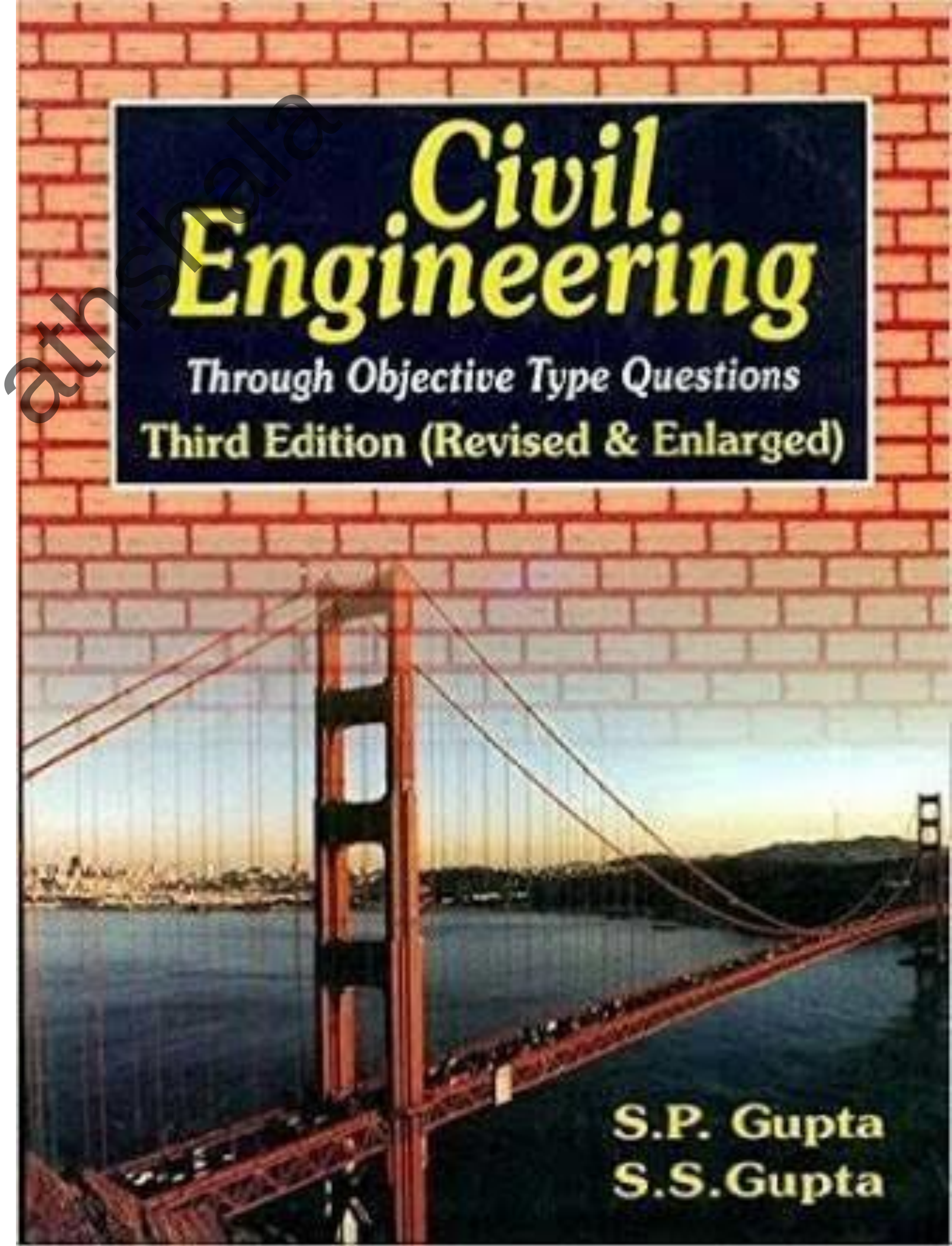
Objective Questions
(46 to 60)

Irrigation & Hydrology



Q. 46) The relation between Probability (P) and recurrence interval (T) is given by

A. $PT = 1$
B. $PT^2 = 1$
C. $P/T = 1$
D. $P/T^2 = 1$

Answer A

Return period/recurrence interval/repeat interval:-
is an average time or an estimated average time between events such as earthquakes, floods, landslides, or a river discharge flows to occur.

100-year flood" to mean a "flood with a 1% probability of occurring in any given year."

The probability (P) of an event with recurrence interval T is

$$P = 1/T$$

Q. 47) Dimension of coefficient of transmissibility are

A. $M^{\circ}L^{\circ}T^{\circ}$
B. $M^{\circ}L^{1}T^{-1}$
C. $M^{0}L^{2}T^{-1}$
D. $M^{\circ}L^{3}T^{-1}$

Answer C

The coefficient of transmissibility (T) equals to the field coefficient of permeability (k) multiplied by the aquifer thickness (B)

$$T = B.k$$
$$T = m.m/Sec$$
$$T = M^0L^2T^{-1}$$

Q. 48) If d is the depth of the aquifer through which water is flowing, then the relationship between permeability k and transmissibility T is given by

A. $T = kd$
B. $T = k/d$
C. $T = \sqrt{kd}$
D. $k = \sqrt{Td}$

Answer A

Q. 49) An artesian aquifer is the one where

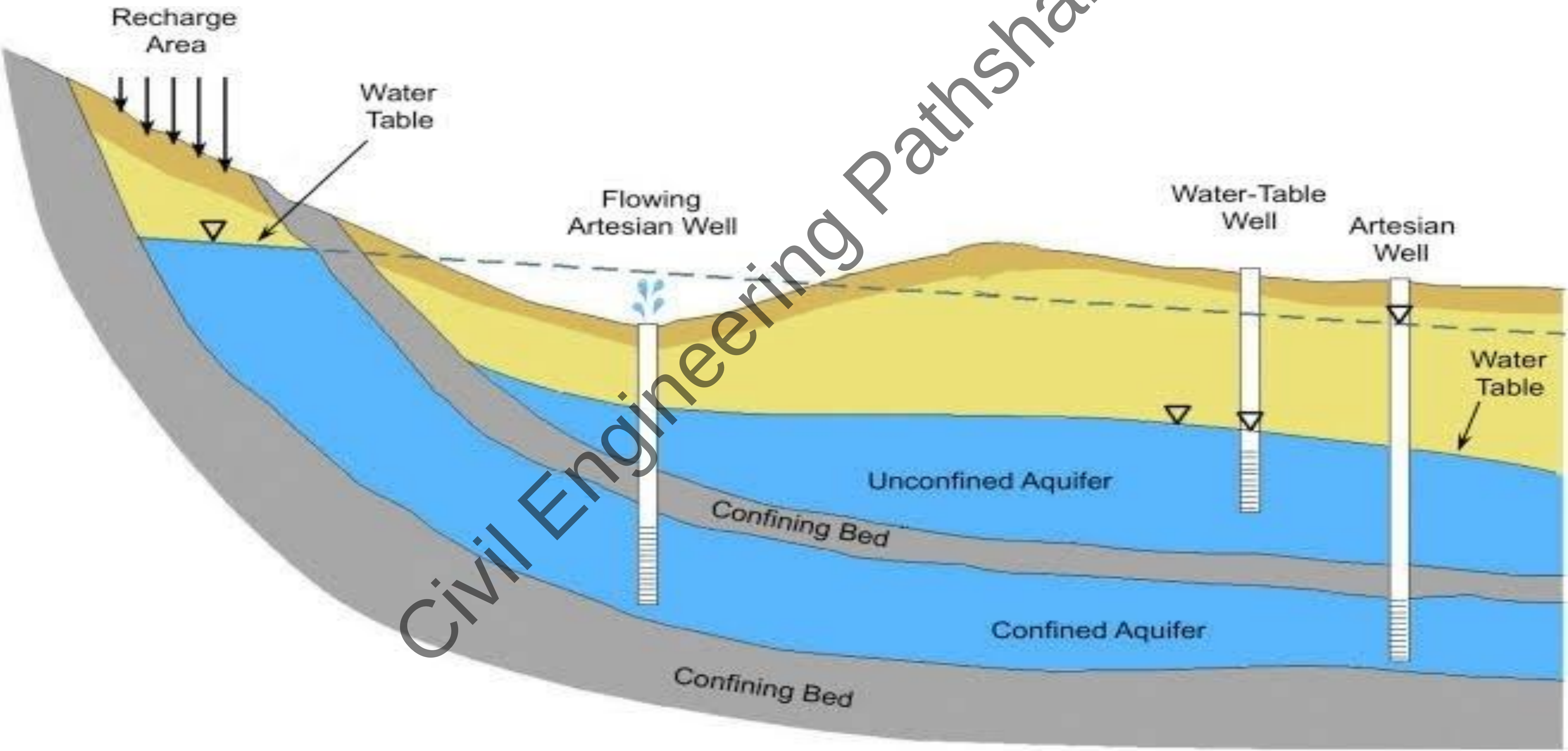
A. Water surface under the ground is at atmospheric pressure
B. Water is under pressure between two impervious strata
C. Water table serves surface as upper surface of zone of saturation
D. None of the above

Answer B

Aquifer:- is an underground layer of permeable rock (sand, gravel etc) which can contain or transmit groundwater.

1. Unconfined aquifer (water table/free/phreatic/non-artesian aquifer):-
Are those into which water seeps from the ground surface directly above the aquifer.

2. Confined aquifers or artesian aquifer: -
Are those in which an impermeable layer exists that prevents water from seeping into the aquifer from the ground surface located directly above. Instead, water seeps into confined aquifers from farther away where the impermeable layer doesn't exist.


Recharge Area
Water Table
Flowing Artesian Well
Water-Table Well
Artesian Well
Water Table
Unconfined Aquifer
Confining Bed
Confined Aquifer
Confining Bed

Q. 50) A deep well

A. Is always deeper than a shallow well
B. Has more discharge than a shallow well
C. Is weaker structurally than a shallow well
D. Both A and B

Answer B

Q. 51) A multipurpose Reservoir is the one which is

A. Designed for one purpose but serves more than one purpose
B. Planned and constructed to serve various purposes
C. Both A and B
D. None of the above

Answer B

The term multipurpose reservoir includes all reservoirs actually designed and operated to serve more than one function.

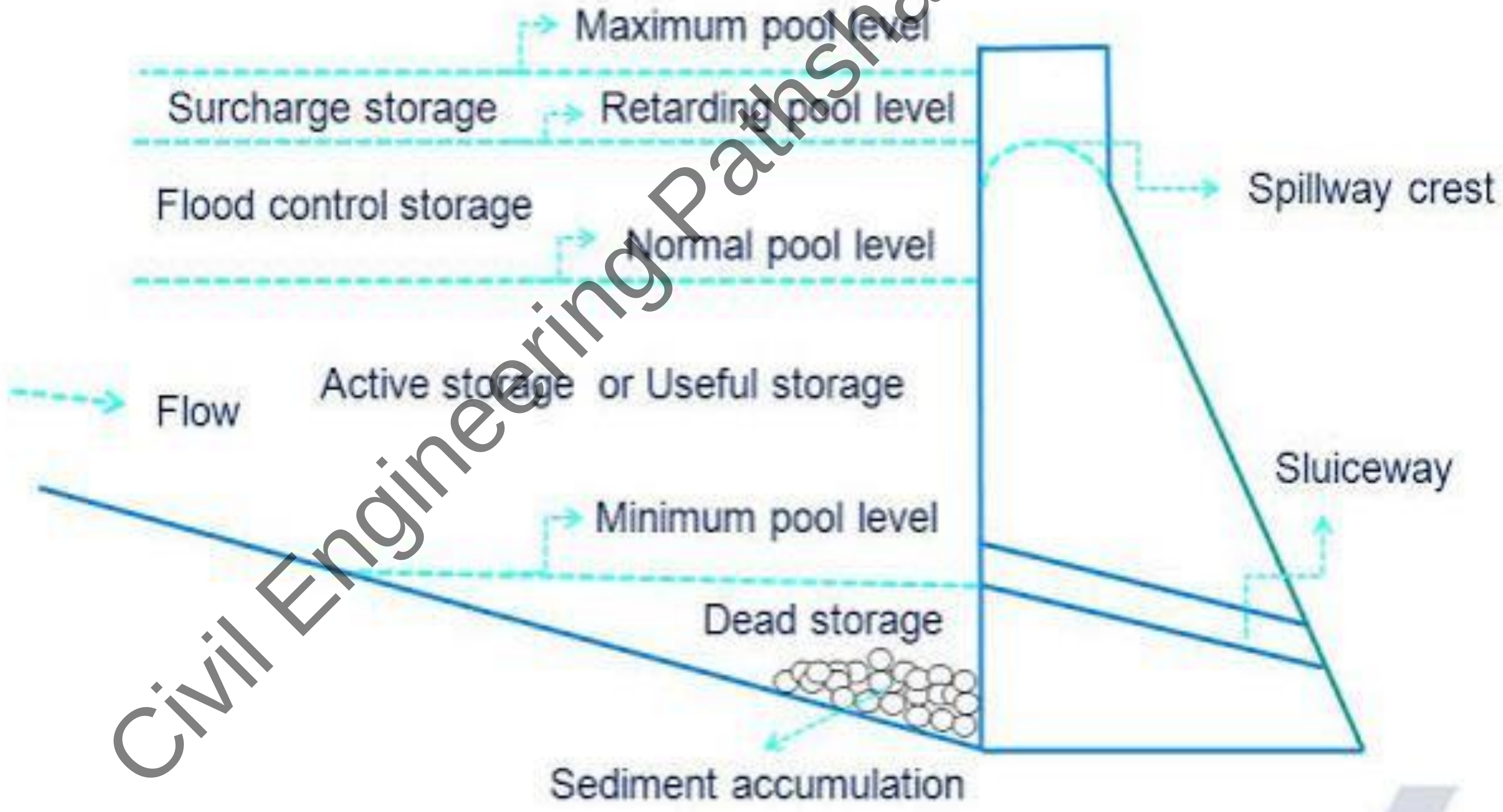
There can be several purposes for which a reservoir may be made .If some of these purpose are combined there will be more effective utilization of water and economical construction of a reservoir.
Preferable combinations for a multipurpose reservoir are:

1. Reservoir for Irrigation and Power
2. Reservoir for Irrigation, Power and Navigation.
3. Reservoir for Irrigation, Power and Water supply.
4. Reservoir for Recreation, Fisheries and Wild life.
5. Reservoir for Flood control and water supply.
6. Reservoir for Power and Water supply.

Q. 52) The useful storage is the volume of water stored in the reservoir between

A. Minimum pool level and maximum pool level
B. Minimum pool level and normal pool level
C. Normal pool level and maximum pool level
D. River bed and minimum pool level

Answer B



Maximum pool level
Surcharge storage
Retarding pool level
Spillway crest
Flood control storage
Normal pool level
Active storage or Useful storage
Flow
Sluiceway
Minimum pool level
Dead storage
Sediment accumulation

Q. 53) The water stored in the reservoir below the minimum pool level is called

A. Useful storage
B. Dead storage
C. Valley storage
D. Surcharge storage

Answer B

Dead or inactive storage refers to water in a reservoir that cannot be drained by gravity through a dam's outlet. It can only be pumped out.

Q. 54) For a flood control reservoir, the effective storage is equal to

A. Useful storage – Valley storage
B. Useful storage + surcharge storage
C. Useful storage + surcharge storage + Valley storage
D. Useful storage + surcharge storage – Valley storage

<u>Answer D</u>

Valley storage:- The volume of water held by the natural river channel in its valley up to the top of its banks before the construction of a reservoir is called the valley storage.

Q. 55) Trap efficiency of reservoir is a function of

A. Capacity/inflow ratio
B. Capacity/outflow ratio
C. Outflow/inflow ratio
D. None of the above

Answer A

Trap efficiency:- Measure of reservoir sedimentation.

Trap efficiency is a function of the ratio of reservoir capacity to total inflow.

$$\text{Efficiency} = f(\text{capacity}/\text{inflow})$$

Q. 56) The total capacity of reservoir is 25 million cubic metres and dead storage is 5 million cubic metre. If the average volume of sediment deposition is 0.10 million cubic metre per year, then the usefulness of the reservoir will start reducing after

A. 50 year
B. 150 year
C. 200 year
D. 250 year

Answer A

usefulness of the reservoir will start reducing after dead storage completely fill with sediment.

Given,
Dead storage = 5 million cubic metre
Average volume of sediment deposition = 0.10 million cubic metre per year

$\rightarrow$ 5/0.10 = 50 year

Q. 57) The forces, which are considered for the analysis of an elementary profile of gravity dam under empty reservoir condition, are

i) Water pressure
ii) Self weight
iii) Uplift
iv) Pressure due to earthquake

The correct answer is
A. Only (ii)
B. (i), (ii) and (iii)
C. (i), (ii) and (iv)
D. (i), (ii), (iii) and (iv)

Answer A

Where,
P = water pressure
W = weight of the dam
U = uplift pressure

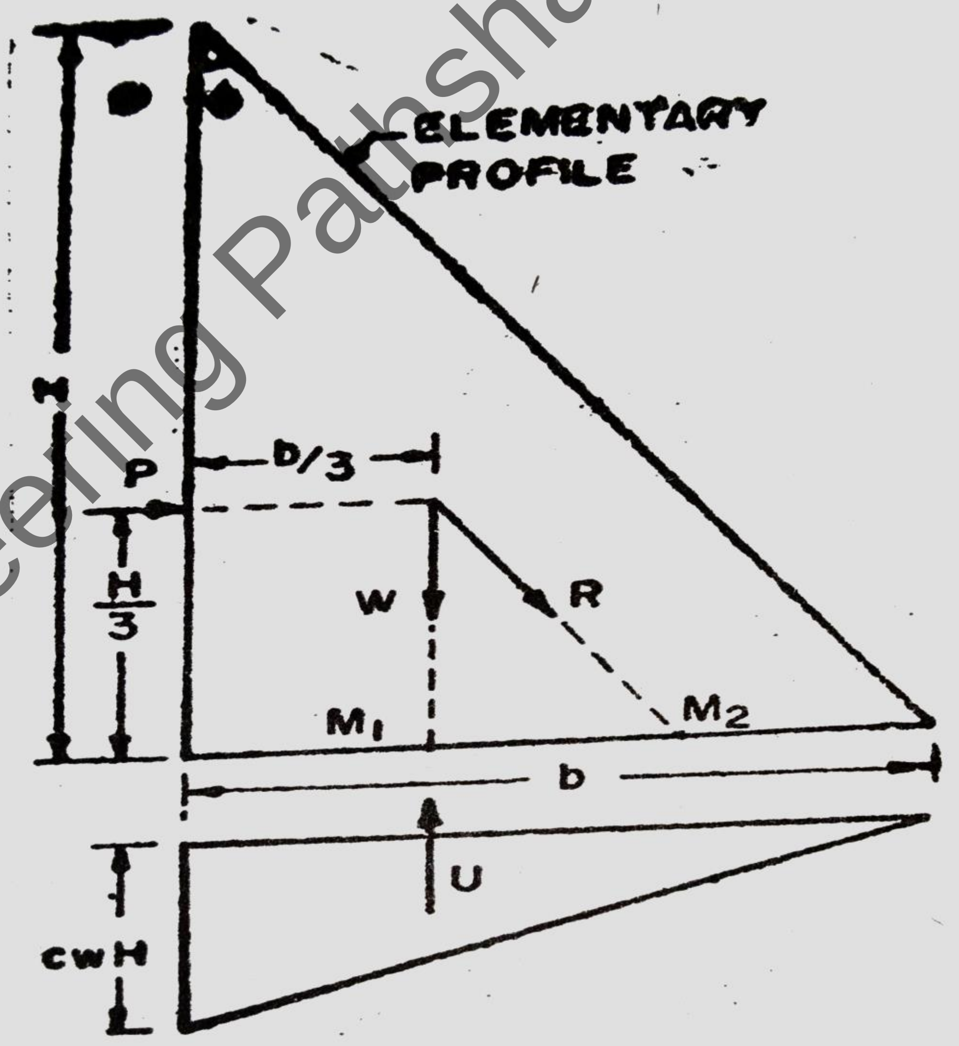


Fig. 9·7. Elementary profile.

Q. 58) When the upstream face of gravity dam is vertical, then the intensity of water pressure at the water surface and at the base respectively will be

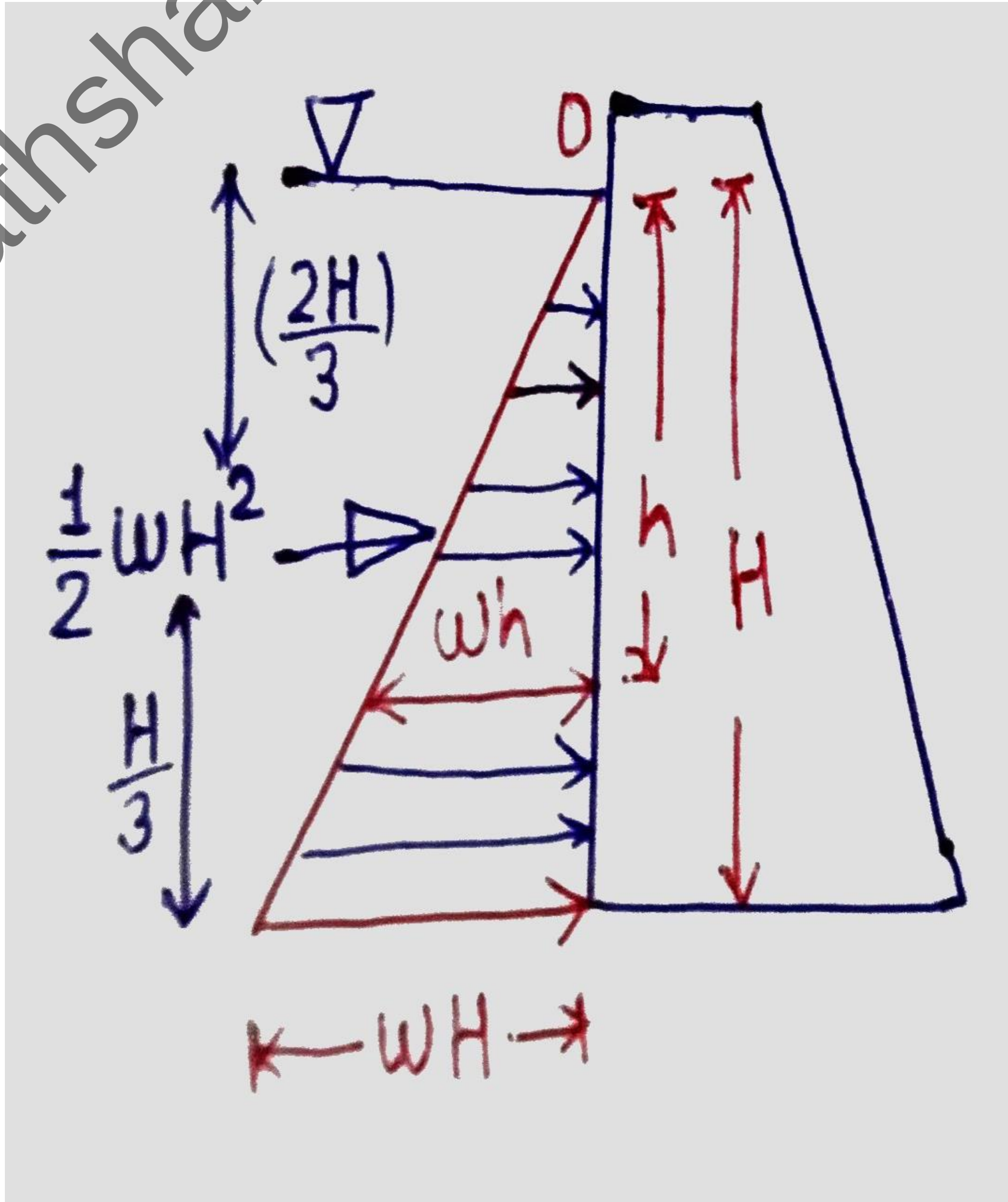
A. 0 and $wH^2/2$
B. $wH^2/2$ and $wH^2/3$
C. wH and 0
D. 0 and wH

Where w is unit weight of water and H is the depth of water

Answer D

Water pressure:-

This is the major external force acting on a dam. When the upstream face of the dam is vertical, the water pressure acts horizontally. The intensity of pressure varies is triangularly with a zero intensity at the water surface, to a value wh at any depth h below water surface.



Q. 59) The uplift pressure on a dam can be controlled by
i) Constructing cutoff under upstream face
ii) Constructing drainage channels between the dam and its Foundation
iii) By pressure grouting in foundation

The correct answer is
A. Only (i)
B. Both (i) and (ii)
C. Both (i) and (iii)
D. (i), (ii) and (iii)

Answer D

The **uplift pressure** is defined as the upward pressure of water as it flows or seeps through the body of the dam or it’s foundation.

Uplift pressure is generally reduced by
1. constructing drainage pipes between dam and its foundation
2. constructing cut off walls under the upstream face
3. pressure grouting the dam foundation.

Q. 60) The uplift pressure on the face of a drainage gallery in a dam is taken as

A. Hydrostatic pressure at toe
B. Average of hydrostatic pressure toe and heel
C. Two third of hydrostatic pressure at toe plus one third of hydrostatic pressure at heel
D. None of the above

Answer C

The uplift pressure is defined as the upward pressure of water as it flows or seeps through the body of the dam or it's foundation.
The uplift pressure intensities equal to hydrostatic pressure of water at toe and heel joined by straight line in between. (Elementary profile)

Sometimes drainage galleries are also provided in the body of the dam which releases the uplift pressure built up under it.
The magnitude of the uplift pressure at the face of gallery is equal to the hydrostatic pressure at the toe plus 1/3rd the difference of the hydrostatic pressure at the heel and toe.
Uplift pressure at heel = wH
Uplift pressure at toe = wH'
Uplift pressure at gallery = $wH' + \frac{1}{3}w(H-H')$

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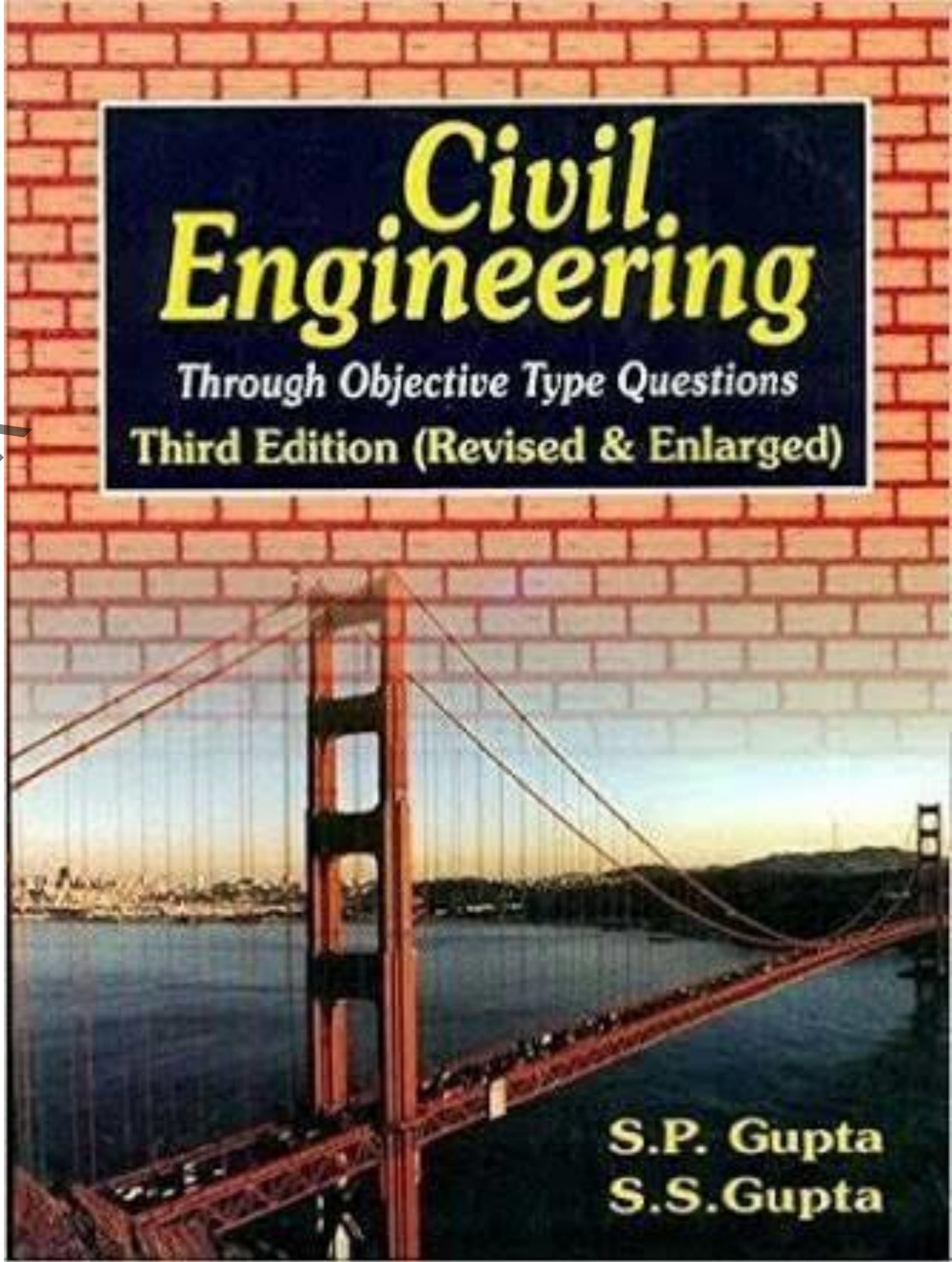
Objective Questions (61 to 75)

Irrigation & Hydrology



Q. 61) Horizontal acceleration due to earthquake results in

A. Hydrodynamic pressure
B. Inertia force into the body of the dam
C. Both A and B
D. None of the above

Answer C

Earthquake wave may travel in any direction. The general direction of acceleration is horizontal and vertical.

1. Effect of horizontal acceleration:- causes two forces.

(i) Inertia force in the body of the dam:-
The inertia force acts in a direction opposite to the acceleration imparted by earthquake forces and is equal to the product of the mass of the dam and the acceleration.

Inertia force = mass × acceleration

(ii) Hydrodynamic pressure of water:-

The horizontal acceleration of the dam and foundation towards the reservoir causes a momentary increase in the water pressure since the water resists the movement owing to its inertia.

If the hydrodynamic pressure variation is assumed to be parabolic, the increase in water pressure is given by,

$$p = 0.555\ \alpha w H^2$$

and act at a height of $(4H/3\pi)$ above the base.

2. Effect of vertical acceleration:-

Due to vertical acceleration, a vertical inertia force is exerted on the dam, in the direction opposite to that of the acceleration.

Q. 62) Hydrodynamic pressure due to earthquake acts at a height of

A. $3H/4\pi$ above the base
B. $3H/4\pi$ below the water surface
C. $4H/3\pi$ above the base
D. $4H/3\pi$ below the water surface

Where H is the depth of water

Answer C

Q. 63) The major resisting force in a gravity dam is

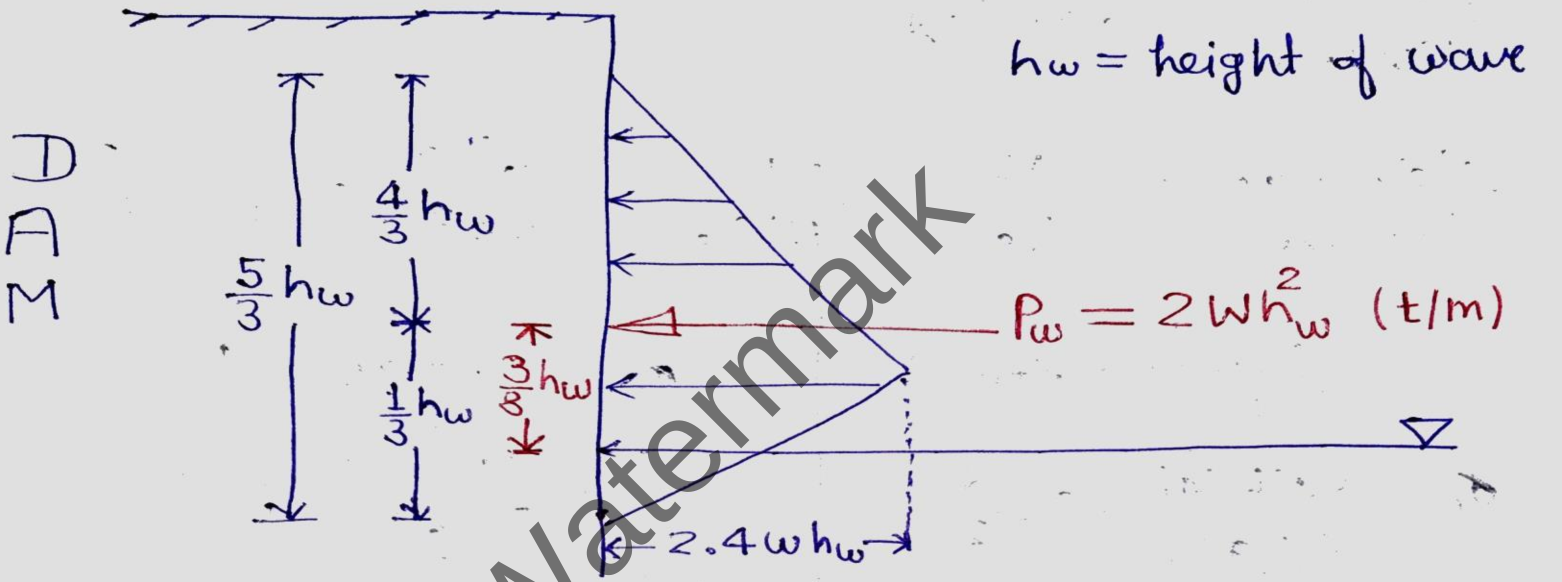
A. Water pressure
B. Wave pressure
C. Self-weight of dam
D. Uplift pressure

Answer C

Q. 64) Total force due to wave action on gravity dam acts at a height of

A. $h_w/2$ above the reservoir surface
B. $5h_w/4$ above the reservoir surface
C. $3h_w/8$ above the reservoir surface
D. $2h_w/3$ above the reservoir surface

Answer C



→ Waves are generated on the reservoir surface because of the wind blowing over it.

→ For design purpose, the pressure distribution may be assumed to be represented by a triangle of height equal to $\left(\frac{5}{3} h_w\right)$.

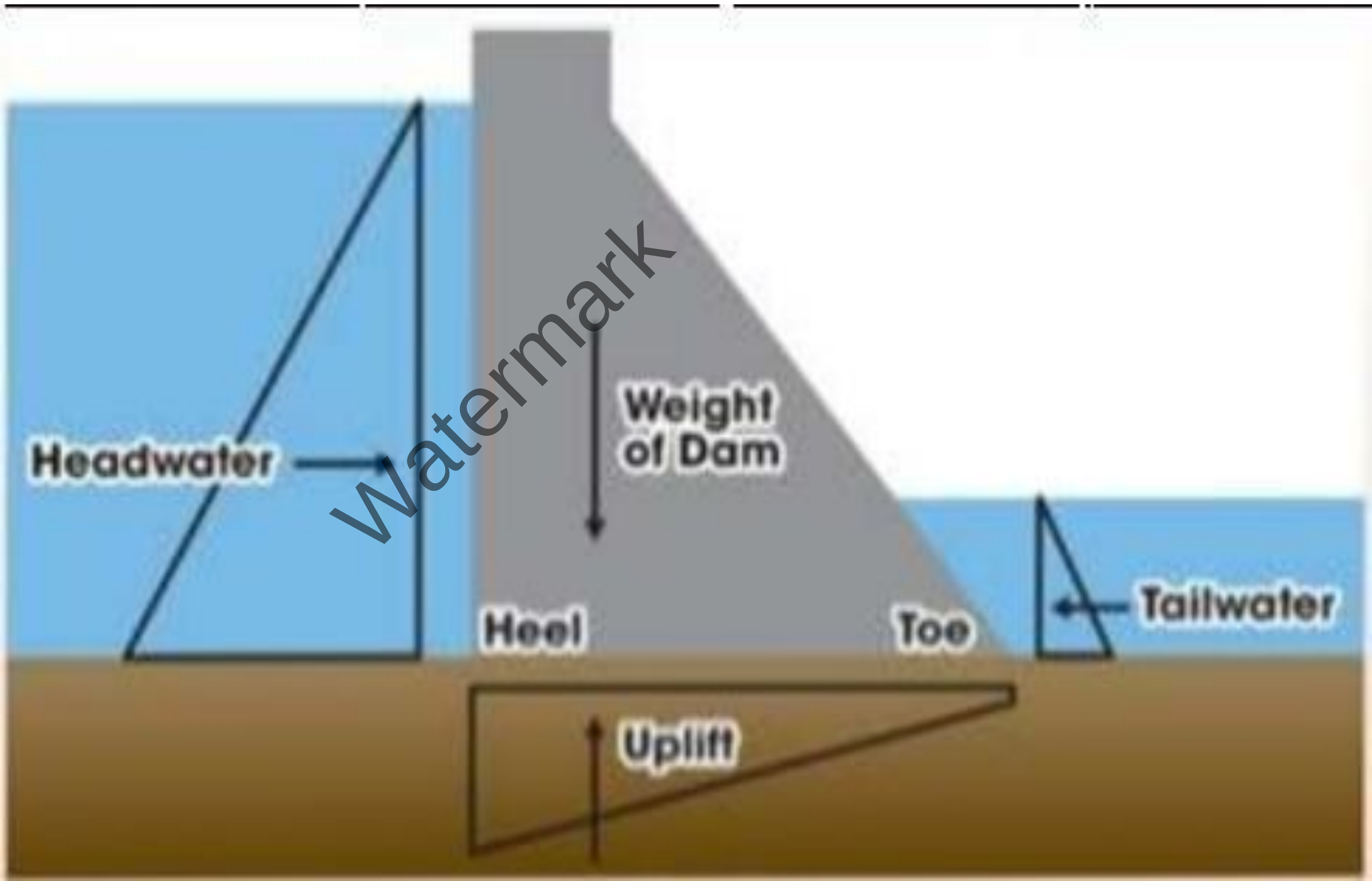
→ Total pressure $= \frac{1}{2} \times 2.4\, W h_w \times \frac{5}{3} h_w$

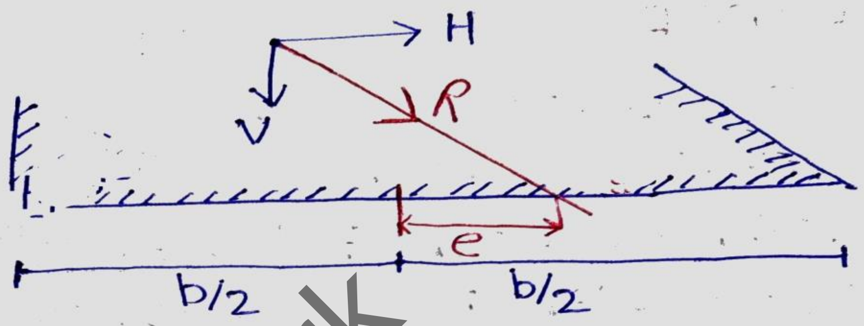
$= 2 W h_w^2$ @ $\frac{3}{8} h_w$ above reservoir surface

Q. 65) When the reservoir is full, the maximum compressive force in a gravity dam is produced

A. At the toe
B. At the heel
C. Within the middle third of base
D. At centre of base

Answer A





R = Resultant force cutting the base at an eccentricity e from the centre of the base of width b.

The normal stress at any point on the base will be the sum of direct stress and the bending stress.

Direct stress $= \frac{V}{b \times 1}$ $\left\{ \begin{array}{l} V = \text{total vertical force} \\ b = \text{base width} \end{array} \right.$

Bending stress $= \pm \frac{My}{I}$

$$= \pm \frac{V \cdot e}{\frac{b^3 L}{12}} \cdot \left(\frac{b}{2}\right) = \pm \frac{6Ve}{b^2}$$

$\boxed{(P_n)_{toe} = \frac{V}{b}\left(1 + \frac{6e}{b}\right)}$ $\boxed{(P_n)_{heel} = \frac{V}{b}\left(1 - \frac{6e}{b}\right)}$

For no tension to develop, the eccentricity $< \frac{b}{6}$

Q. 66) The maximum permissible eccentricity for no tension at the base of a gravity dam is

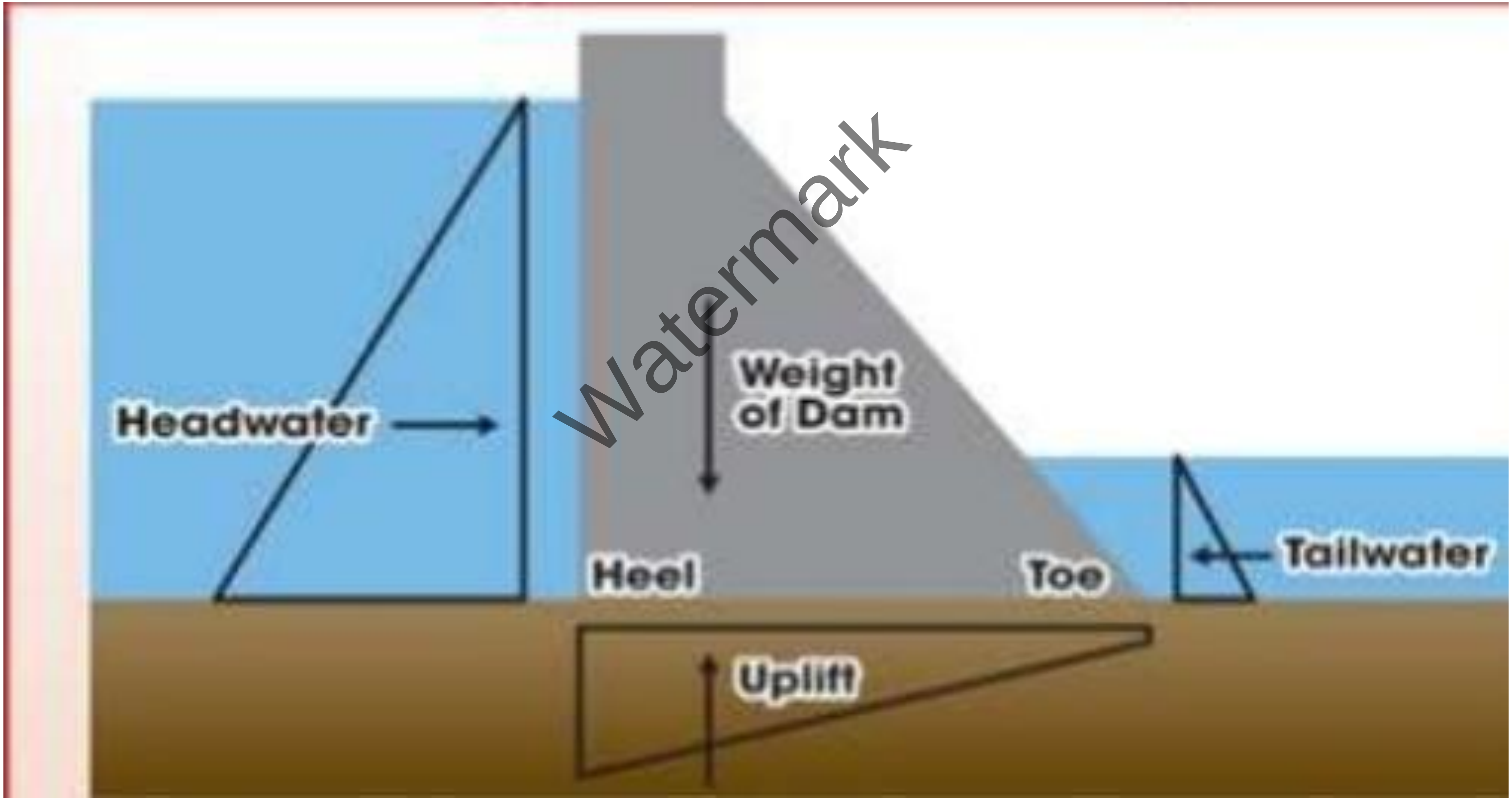
A. B/2
B. B/3
C. B/4
D. B/6

Answer D

Q. 67) Presence of tail water in a gravity dam

i) Increases the principal stress
ii) Decreases the principal stress
iii) Increases the shear stress
iv) Decreases the shear stress

The correct answer is
A. (i) and (iii)
B. (i) and (iv)
C. (ii) and (iii)
D. (ii) and (iv)


Weight
of Dam
Headwater
Heel
Toe
Tailwater
Uplift

Answer D

Principal and Shear Stresses :-

① Principal Stress, $\sigma = P_n \sec^2\phi - P\tan^2\phi$ Both up & downstream

When there is no tail water P will be zero.

$$\sigma = P_n \sec^2\phi$$

Where, P_n = normal stress, P = Intensity of water pressure

② Shear stress, $\tau = (P_n - P)\tan\phi$ downstream side

$= -(P_n - P)\tan\phi$ upstream side

If tail water is neglected,

$\tau = P_n \tan\phi$ downstream side

$\tau = -P_n \tan\phi$ upstream side

Q. 68) Neglecting the effect due to earthquake forces and tail water pressure, the principal stress in a gravity dam is given by

A. P_v
B. $P_v \sec^2\theta$
C. $P_v \tan^2\theta$
D. $P_v \tan\theta$

where P_v is vertical direct stress and θ is angle of downstream face of dam with the vertical.

Answer B

If P_e' is the intensity of hydrodynamic pressure of tail water due to an earthquake, the principal stress at the downstream is given by

$$\sigma = P_n \sec^2\phi - (P - P_e')\tan^2\phi$$

Similarly, considering the hydrodynamic pressure (P_e) to upstream side,

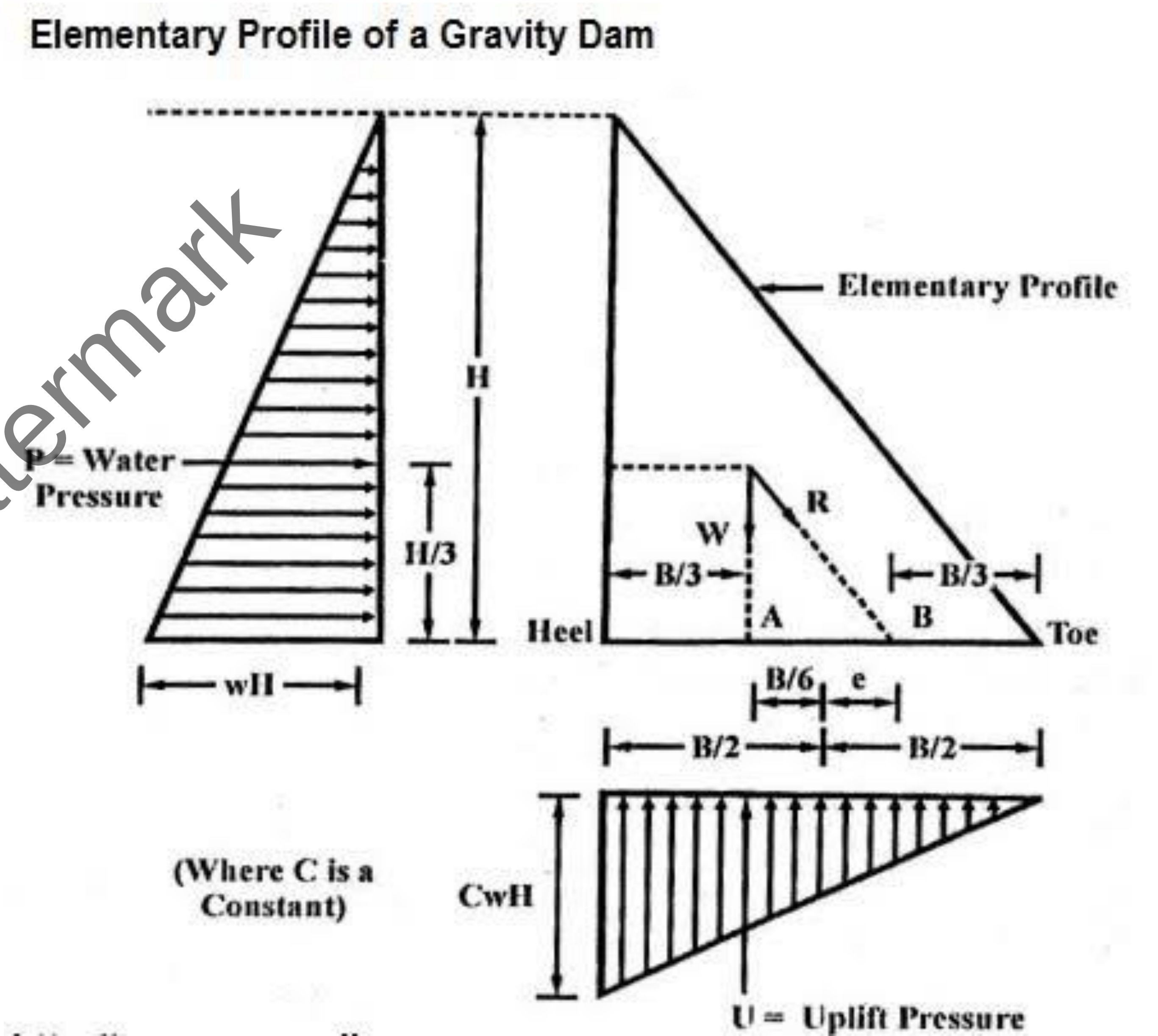
$$\sigma = P_n \sec^2\phi - (P + P_e')\tan^2\phi$$

Q. 69) The elementary profile of a dam is

A. A rectangle
B. A trapezoidal
C. An equilateral triangle
D. A right angled triangle

Answer D

The elementary profile of a dam, subjected only to the external water pressure on the upstream side, will be right angled triangle, having zero width at the water level and a base width (B) at bottom, i.e.. the point where the maximum hydrostatic water pressure acts.



Q. 70) In the empty condition of reservoir and with the elementary profile of a dam, the vertical stress at heel and toe respectively are given by

A. 0 and W/2B
B. W/2B and 0
C. 2W/B and 0
D. 0 and 2W/B

Where B is base width and W is self weight of unit length of dam

Answer C

Reservoir empty condition. When the reservoir is empty, the only force acting on the elementary profile will be its weight, acting through the first third point M_1. Hence the maximum compressive stress at the heel will be $= \frac{W}{b}(1+1) = \frac{2W}{b}$, and the corresponding normal stress at the toe will be $= \frac{W}{b}(1-1) =$ zero.

Q. 71) Neglecting uplift pressure, the base width of an elementary profile of a gravity dam shall be taken as

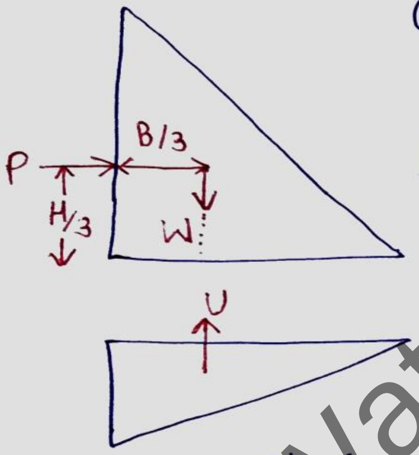
A. $H/\sqrt{G}$
B. $H/\mu G$
C. Lesser of $H/\sqrt{G}$ and $H/\mu G$
D. Greater of $H/\sqrt{G}$ and $H/\mu G$

Where H is depth of water, G is specific gravity of material and μ is coefficient of friction.

Answer D

Base width of elementary profile is to be found under two criterion

① Stress criterion ② Stability or sliding criterion



① weight of the dam $(W) = \frac{1}{2} BH\rho w$

Where, ρ = unit weight dam material

w = unit weight of water

② Water pressure $(P) = \frac{1}{2} wH^2$ @ $\frac{H}{3}$ from the base

③ Uplift pressure $(U) = \frac{1}{2}$ C.W.B.H

Where, C = uplift pressure intensity pressure coefficient

① Stress criterion → Considering the force triangle

$$\frac{W-U}{P} = \frac{H/3}{b/3} \Rightarrow \frac{\left(\frac{1}{2}BH\rho w - \frac{1}{2}C.w.B.H\right)}{\frac{1}{2}wH^2} = \frac{H}{b}$$

$$\boxed{B = \frac{H}{\sqrt{\rho - C}}} \quad \text{If } U = 0 \quad \boxed{B = \frac{H}{\sqrt{\rho}}}$$

② Stability or Sliding criterion → For no sliding to occur, horizontal forces causing sliding should be balanced by the frictional forces opposing the same.

$$P = \mu(W-U)$$

$$\frac{1}{2}wH^2 = \mu\left(\frac{1}{2}BH\rho w - \frac{1}{2}CBwH\right) \quad \boxed{B = \frac{H}{\mu(\rho - C)}} \quad U = 0 \quad \boxed{B = \frac{H}{\mu\rho}}$$

The width provided for the elementary profile should be greater of the widths given by above two criterion.

Q. 72) The maximum possible height of a safe dam having an elementary profile is

A. $f / w\sqrt{(G+1)}$
B. $f / w\sqrt{G}$
C. $f / w\,(G+1)$
D. $f / w\sqrt{(G-1)}$

Where f = allowable stress of dam material
G = specific gravity of dam material
w = unit weight of water

Answer C

The principal stress at the toe is given by

$$\sigma = wH(\rho - C + 1)$$

The maximum value of this principal stress should not exceed the allowable stress (f) for the material

$$f = \sigma_1 = wH(\rho - C + 1)$$

$$H = \frac{f}{W(\rho - C + 1)}$$

For finding the limiting height H, it is usual not to consider the uplift.

$$\boxed{H = \frac{f}{W(\rho - 1)}}$$

Q. 73) The focus of base parabola for a dam having a horizontal drainage filter is at a distance of

A. B/2 from toe
B. (B-b) from toe
C. b from toe
D. b/2 from toe

Where B is base width of dam and b is width of horizontal drainage filter.

Answer C

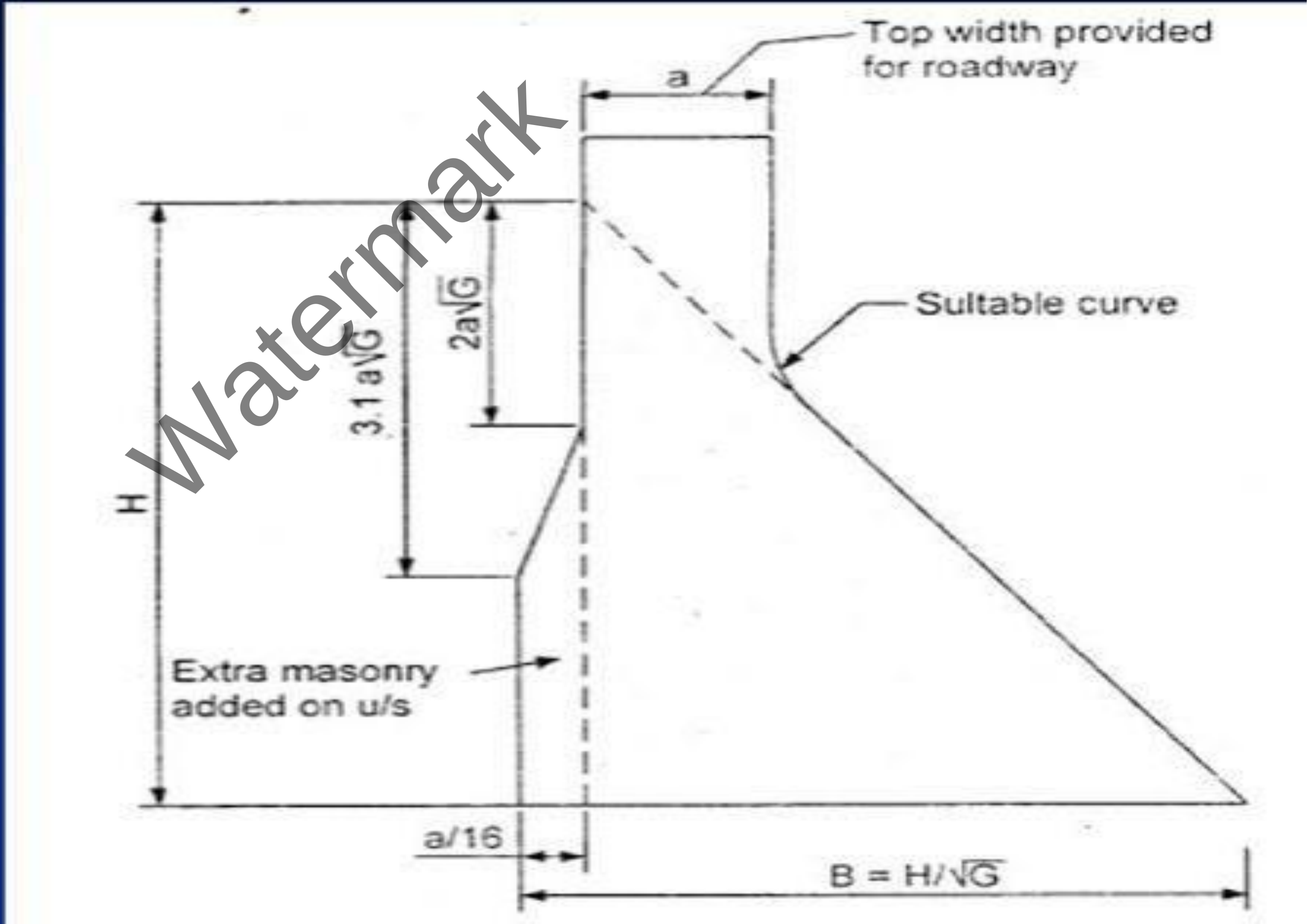
Q. 74) By providing a top width for roadway and freeboard in the elementary profile of a gravity dam, the resultant force for full reservoir condition will

A. Shift towards the heel
B. Shift towards the toe
C. Not shift at all
D. None of the above

Practical profile of a Gravity Dam

1) Free board

2) Top Width



Answer A

Elementary profile of a given dam is only theoretical profile. Certain changes have to be made in this profile in order to cater practical needs. These needs are:

(i) Providing a top width for roadway construction.

(ii) Providing a free board over top water surface.

These additions of two provisions will cause the resultant force to shift towards heel.

In order to avoid tension, some masonry or concrete will have to be added on upstream side.

Q. 75) For wave action in dams, the maximum height of freeboard is generally taken to be equal to

A. $0.5h_w$
B. $0.75h_w$
C. $1.25h_w$
D. $1.50h_w$

Where h_w is height of wave.

<u>Answer D</u>

Freeboard is the margin provided between the top of dam and HFL in the reservoir to prevent the splashing of the waves over the non-overflow section.

The freeboard usually provided is $1.50h_w$ and not less than 0.9m

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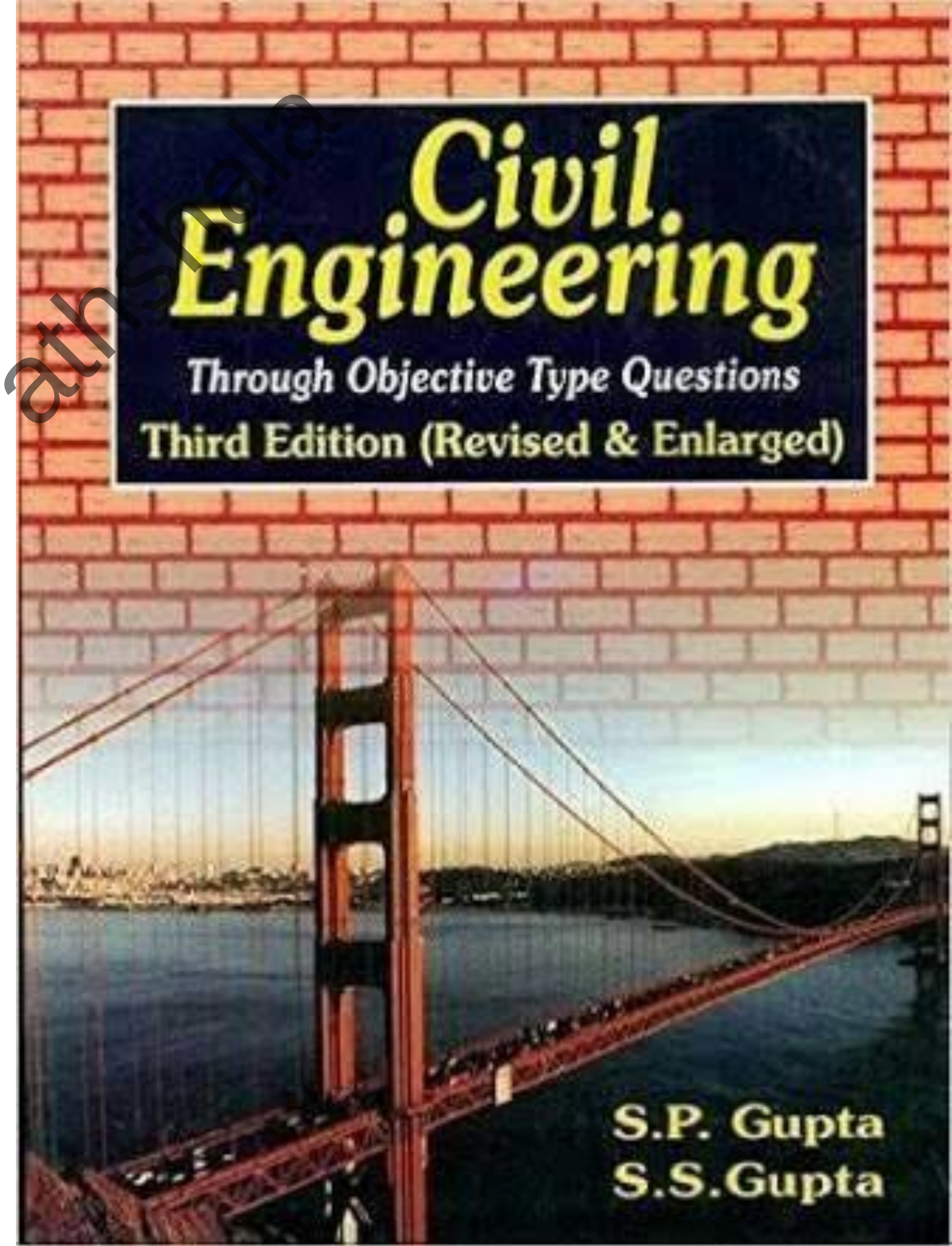
Objective Questions
(76 to 90)

Irrigation & Hydrology



Q. 76) As compared to gravity dams, earthen dams

A. Are costlier
B. Are less susceptible to failure
C. Require sound rock foundations
D. Require less skilled labour

Answer D

Gravity dams:
It is made up of masonry or solid concrete
It can be constructed to any height
Less maintenance
Require skilled labour

Earthen dams:
It is made up of soil and gravel
It can be constructed to moderate height
It is cheaper
Require less skilled labour

Q. 77) The most suitable material for the central impervious core of a zoned embankment type dam is

A. Clay
B. Coarse sand
C. Silty clay
D. Clay mixed with fine sand

Answer D

1. Homogenous embankment type:-
-Homogenous type earth dam is composed of a single kind of material.

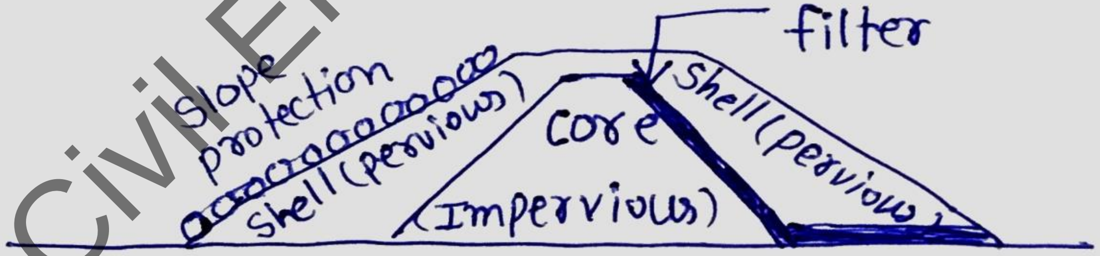
2. Non-Homogeneous (Zoned) embankment type:-
-Dam made up of more than one material.
-The outer shells are made of pervious, freely drainage material. The shells give stability to the central impervious fill (clay and fine sand), and at the same time distribute the load over a larger area in the foundation.

3. Diaphragm type embankment:-
The bulk of the embankment is constructed of previous material and a thin diaphragm of impermeable material is provided to check the seepage.

: Diaphragm type embankment

a) Purely Homogeneous dam (b) Modified Homogeneous dam

: Homogeneous dam



: Zoned Embankment

Q. 78) Seepage through embankments in an earthen dam is controlled by

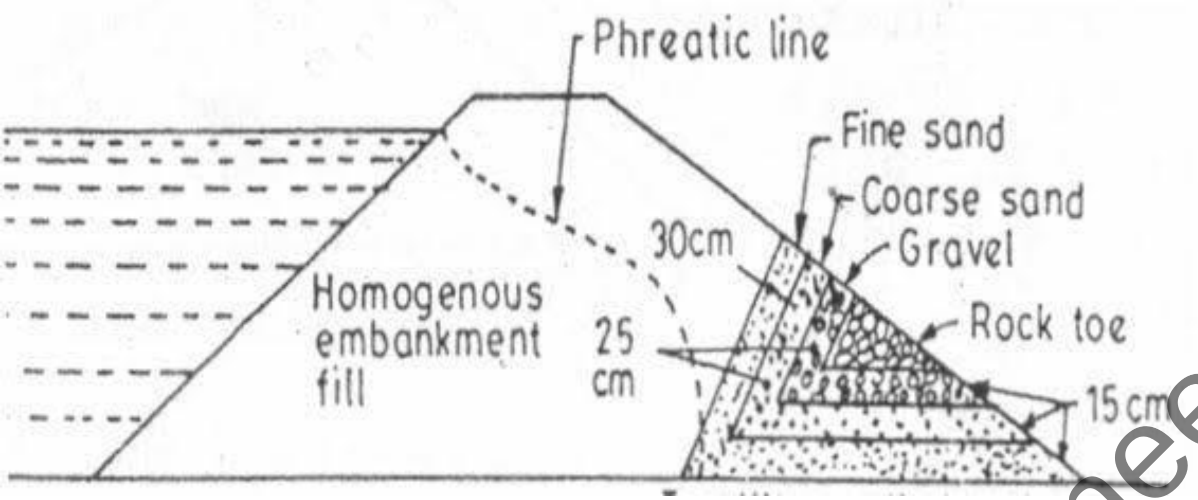
A. Drainage filters
B. Relief wells
C. Drain trenches
D. Provision of downstream berms

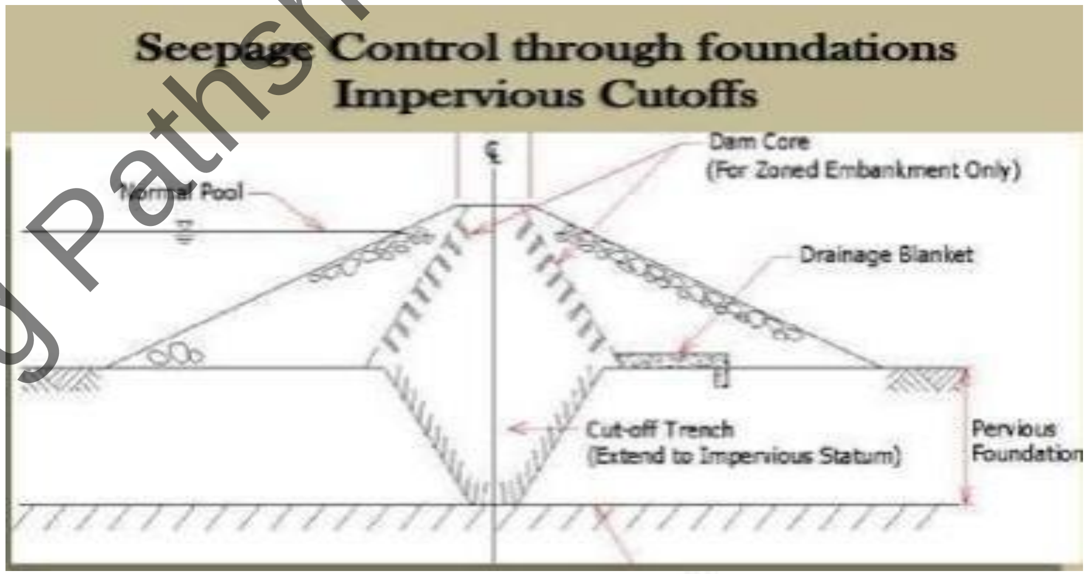
Answer C

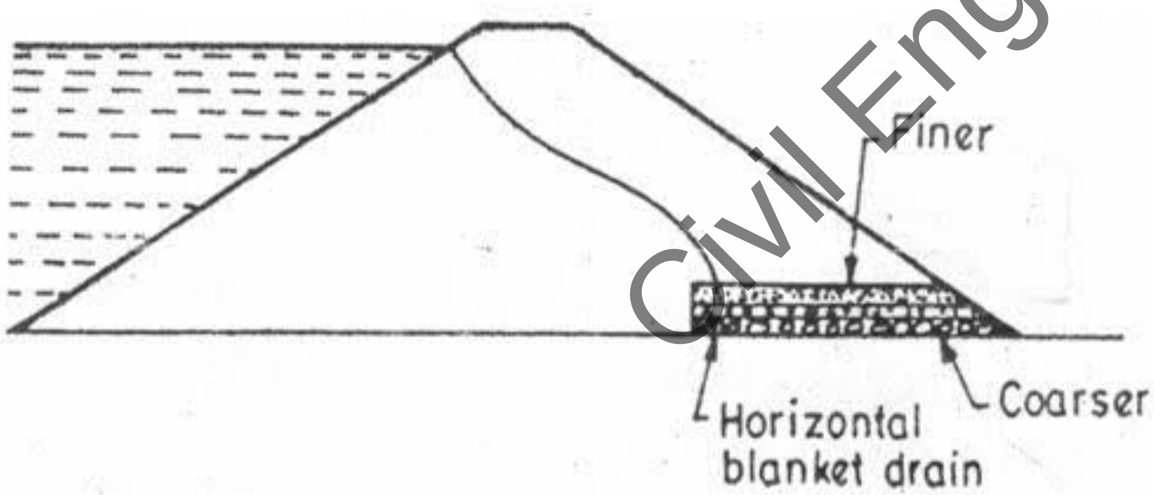
Q. 79) Seepage through foundation in an earthen dam is controlled by providing

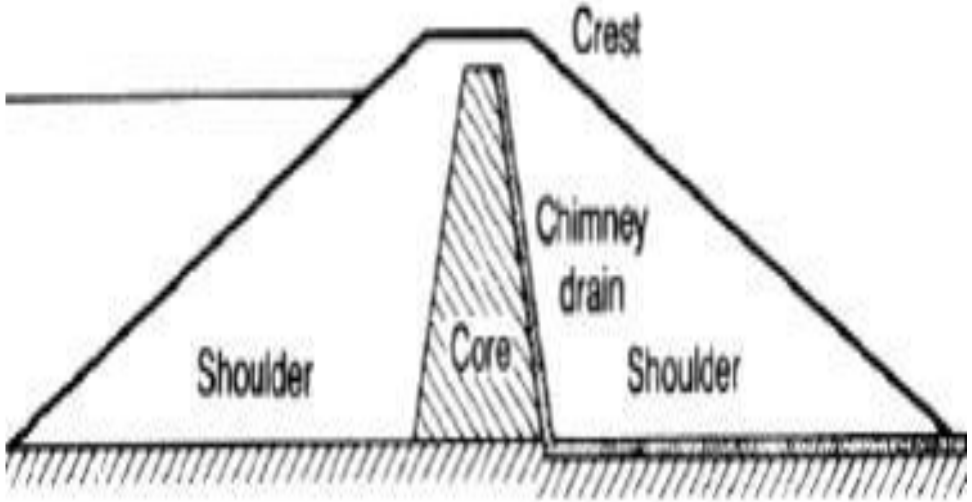
A. Rock toe
B. Horizontal blanket
C. Impervious cut off
D. Chimney drain

Answer C


Phreatic line
Fine sand
Coarse sand
Gravel
30cm
Rock toe
Homogenous
embankment
fill
25
cm
15cm


Seepage Control through foundations
Impervious Cutoffs
Dam Core
(For Zoned Embankment Only)
Normal Pool
Drainage Blanket
Cut-off Trench
(Extend to Impervious Statum)
Pervious
Foundation


Finer
Horizontal
blanket drain
Coarser


Crest
Chimney
drain
Shoulder
Core
Shoulder

Q. 80) The flow of water after spilling over the weir crest in chute spillway and side channel spillway respectively are

A. At right angle and parallel to weir crest
B. Parallel and at right angle to weir crest
C. Parallel to weir crest in both
D. At right angle to weir crest in both

Answer A

-A **spillway** is a hydraulic structure built at a dam site for diverting the surplus water from a reservoir after it has been filled to its maximum capacity.

-The **weir** is a solid obstruction put across the river to raise its water level and divert the water into the canal.

-**Chute or through spillway:-**
Which passes the surplus discharge through a steep slopes open channel.
Its crest is kept normal to its center line.
This type of spillway is provided on earth or rockfill dam

-**Side channel spillway:-**
In which the flow, after passing over a weir crest, is carried away by a channel running essentially parallel to the crest.
This type of spillway is suitable for earth or rock fill dam.

Q. 81) The discharge passing over an ogee spillway is given by

A. $CLH^{3/2}$
B. $CHL^{3/2}$
C. $CLH^{5/2}$
D. $CLH^{1/2}$

Where, L is effective length of spillway crest and H is the total head over the spillway crest including velocity head

Answer A

The discharge over an ogee shaped spillway is given by

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

where

Q = discharge

C = a variable coefficient of discharge which influenced by several factors such as

1. Depth of approach
2. Relation of actual crest shape to the ideal nappe shape
3. Upstream face slope
4. Upstream apron interference and
5. Downstream submergence

Its value varies from 2.1 to 2.5

Q. 82) Coefficient of discharge of an ogee spillway

A. Depends on depth of approach and upstream slope
B. Depends on downstream apron interference and downstream submergence
C. Remains constant
D. Both A and B

Answer D

Q. 83) Which of the following spillways is least suitable for an earthen dam?

A. Ogee spillway
B. Chute spillway
C. Side channel spillway
D. Shaft spillway

Answer A

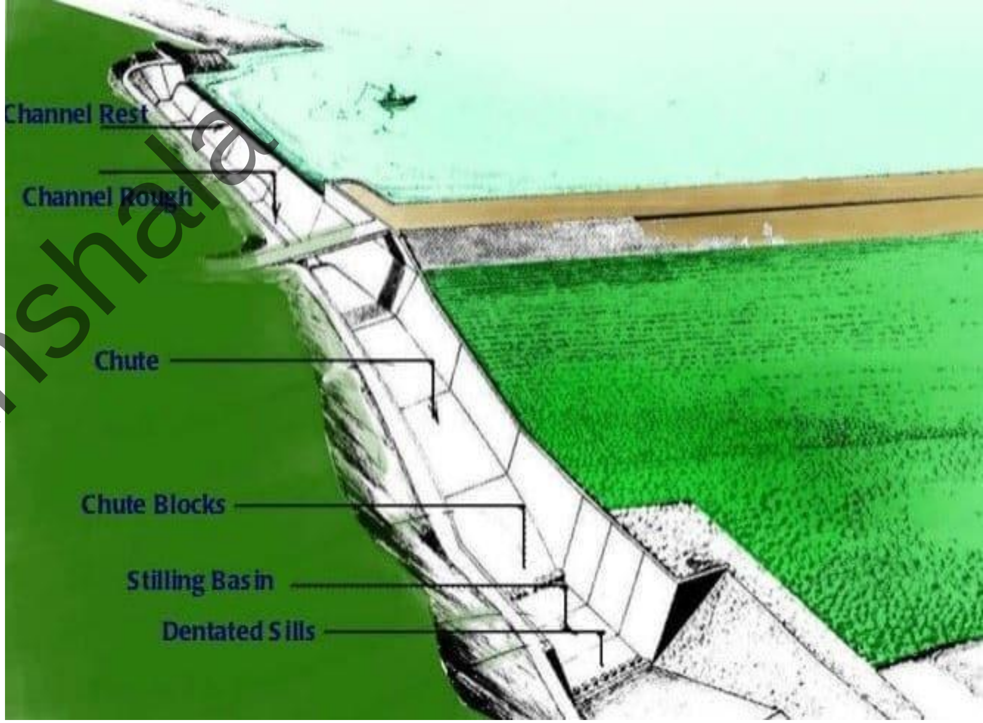
A spillway is a hydraulic structure built at a dam site for diverting the surplus water from a reservoir after it has been filled to its maximum capacity.

A. **Ogee spillways** are most commonly used in case of gravity dams

B. **Chute spillway** is a type of spillway in which surplus water from upstream is disposed to the downstream through a steeply sloped open channel.

The slope of chute spillway is designed in such a way that the flow should be always in super critical condition.

C. Side channel spillway is similar to chute spillway but the only difference is the crest of side channel spillway is located on one of its sides whereas crest of chute spillway is located between the side walls.



D. A Shaft spillway is consists of a vertical shaft followed by a horizontal conduit. The surplus water enters into the vertical shaft and then to the horizontal conduit and finally reaches the downstream of the channel.

Shaft spillway is recommended when there is no space to provide for other types of spillways

Q. 84) In case of non-availability of space due to topography, the most suitable spillway is

A. Straight drop spillway
B. Shaft spillway
C. Chute spillway
D. Ogee spillway

Answer B

Straight Drop Spillway:-

A Straight drop spillway consists of low height weir wall having its downstream face roughly or perfectly vertical. When the water level in the reservoir rises above the normal pool level, the surplus water falls freely from the crest of the weir and hence it is known as Straight drop spillway or free overfall spillway

Q. 85) In a chute spillway, the flow is usually

A. Uniform
B. Subcritical
C. Critical
D. Super critical

Answer D

The slope of chute spillway is designed in such a way that the flow should be always in super critical condition.

When the actual depth is less than critical depth it is classified as supercritical. Supercritical flow has a Froude number greater than one.

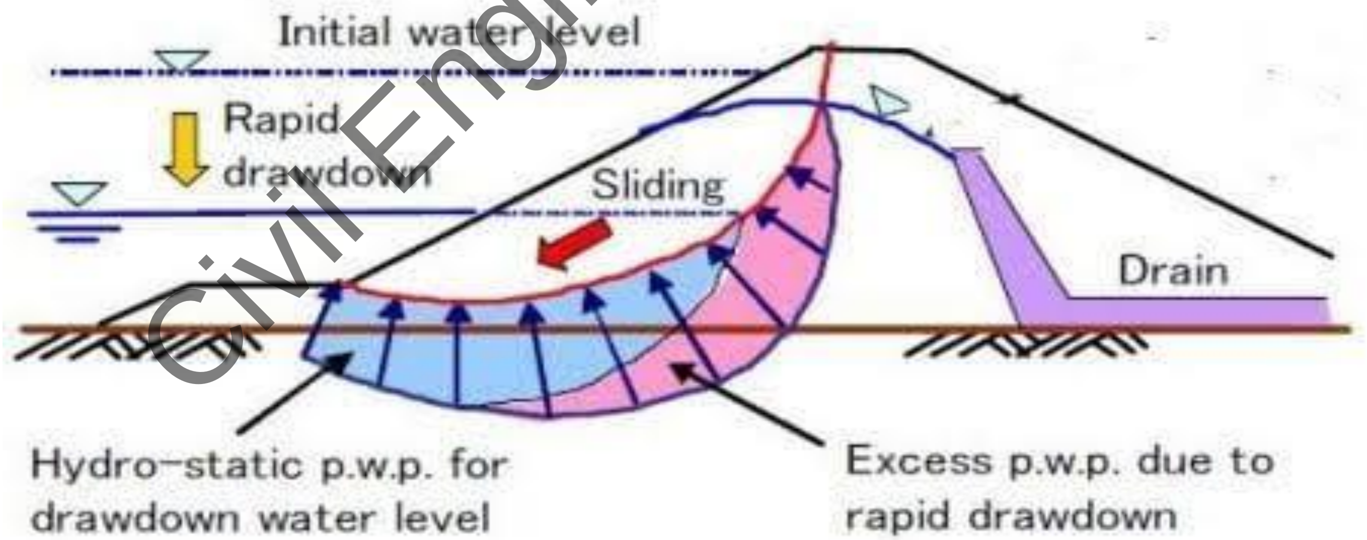
Q. 86) For the upstream face of an earthen dam, the most adverse condition for stability of slope is

A. Sudden drawdown
B. Steady seepage
C. During construction
D. Sloughing of slope

Answer A

Upstream slope slide during sudden drawdown:-

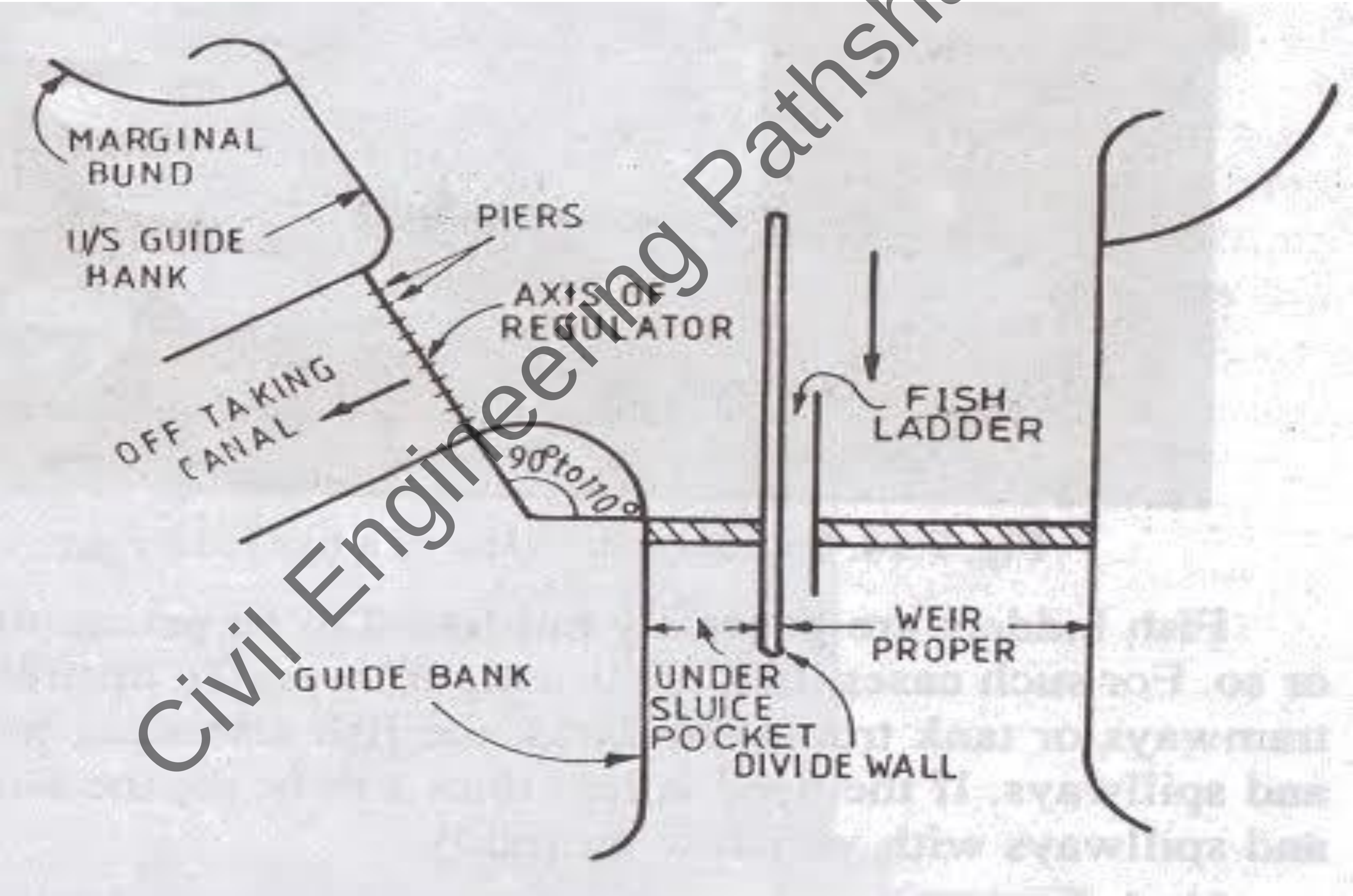
For the upstream Slope the critical condition is when the reservoir is suddenly emptied without allowing any appreciable change in the water level within the saturated soil mass. The stage is known as sudden drawdown. With complete drawdown, the hydrostatic force acting along the upstream slope at the time of full reservoir is removed without the hydrostatic pressure on the slope of counteract it.



Q. 87) If there are two canals taking off from each flank of a river, then there will be

A. One divide wall and one undersluice
B. One divide wall and two undersluices
C. Two divide walls and one undersluice
D. Two divide walls and two undersluices

Answer D



MARGINAL BUND
U/S GUIDE BANK
PIERS
AXIS OF REGULATOR
OFF TAKING CANAL
90° to 110°
FISH LADDER
WEIR PROPER
GUIDE BANK
UNDER SLUICE POCKET
DIVIDE WALL

Q. 88) Generally the weird is aligned at right angles to the direction of the main river current because

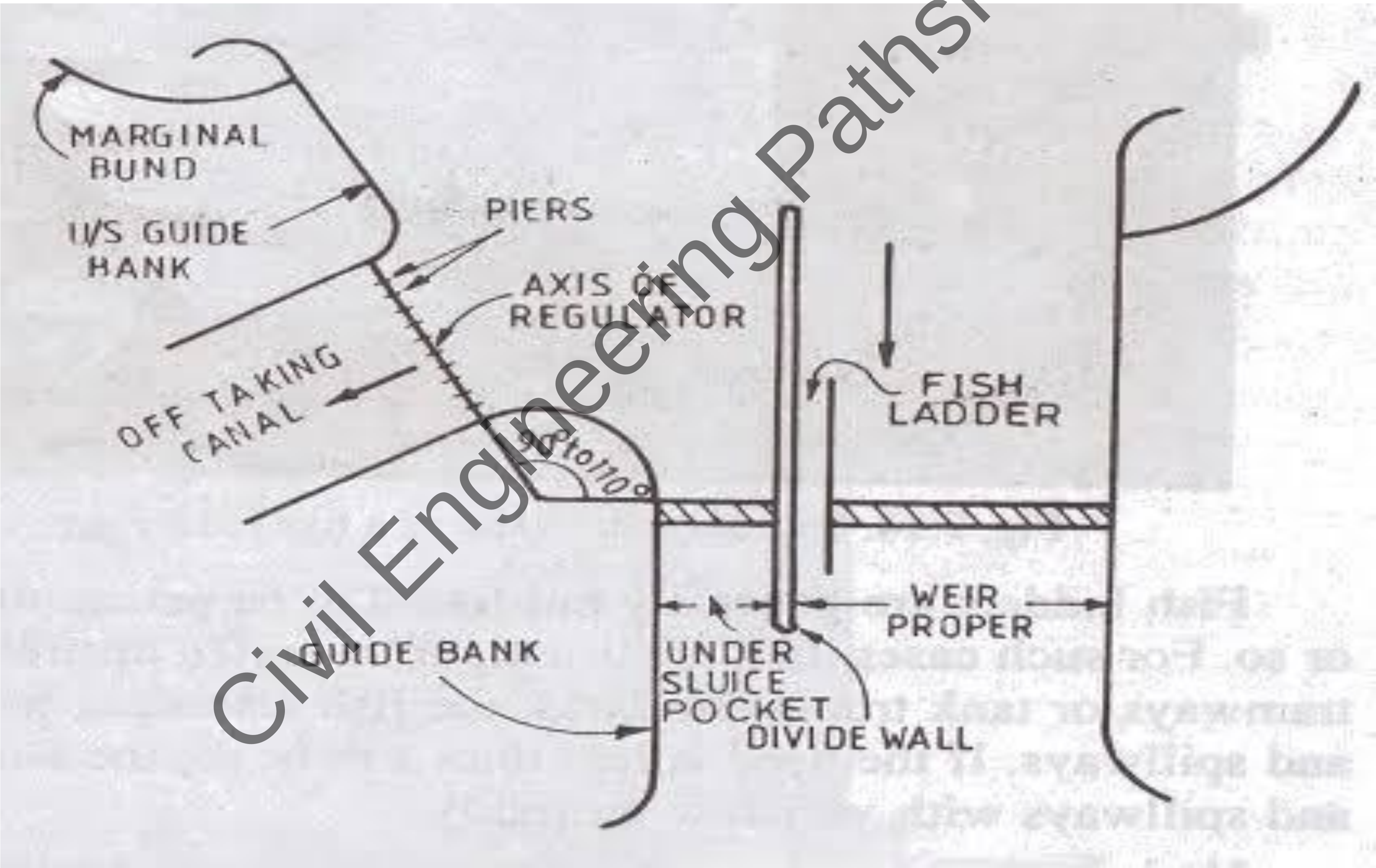
A. It ensures less length of the weir
B. It gives better discharging capacity
C. It is economical
D. All of the above

Answer D

As far as possible, the weir should be aligned at right angle to the direction of the main river current.

1. This ensures lesser length of the weir,
2. Better discharging capacity and
3. Lesser cost.

Sometimes, the weir may be aligned at an oblique angle to the direction of the river current.
In such a case, the weir will be of greater length, will have less discharging power and will be costlier.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OFF TAKING CANAL
FISH LADDER
90° to 110°
WEIR PROPER
GUIDE BANK
UNDER SLUICE POCKET
DIVIDE WALL

Q. 89) The main function of a divide wall is to

A. Control the silt entry in the canal
B. Prevent river floods from entering the canal
C. Separate the undersluices from weir proper
D. Provide smooth flow at sufficiently low velocity

<u>Answer C</u>

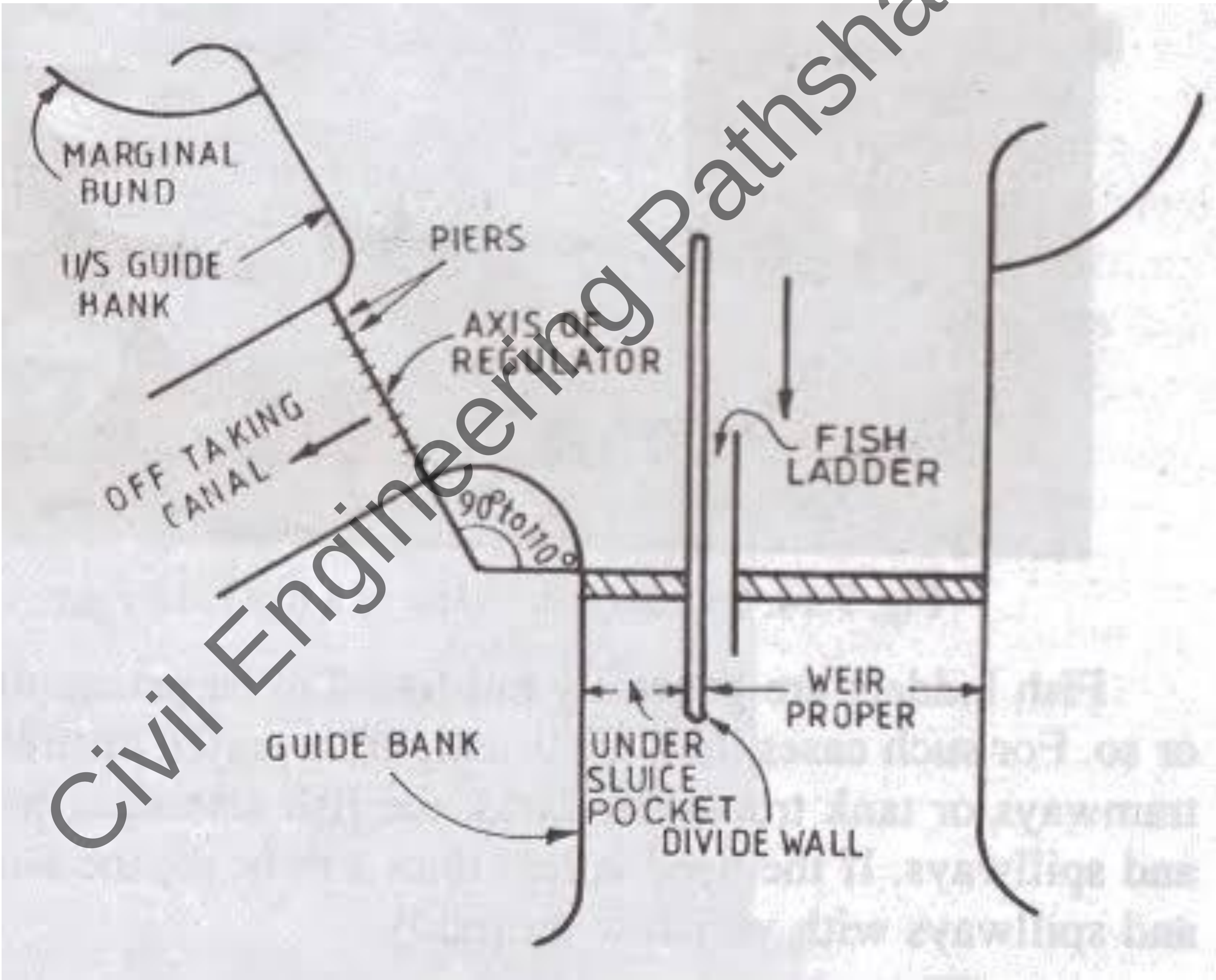
A, B are correct for canal head regulator and D is correct for fish ladder.

The divide wall is a masonry or concrete wall constructed at right angle to the axis of the weir.

It separates the ‘under-sluices’ with lower crest level from the ‘weir proper’ with higher crest level.

Weir Proper: It is a barrier constructed across the river. It aims to raise the water level in order to feed the canal.

Under-sluices: The under sluices are the openings provided at the base of the weir. They are located on the same side as the off-taking canal.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AXIS OF REGULATOR
OFF TAKING CANAL
90° to 110°
FISH LADDER
WEIR PROPER
GUIDE BANK
UNDER SLUICE POCKET
DIVIDE WALL

Q. 90) A divide wall is provided

A. At right angle to the axis of weir
B. Parallel to the axis of weir and upstream of it
C. Parallel to the axis of weir and downsream of it
D. At an inclination to the axis of weir

Answer A

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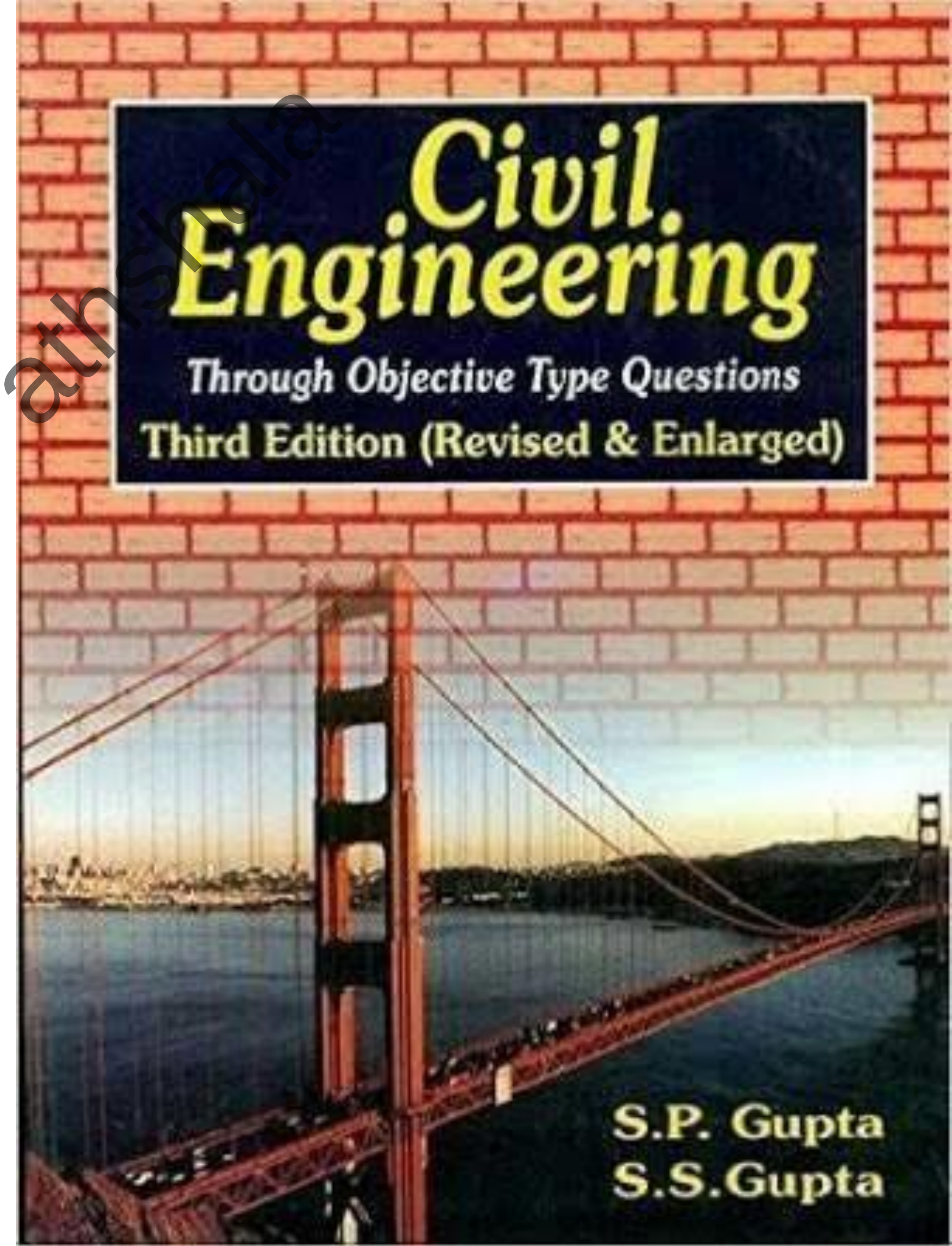
Objective Questions (91 to 105)

Irrigation & Hydrology



Q. 91) As compared to crest of the normal portion of the weir, the crest of the undersluice portion of the weir is kept at

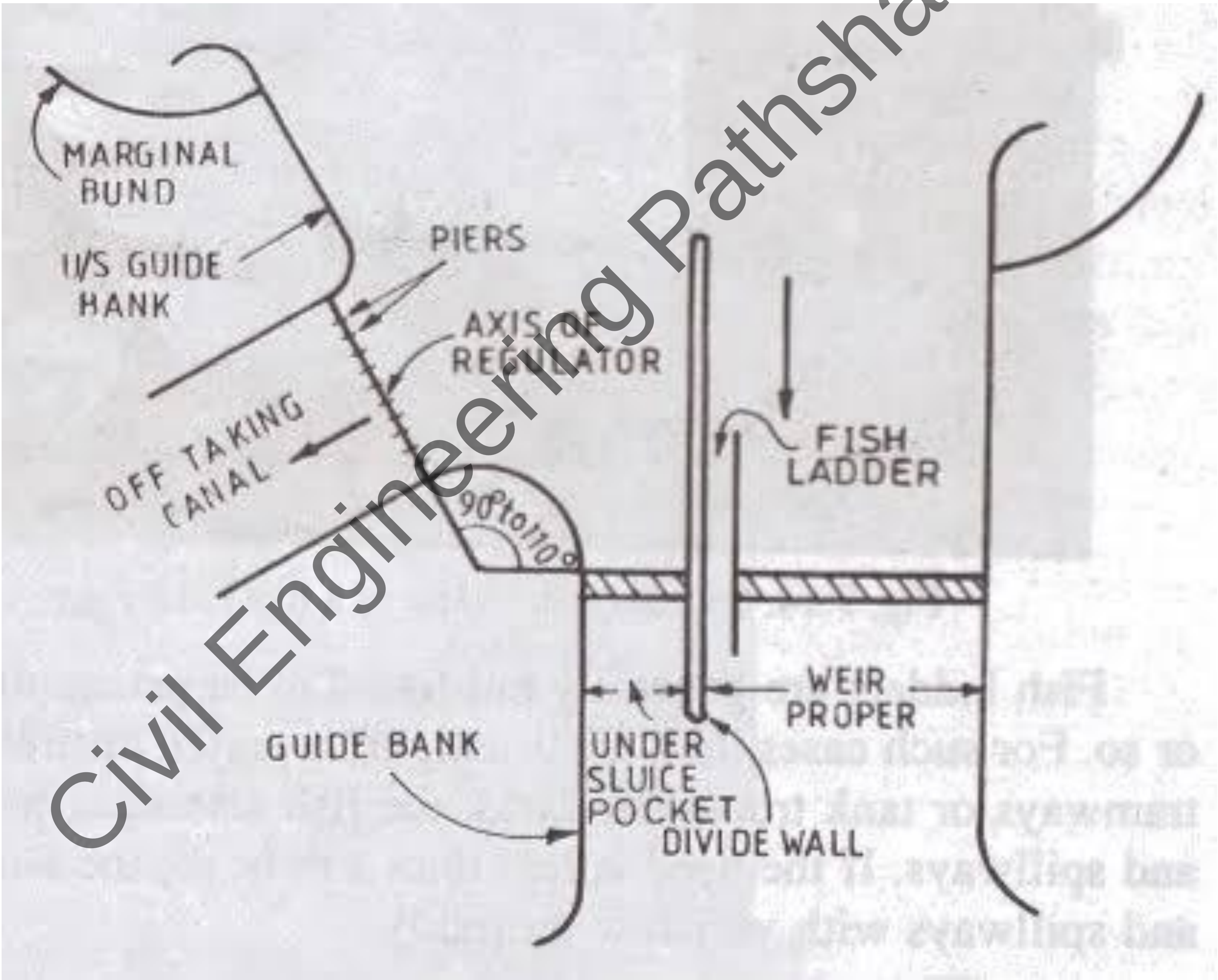
A. Lower level
B. Higher level
C. Same level
D. Any of the above depending on the design

Answer A

Weir Proper: It is a barrier constructed across the river. It aims to raise the water level in order to feed the canal.

Under-sluices: The under sluices are the openings provided at the base of the weir. They are located on the same side as the off-taking canal.

The divide wall separates the 'under-sluices' with lower crest level from the 'weir proper' with higher crest level.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90° to 110°
FISH LADDER
WEIR PROPER
GUIDE BANK
UNDER SLUICE POCKET
DIVIDE WALL

Q. 92) Silt excluders are constructed on the

A. River bed upstream of head regulator
B. River bed downstream of head regulator
C. Canal bed upstream of head regulator
D. Canal bed downstream of head regulator

Answer A

Head regulator:- is a structure constructed at the head of a canal.
Function:- 1. To make the regulation of supply in the canal easy.
2. To control the silt entry into the canal.
3. To shut out river floods.

There are two types of special works constructed to control the silt entering into the canal

1. Silt Excluder:-Is a device by which silt is excluded from water entering the canal. It is constructed in the **river bed** upstream of head regulator.

2. Silt Extractor or silt Ejector:-Is a device by which the silt after it has entered the canal is extracted. While a silt excluder is a preventive measure, the silt extractor is a curative measure and is constructed in the **canal bed** downstream of head regulator.

Q. 93) If h is the ordinate of hydraulic gradient line above the top of the floor and G is specific gravity of floor material, then the thickness of floor is given by the formula

A. h/(G+1)
B. (h-1)/(G-1)
C. h/(G-1)
D. (h-1)/G

Answer C

If h is the ordinate of hydraulic gradient line above the top of the floor and G is specific gravity of floor material, then the thickness of floor is given by the formula h/(G-1).

Q. 94) According to Khosla's theory, the exit gradient in the absence of downstream cutoff is

A. 0
B. Unity
C. Infinity
D. Very large

Answer C

According to Khosla's theory, the exit gradient in the absence of a downstream cutoff is infinity.

Q. 95) The minimum size of a stone that will remain at rest in a channel of longitudinal slope S and hydraulic mean depth R is given by

A. 4RS
B. 11RS
C. 7RS
D. 15RS

Answer B

Q. 96) The ratio of average values of shear stress produced on the bed and banks of a channel due to flowing water is

A. Less than 1
B. Equal to 1
C. Greater than 1
D. Equal to zero

Answer C

Average shear stress on bed of a channel, $\tau 1 = \gamma Rs$
Average shear stress on bank of a channel, $\tau 2 = 0.75\gamma Rs$

This ratio is, $\tau 1/\tau 2 = \gamma RS/0.75\gamma RS = 4/3 > 1$

where, τ is the fluid shear stress
γ is the specific gravity of water
R is the hydraulic radius (approximately mean depth)
s is the slope of the channel

Q. 97) If the critical shear stress of a channel is τc, then the average value of shear stress required to move the grain on the bank is

A. $0.5\tau c$
B. $0.75\tau c$
C. τc
D. $1.33\tau c$

Answer B

Average value of shear stress required to move the grain on the **bank** is = 0.75τc

Critical shear stress is same as shear stress required to move a grain on **bed.**

Q. 98) A water shed canal

A. Irrigates only on one side
B. Is most suitable in hilly areas
C. Avoids the cross drainage works
D. Is generally aligned parallel to the contours of the area

Answer C

Clasification of canal based on its alignment

1. Contour canal:-

Is aligned nearly parallel to the contours.

It can irrigate only one side.

Is most suitable in hilly areas.

When it crosses a valley line, extra cost on cross drainage works is required.

2. Ridge canal or watershed canal:-

It can irrigate on both sides.

No drainage can intersect a watershed and hence avoid cross drainage work.

3. Side slope canal:-

Is aligned roughly at right angles to the contours of the country.

Cross drainage works are required.

Q. 99) A canal which is aligned at right angles to the contour is called

A. Contour canal
B. Watershed canal
C. Branch canal
D. Side slope canal

Answer D

Q. 100) Garret’s diagrams are based on

A. Kennedy’s theory
B. Lacey’s theory
C. Khosla’s theory
D. Bligh’s theory

Answer A

Since two or three trials are required in designing the canal by Kennedy’s theory, the numerical work and hence the solution takes a very long time.

Garret simplified the numerical work by providing diagrams with the help of which design can be done more quickly.

Garret’s diagrams have been drawn for a semi-circular channel.

In these diagram, the bed slope of the canal is indicated on the vertical axis while the discharge is plotted on the horizontal axis.

Q. 101) Garret's diagrams have been drawn for

A. A semi-circular channel
B. A trapezoidal channel with side slope ½H:1V
C. A trapezoidal channel with side slope 1H:½V
D. Semi-elliptical channel

Answer B

102. Lacey's regime scour depth is given by

a) $1.35\left(\frac{q}{f}\right)^{1/3}$

b) $1.35\left(\frac{q^2}{f}\right)^{1/6}$

c) $1.35\left(\frac{q^2}{f}\right)^{1/3}$

d) $1.35\left(\frac{q}{f}\right)^{1/6}$

where q is discharge per unit width and f is silt factor.

Answer C

Lacey's equations

1. Silt factor, $f = 1.76 \sqrt{m_r}$
Where m_r is mean particle diameter of silt in mm

2. Perimeter Discharge relation, $P = 4.75 \sqrt{Q}$

3. Velocity Discharge relation, $V = (Qf^2/140)^{1/6}$

4. Regime slope equation, $S = f^{5/3}/3340Q^{1/6}$

5. Regime scour depth relation, $R = 1.35\ (q^2/f)^{1/3}$

Q. 103) According to Lacey's theory, the silt supporting eddies are generated from

A. Bottom of channel only
B. Sides of channel only
C. Bottom as well as sides of channel
D. None of the above

<u>Answer C</u>

According to Lacey's theory, the silt supporting eddies are generated from perimeter of channel.

104. According to Lacey, the bed slope is given by

a) $\dfrac{f^{4/3}}{3340Q^{1/2}}$

b) $\dfrac{f^{2/3}}{3340Q^{1/4}}$

c) $\dfrac{f^{5/3}}{3340Q^{1/6}}$

d) $\dfrac{f^{1/3}}{3340Q^{5/3}}$

where f is silt factor and Q is discharge in cumecs.

Answer C

Q. 105) As per Lacey's theory, the silt factor is

A. Directly proportional to average particle size
B. Inversely proportional to average particle size
C. Directly proportional to square root of average particle size
D. Not related to average particle size

Answer C

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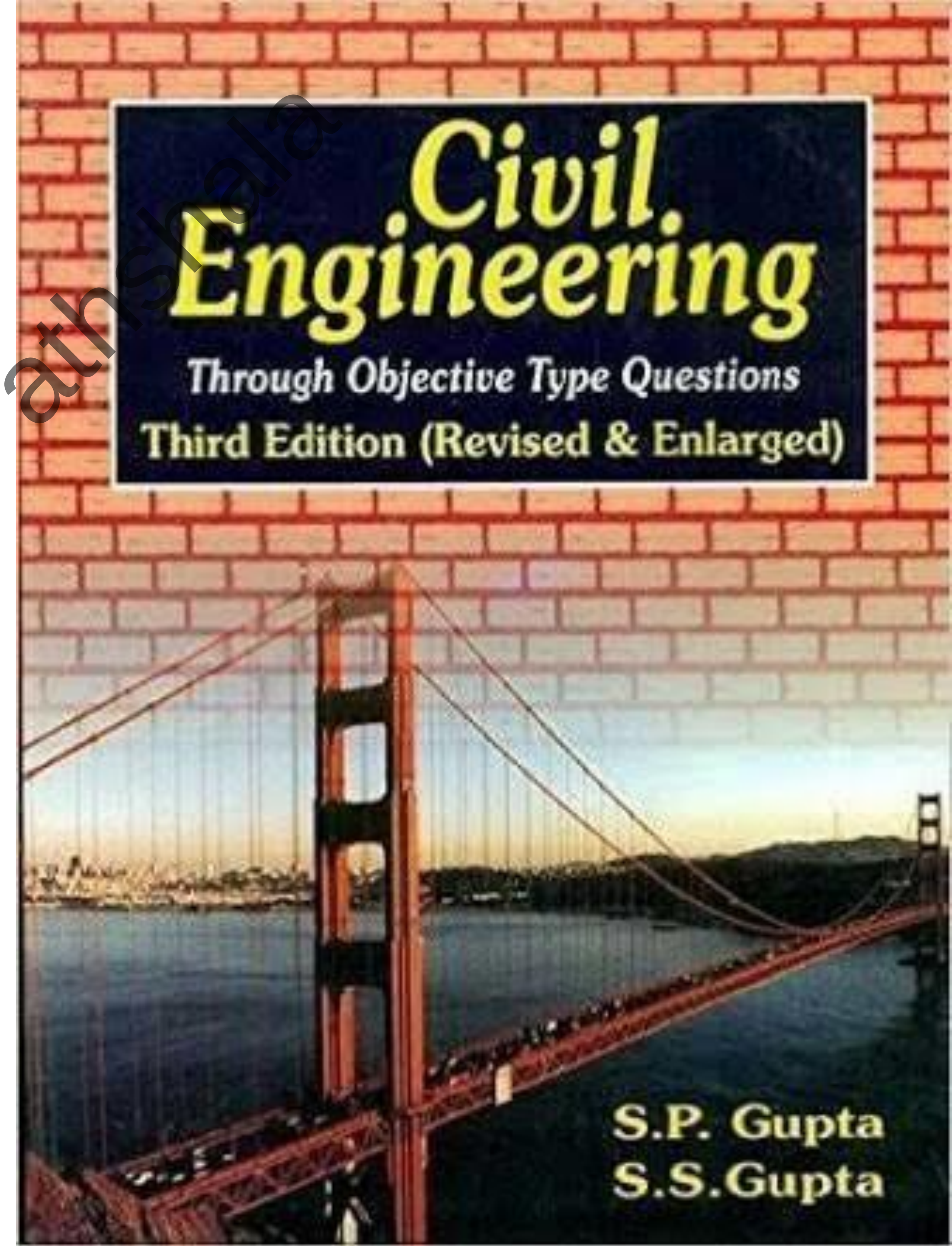
Objective Questions (106 to 120)

Irrigation & Hydrology



106. As per Lacey's regime theory, the flow velocity is proportional to

a) $\left(Qf^2\right)^{1/3}$

b) $\left(Qf^2\right)^{1/6}$

c) $\dfrac{Q}{f^2}$

d) $\left(\dfrac{Q}{f^2}\right)^{1/6}$

Answer B

Lacey's equations

1. Silt factor, $f = 1.76 \sqrt{m_r}$
Where m_r is mean particle diameter of silt in mm

2. Perimeter Discharge relation, $P = 4.75 \sqrt{Q}$

3. Flow Velocity Discharge relation, $V = (Qf^2/140)^{1/6}$

4. Regime slope equation, $S = f^{5/3}/3340Q^{1/6}$

5. Regime scour depth relation, $R = 1.35\ (q^2/f)^{1/3}$

Q. 107) Wetted perimeter of a regime channel for a discharge of 64 cumec as per Lacey's theory will be

A. 19 m
B. 38 m
C. 57 m
D. 76 m

Answer B

As per Lacey's theory, wetted perimeter,

$$P = 4.75\sqrt{Q}$$

$$P = 4.75\sqrt{64}$$

$$P = 38 \text{ m}$$

Q. 108) Which of the following Canal structures is used to remove surplus water from an irrigation channel into a natural drain

A. Canal fall
B. Canlal outlet
C. Canal escape
D. Canal regulator

Answer C

A. Canal fall is a solid masonry structure which is constructed on the canal if the natural ground slope is steeper than the designed channel bed slope.

B. Canal outlet or a module is a small structure built at the head of the water course so as to connect it with a minor or a distributary channel.

C. Canal Escape It is the structure required to dispose of surplus or excess water from canal from time to time. Thus, a canal escape serves as safety valve for canal system.

D. Canal Regulators Constructed at the off taking point are called head regulators. When it is constructed at the head of main canal it is known as canal head regulator. And when it is constructed at the head of distributary, it is called distributary head regulator.
To control the entry of silt into off taking or main canal.

Q. 109) For a proportional outlet, the flexibility is

A. Zero
B. Between zero and 1
C. 1
D. Greater than 1

Answer C

Flexibility (F) :-

It is the ratio of rate of change of discharge of an outlet to the rate of change of discharge of the distributing channel.

$$F = (dq/q) /(dQ/Q)$$

Where, q = discharge through the outlet

Q = discharge of the distributing channel

1. **Proportional outlet:-** the rate of change of its discharge is equal to the rate of change of the discharge of the distributing channel. **$F = 1$**
2. **Hyper-proportional outlet:-** $(dq/q) > (dQ/Q)$, $F > 1$
3. **Sub-proportional outlet:-** $(dq/q) < (dQ/Q)$, $F < 1$

Q. 110) The sensitivity of a rigid module is

A. Zero
B. Between zero and 1
C. 1
D. Infinity

Answer A

Sensitivity (S):- it is defined as the ratio of the rate of change of discharge of an outlet to the rate of change in the level of the distributing surface, referred on the normal depth of the channel.

$$S = (dq/q) / (dG/D)$$ (sensitivity of a rigid module is zero)

Where, q = discharge through the outlet

dq = change in the discharge of the outlet

G = gauge reading

D = depth of water in the distributing channel

Q. 111) Which of the following is a flexible outlet

A. Submerged pipe outlet
B. Kennedy’s gauge outlet
C. Gibb’s outlet
D. None of the above

Answer B

A **canal outlet** or a module is a small structure built at the head of the water course so as to connect it with a minor or a distributary channel.

Types of outlets

1. **Non-modulur outlet:-** in which the discharge depends upon the difference in level between the water levels in the distributing channel and the water course. Exmp: submerged pipe outlet, masonry sluice and orifices, and wooden shoots.
2. **Semi-module or flexible outlet:-** in which the discharge is affected by the fluctuations in the water level of the distributing channel while the fluctuations in the water levels of the field channel do not have any effect on its discharge. Exmp: pipe outlet, Kennedy's gauge outlet, crump's open flume outlet and pipe-cum-open flume outlet.
3. **Rigid module:-** in which maintain constant discharge, within limits, irrespective of the fluctuations in the water levels in the distributing channel and field channel. Exmp: Gibb's rigid module

Q. 112) A straight glacis type fall with a baffle platform and baffle wall is called

A. Vertical dropfall
B. Glacis fall
C. Montague type fall
D. Inglis fall

Answer D

Canal fall is a solid masonry structure which is constructed on the canal if the natural ground slope is steeper than the designed channel bed slope. If the difference in slope is smaller, a single fall can be constructed. If it is of higher then falls are constructed at regular suitable intervals.

The important types of falls is

1. Ogee falls
2. Rapids
3. Stepped falls
4. Trapezoidal notch falls
5. Well type falls
6. Simple vertical drop falls
7. Straight glacis falls
8. Montague type falls
9. Inglis falls or baffle falls

1. Simple Vertical Drop Falls (Sarda Type fall)

Consists, single vertical drop which allows the upstream water to fall with sudden impact on downstream. The downstream acts like cushion for the upstream water and dissipate extra energy. This type of fall is tried in Sarda Canal UP (India) and therefore, it is also called Sarda Fall.

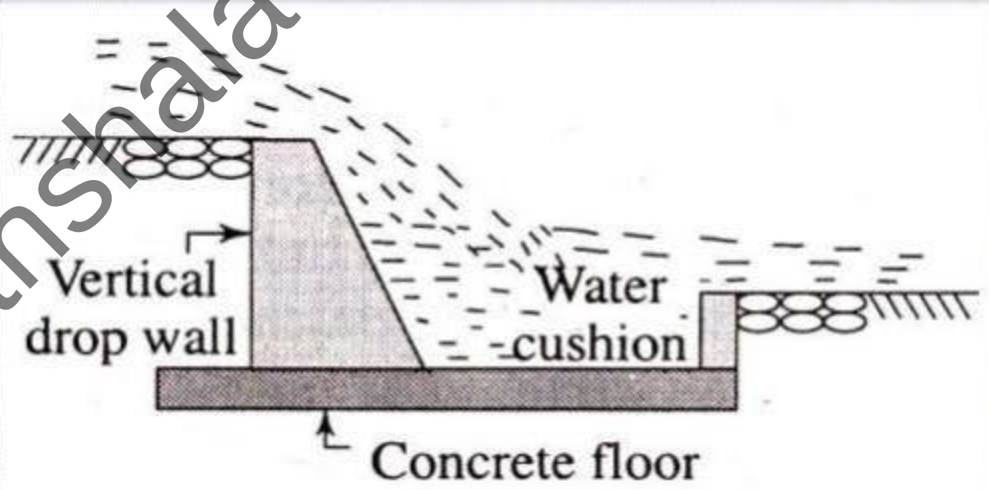


Fig: Vertical Drop Fall

2. Straight Glacis Canal Falls

This is the modern type of construction, in which a raised crest is constructed across the canal and a gentle straight inclined surface is provided from raised crest to the downstream. The water coming from upstream crosses the raised crest and falls on inclined surface with sufficient energy dissipation.

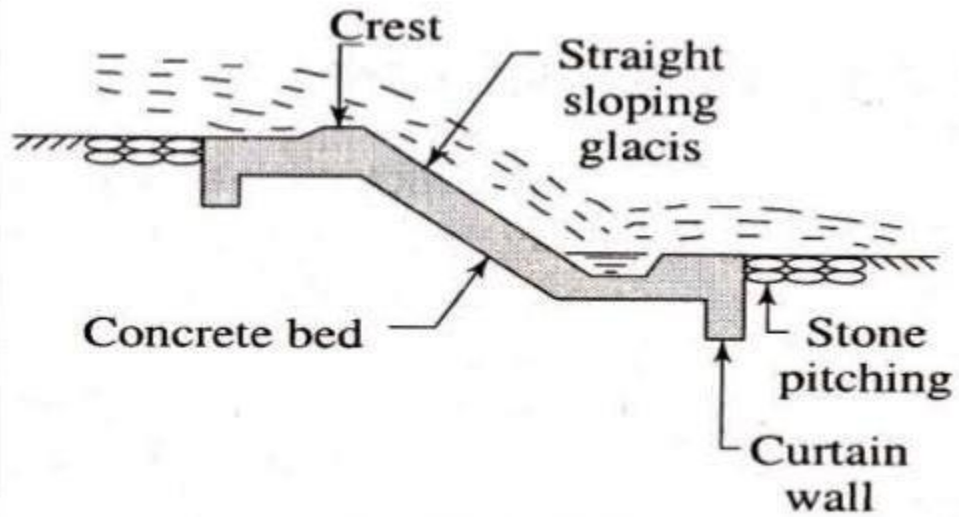


Fig: Glacis Fall

3. Montague Type Canal Falls

Montage fall is similar to straight glacis fall but in this case the glacis is not straight. It is provided in parabolic shape to introduce the vertical component of velocity which improves the energy dissipation to more extent.

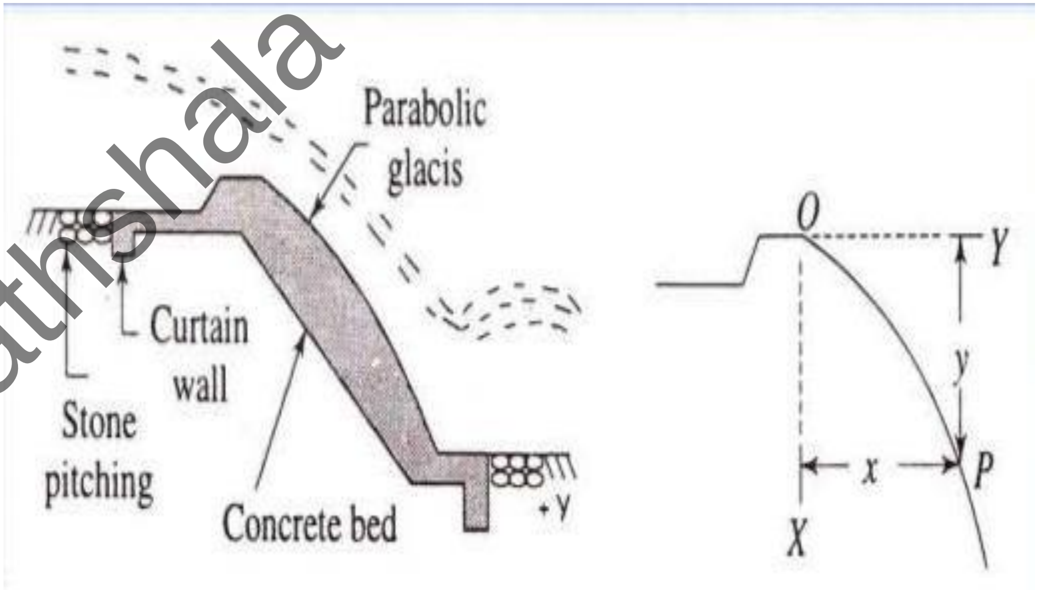


Fig: Montague Type Fall

4. Inglis or Baffle Canal Falls

In this case, straight glacis fall is extended as baffle platform with baffle wall. This is suitable for any discharge. The baffle wall is constructed near the toe of the straight glacis at required distance in designed height. The main purpose of the baffle wall is to create hydraulic jump from straight glacis to baffle platform.

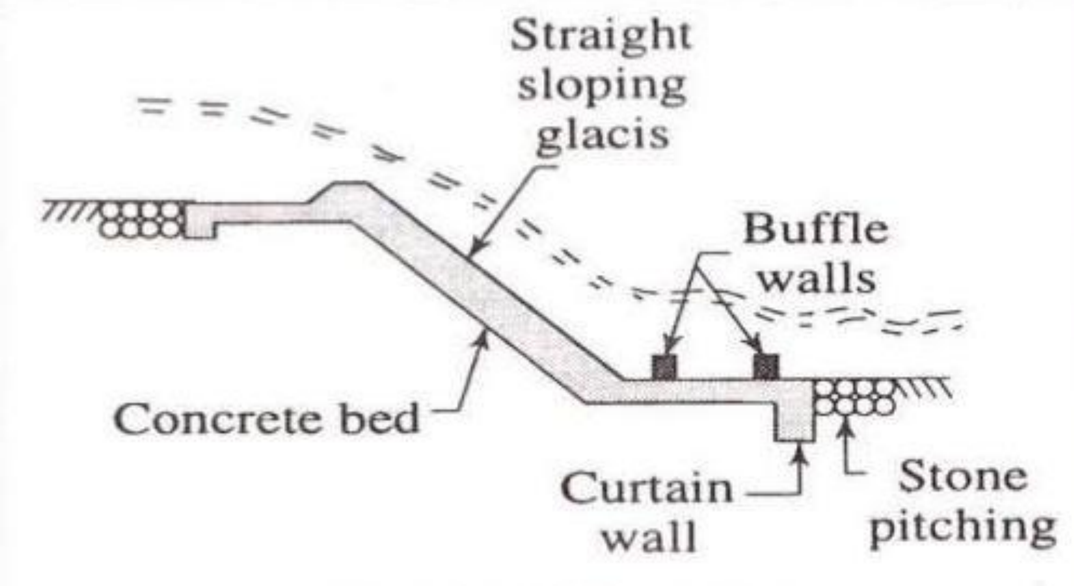


Fig: Inglis Type Fall

Q. 113) Which of the following types of falls use parabolic glacis for energy dissipation

A. Vertical dropfall
B. Glacis fall
C. Montague type fall
D. Inglis fall

Answer C

Q. 114) In a Sarda type fall, rectangular crest is used for discharge upto

A. 6 cumecs
B. 10 cumecs
C. 14 cumecs
D. 20 cumecs

Answer C

The rectangular crest is used for discharge up to 14 cumecs

The Trepezoidal crest is used for discharge over 14 cumecs

Q. 115) Which of the following can be used as a meter fall

A. Vertical drop fall
B. Flumed glacis fall
C. Unflumed glacis fall
D. All of the above

<u>Answer A</u>

Vertical drop fall can be used as a meter fall.

Q. 116) Vertical drop fall is satisfactory for a height upto

A. 0.5 m
B. 1.5 m
C. 3.5 m
D. 5.0 m

Answer B

Vertical drop fall is satisfactory for a height upto 1.5 m

Q. 117) Which of the following canal outlets maintains a constant discharge

A. Non modular outlet
B. Flexible outlet
C. Rigid outlet
D. None of the above

Answer C

Outlet:- is a small structure which admits water from the distributing channel to a water course or field channel.

Types of outlets

1. Non-modulur outlet:- in which the discharge depends upon the difference in level between the water levels in the distributing channel and the water course. Exmp: submerged pipe outlet, masonry sluice and orifices, and wooden shoots.

2. Semi-module or flexible outlet:- in which the discharge is affected by the fluctuations in the water level of the distributing channel while the fluctuations in the water levels of the field channel do not have any effect on its discharge. Exmp: pipe outlet, Kennedy's gauge outlet, crump's open flume outlet and pipe-cum-open flume outlet.

3. Rigid module:- in which maintain constant discharge, within limits, irrespective of the fluctuations in the water levels in the distributing channel and field channel. Exmp: Gibb's rigid module

Q. 118) The ratio of the of change of the discharge of an outlet to the rate of change of the discharge of distributing channel is called

A. Proportionality
B. Flexibility
C. Setting
D. Sensitivity

Answer B

Setting:- is the ratio of the depth of the crest level of the module below the full supply of the distributing channel to the full supply depth of the distributing channel.

$$\text{Setting} = H/D$$

Q. 119) The drainage water intercepting the canal can be disposed of by passing the canal below the drainage is

A. Aqueduct and syphon aqueduct
B. Aqueduct and super passage
C. Super passage and canal syphon
D. Level crossing

Answer C

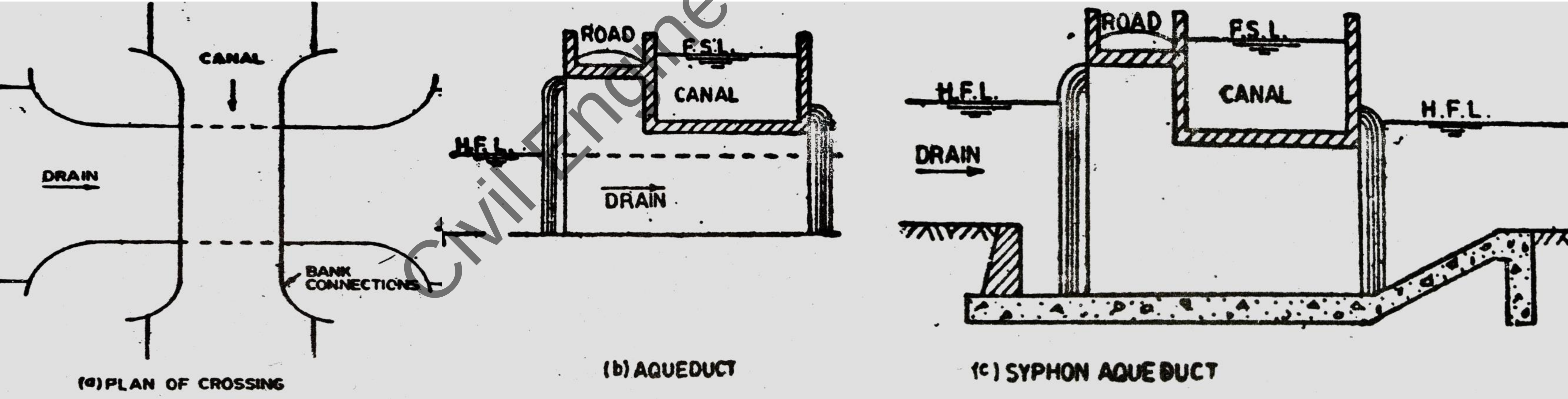
A cross drainage work is a structure carrying the discharge of a natural stream across a canal intercepting the stream.

Types of cross-drainage works

A. CD work carrying canal over the drainage:-

1. Aqueduct:- The HFL (high flood level) of drain is much below the bottom of the canal, and water flows freely under gravity.

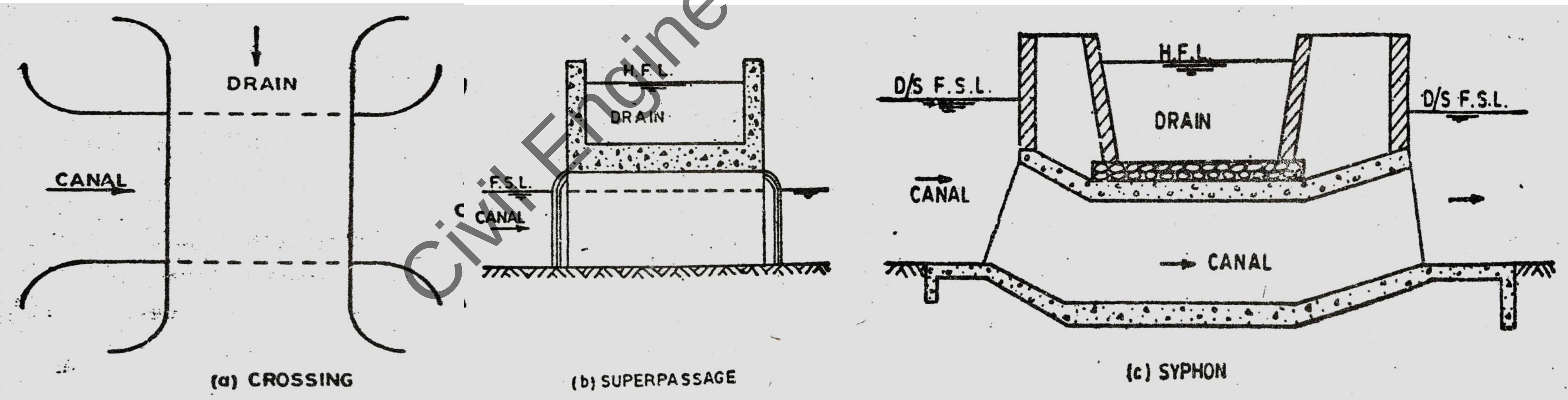
2. Syphon aqueduct:- The HFL of the drain is much higher above the canal bed, and the water runs under syphonic action through the aqueduct barrels.



B. CD work carrying drainage over the canal

1. Super-passage:- is similar to an aqueduct except that in this case the drain is over the canal. The FSL (full supply level) of the canal is lower than the underside of the trough carrying drainage water. Thus, the canal water runs under gravity.

2. Canal syphon:-The FSL of the canal is much above the bed level of the drainage trough, so that canal is runs under syphonic action under the throug.



Q. 120) If the RL’s of canal bed level and high flood level of discharge are 212.0 m and 210.0 m respectively, then cross drainage work will be

A. Aqueduct
B. Superpassage
C. Syphon
D. Syphon aqueduct

Answer A

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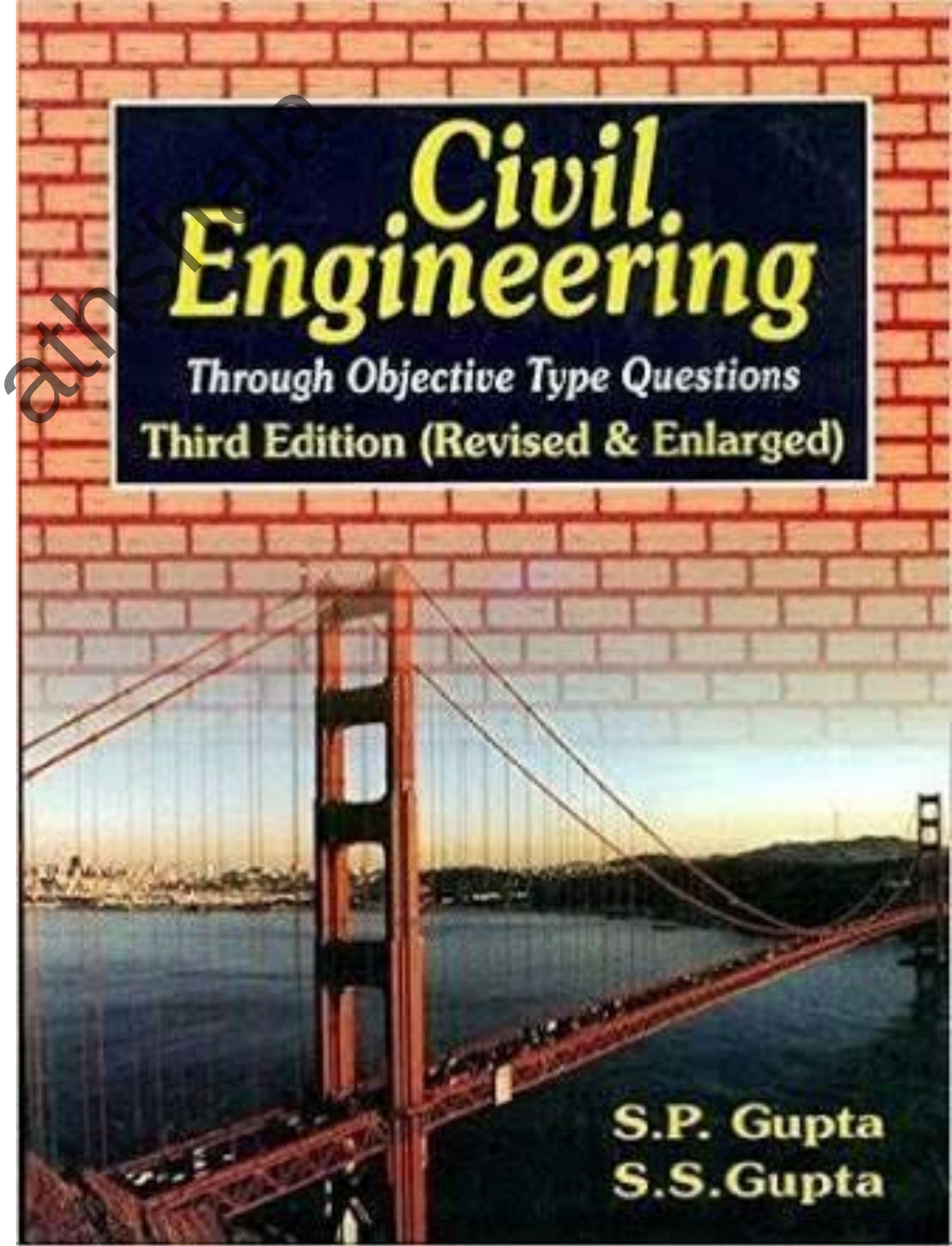
Objective Questions
(121 to 135)

Irrigation & Hydrology



Q. 121) The aqueduct or superpassage type of works are generally used when

A. High flood drainage discharge is small
B. High flood drainage discharges is large and short lived
C. High flood drainage discharge is large and continuous for a long time
D. None of the above

Answer A

A cross drainage work is a structure carrying the discharge of a natural stream across a canal intercepting the stream.

Types of cross-drainage works

A. CD work carrying canal over the drainage:-

1. Aqueduct:- The HFL (high flood level) of drain is much below the bottom of the canal, and water flows freely under gravity.

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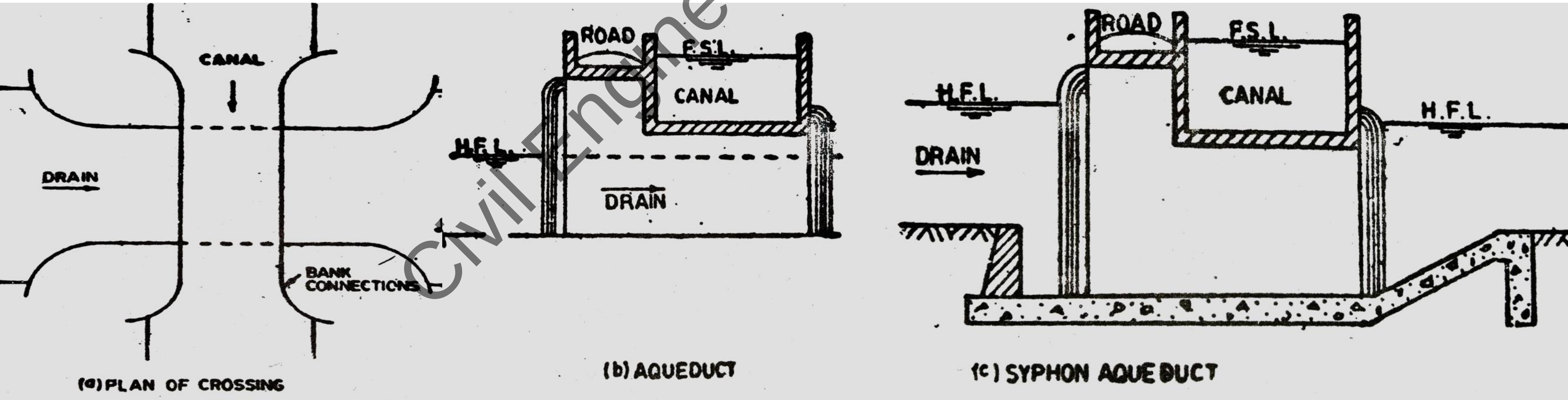
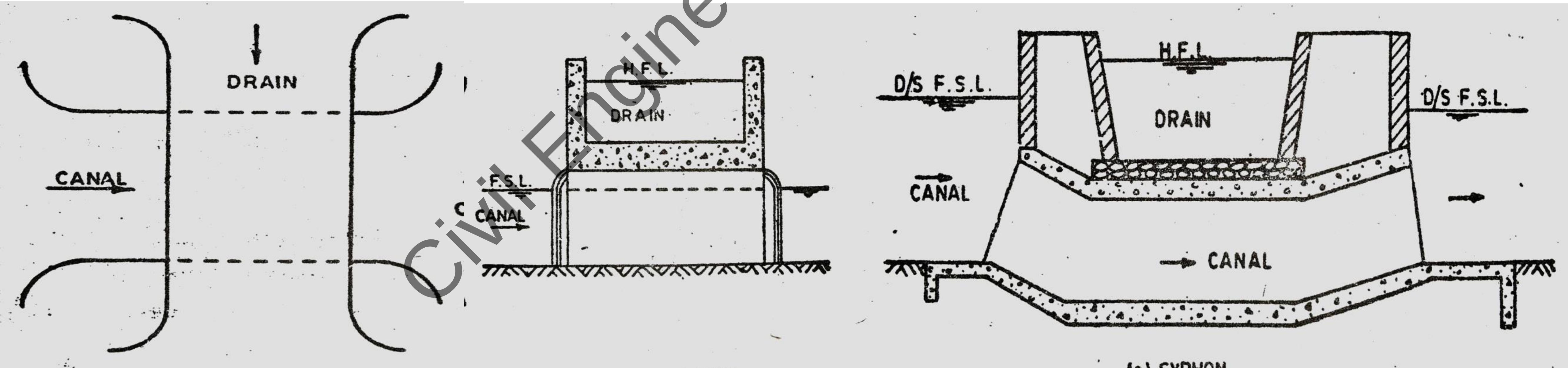


B. CD work carrying drainage over the canal

1. **Super-passage:-** is similar to an aqueduct except that in this case the drain is over the canal. The FSL (full supply level) of the canal is lower than the underside of the trough carrying drainage water. Thus, the canal water runs under gravity.

2. **Canal syphon:-**The FSL of the canal is much above the bed level of the drainage trough, so that canal is runs under syphonic action under the throug.



(a) CROSSING (b) SUPERPASSAGE (c) SYPHON

Q. 122) An aggrading river is

A. Silting river
B. Scouring river
C. Both silting and scouring river
D. Neither silting nor scouring river

Answer A

Agrading river (silting river):- The river builds up its bed by silting or dropping its bed load.

Degrading river (Scouring river):- Scouring is the removal of sediment from its bed.

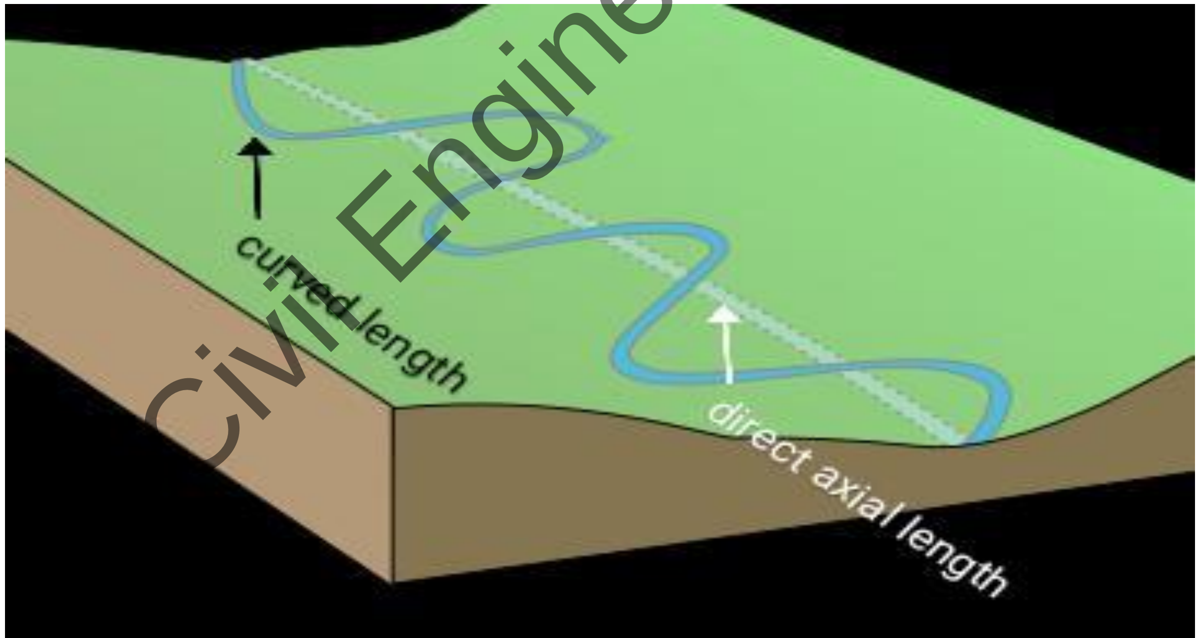
Q. 123) Tortuosity of a meandering river is the ratio of

A. Meander belt to meander length
B. Meander length to meander belt
C. Curved length along the channel to the direct axial length of the river reach
D. Direct axial length of the river reach to curved length along the channel

Answer C

Tortuosity of a meandering river is the ratio of curved length along the channel to the direct axial length of the river reach.

Tortuosity of meandering river is always > 1



Q. 124) The meander pattern of river is developed by

A. Average discharge
B. Dominant discharge
C. Maximum discharge
D. Critical discharge

<u>Answer B</u>

Dominant discharge varies from 1/2 to 1/3 of Qmax

Q. 125) The main cause of meandering is

A. Presence of an excessive bed slope in the river
B. Degradation
C. The extra turbulence generated by the excess of river sediment during floods
D. None of the above

Answer C

Meandering results from the local bank erosion and consequent overloading and deposition of the river of the heavier sediments moving along the bed.
According to Inglis, the primary cause of the meanderig is the excess of total charge during floods when excess of turbulence a developed.

Q. 126) Tortuosity of a meandering river is always

A. Equal to 1
B. Less than 1
C. Greater than 1
D. Less than or equal to 1

Answer C

Q. 127) Select the correct statement

A. A meander increases the river length but a cutoff reduces the river length
B. A cutoff increases the river length but a meander reduces the river length
C. Both meander and cutoff increase the river length
D. Both meander and cutoff decreases the river length

Answer A

During high floods, a cutoff may be developed by straightening out the loop of the meander. After the formation of cutoff, the river flows straight.

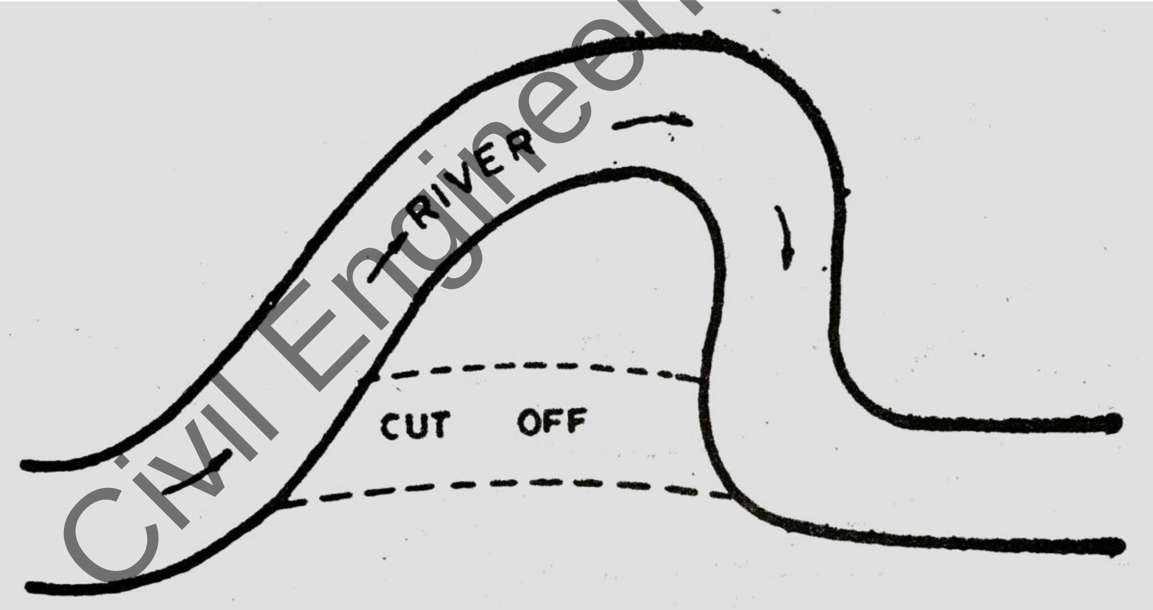


Fig. 28 2. Formation of cutoff.

Q. 128) River training for depth is achieved by

A. Groynes
B. Construction of dykes or leavees
C. Both A and B
D. Groynes and bandalling

Answer D

A. **Groynes or spurs** are the structures that are constructed transverse to flow and extend from bank to the river channel.

B. **(तटबंध) levee, dike, dyke, embankment, floodbank or stopbank** is an elongated naturally occurring ridge or artificially constructed fill or wall, which regulates water levels. It is usually earthen and often parallel to river flow.

C. **Bandalling** is a locally bamboo made structure used for the river course stabilization by river bank erosion protection.

Using spurs and Bandalling to contract the river channel and, thus, increase its depth.

Q. 129) Main purpose of mean water training for rivers is

A. Flood control
B. To provide sufficient depth of water in navigable channels, during low water periods
C. To preserve the channel in good shape by efficient disposal of suspended and bed load
D. All of the above

Answer C

Types of river training works

1. High water training:- is also known as training for discharge. The cross-section of the river is so developed near the works (i.e. Near weir, barrages or bridges) that the maximum flood is passed over efficiently.

2. Low water training:- is also known as training for depth. This type of training is adopted for navigation purpose where a certain minimum depth of flow is maintained by contracting the width of the river channel.

3. Mean water training:- is also known as the training for sediment. The river is trained to correct the configuration of river bed for the efficient transport of sediment load, without either silting or scouring.

Q. 130) If D is the depth of scour below original bed, then the width of launching apron is generally taken as

A. 1.2 D
B. 1.5 D
C. 2.0 D
D. 2.5 D

Answer B

To protect the face of the guide bank at the river bed level a thick stone cover is laid on the bed. It is called an apron.
When the scour undermines the river bed the apron comes down or launches to cover the face of the scour. Hence it is called Launching apron also.

width of launching apron is generally taken as = 1.5 depth of scour below original bed

Q. 131) Study the following statements
i) Levees are constructed parallel to river flow
ii) Spurs are constructed parallel to river flow
iii) levees are constructed transverse to river flow
iv) Spurs are constructed transverse to river flow
The correct answer is
A. (i) and (ii)
B. (i) and (iv)
C. (ii) and (iii)
D. (iii) and (iv)

Answer B

Groynes or spurs are the structure that are constructed transverse to river flow and extend from bank to the river channel.

(तटबंध) levee, dike, dyke, embankment, floodbank or stopbank is an elongated naturally occurring ridge or artificially constructed fill or wall, which regulates water levels. It is usually earthen and often parallel to river flow.

Q. 132) A repelling ground is aligned

A. Pointing upstream
B. Pointing downstream
C. Perpendicular to bank
D. Parallel to bank

Answer A

Q. 133) A river training work is generally required when the river is

A. Aggrading type
B. Degrading type
C. Meandering types
D. Both A and B

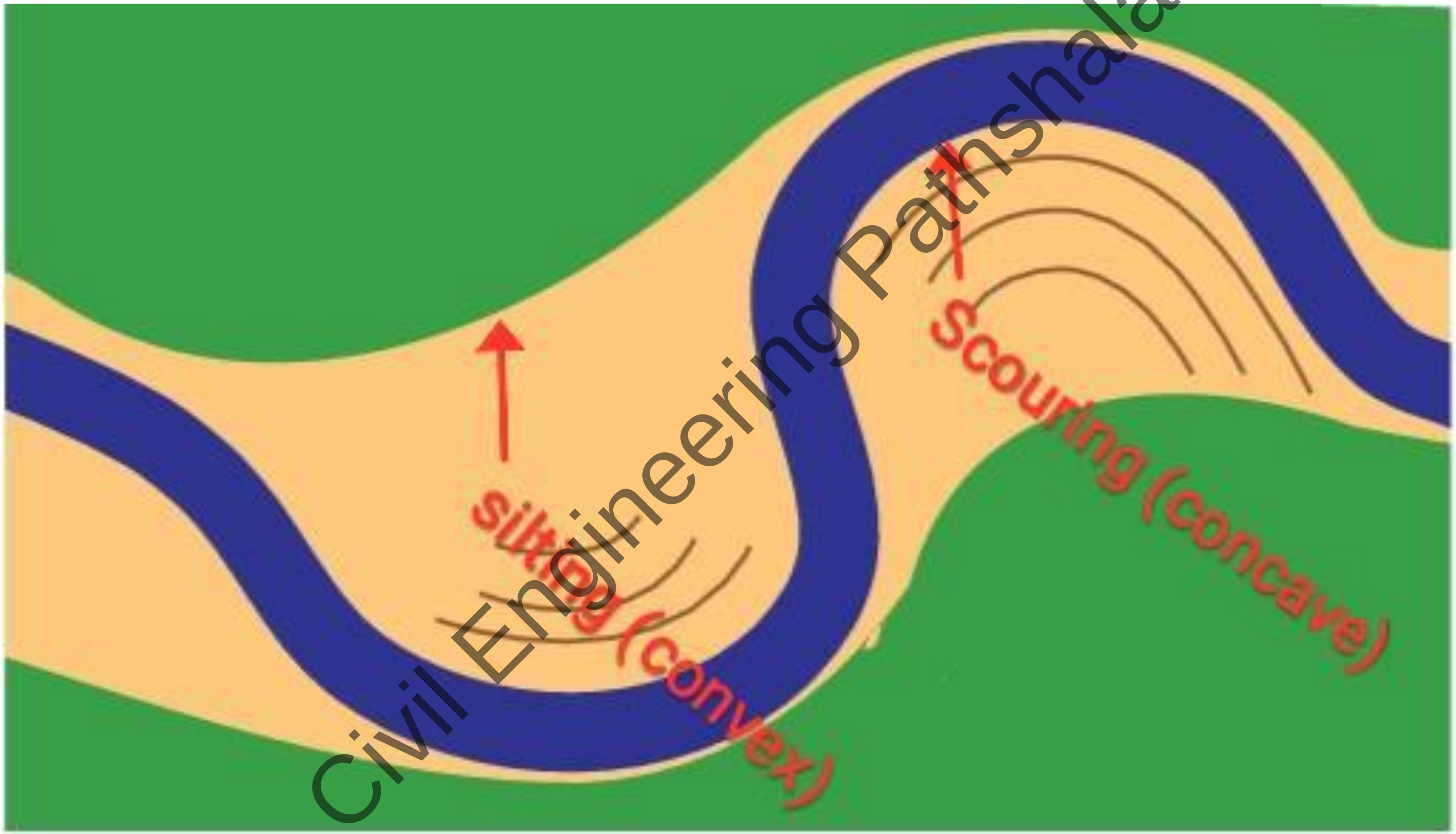
Answer C

River training' refers to the structural measures which are taken to improve a river and its banks. They are used to lower the river gradient in order to reduce the water velocity and protect the river bed and banks from erosion.

A. Agrading river (silting river):- The river builds up its bed by silting or dropping its bed load.

B. Degrading river (Scouring river):- Scouring is the removal of sediment from its bed.

C. Meandering rivers:- Meandering rivers erode sediment from the outer curve of each meander bend and deposit it on an inner curve further down stream.


silting (convex)
Scouring (concave)

Q. 134) Length and width of meander are proportional to

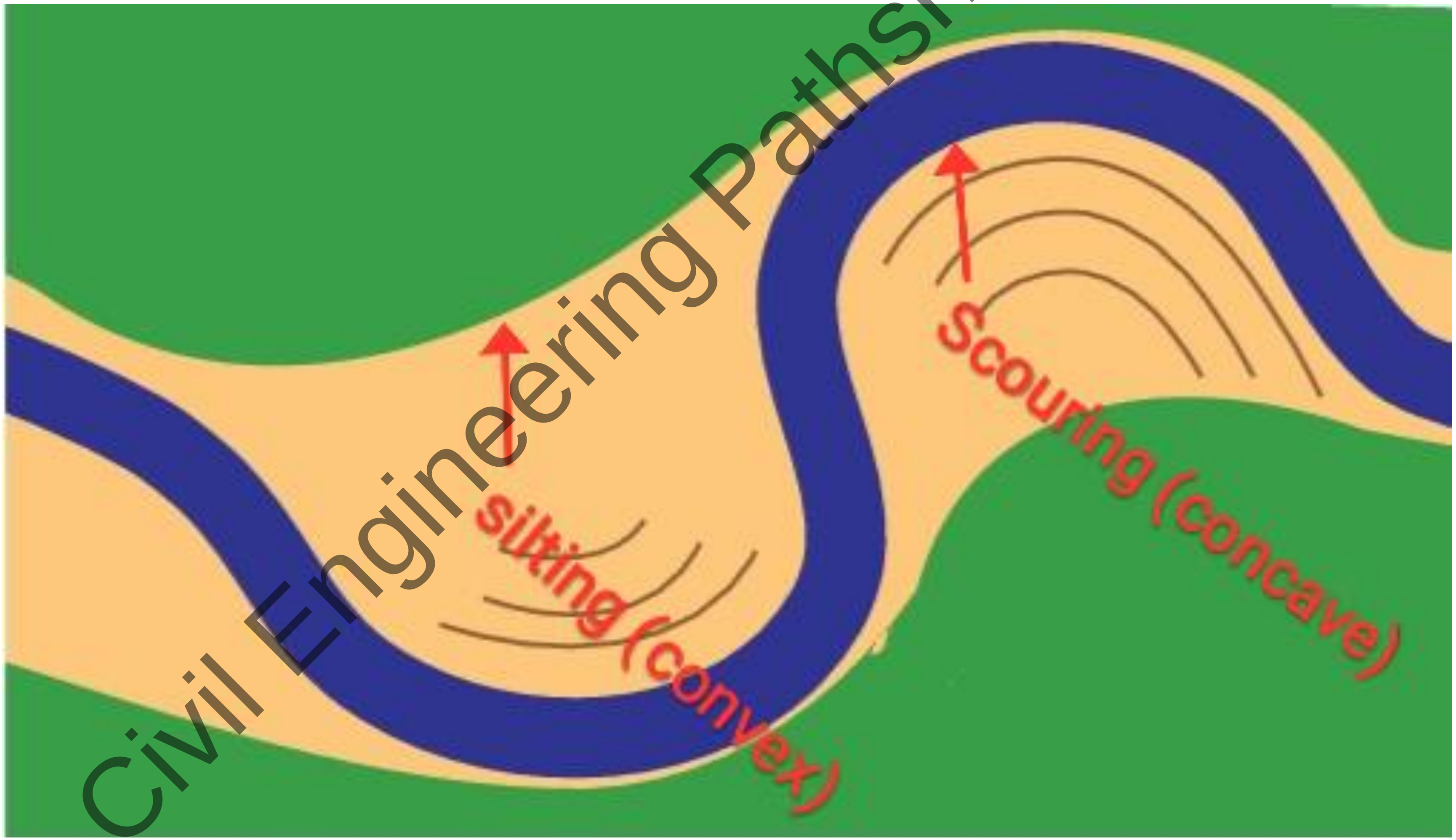
A. Discharge
B. $(\text{Discharge})^{1/2}$
C. $(\text{Discharge})^{2/3}$
D. $(\text{Discharge})^{2}$

Answer B

Q. 135) A river bend in alluvial soil is characterized by

A. Scouring on concave side
B. Silting on convex side
C. Scouring on convex side and silting on cancave side
D. Scouring on concave side and silting on convex side

Answer D



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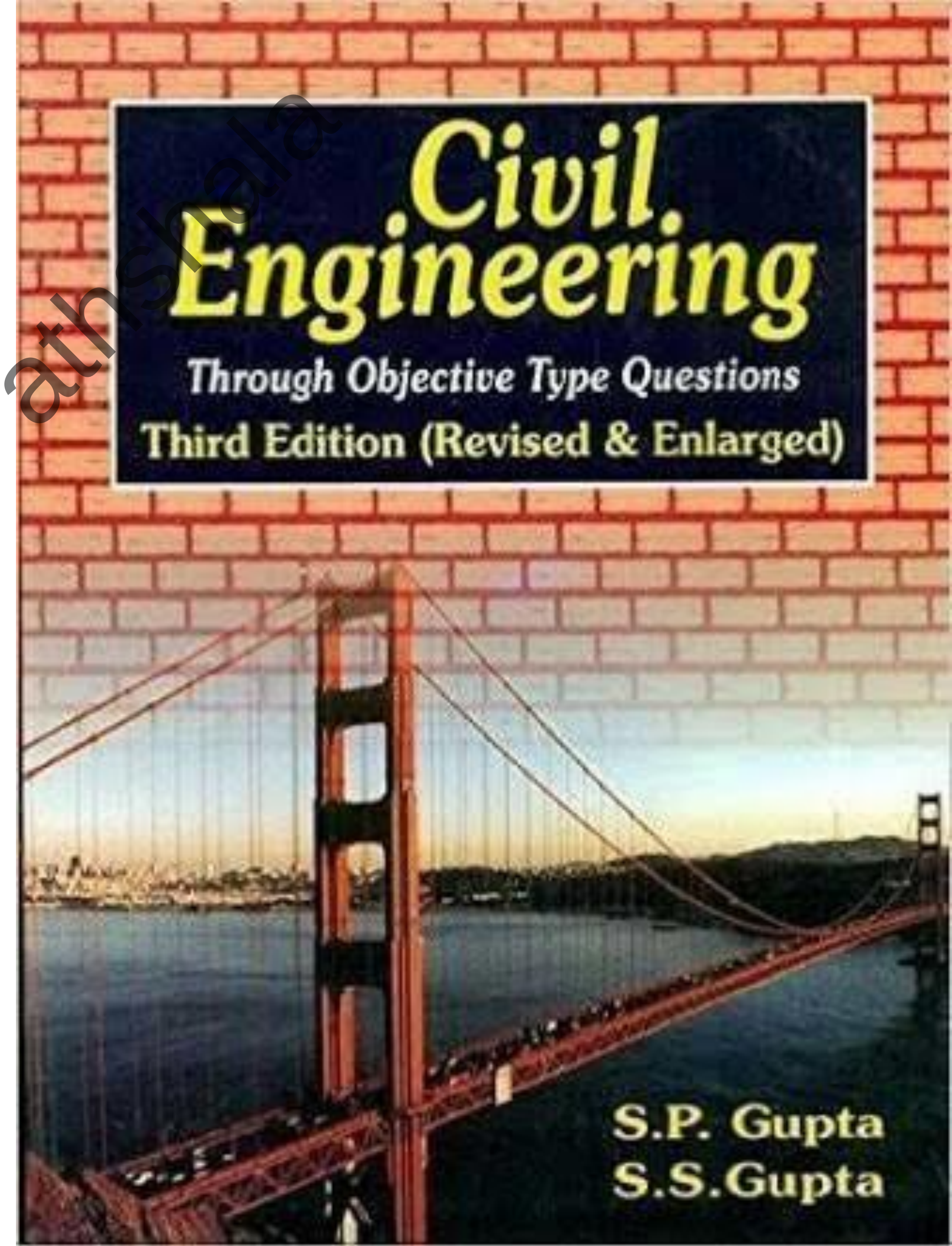
Objective Questions (136 to 150)

Irrigation & Hydrology



Q. 136) Select the incorrect statement

A. Intensive irrigation should be avoided in areas susceptible to water logging
B. Extensive irrigation should be adopted in areas susceptible to water logging
C. Lift irrigation increases water logging
D. All of the above

Answer C

Lift irrigation:-

This is a curative measure. When the process of waterlogging is starts, lift irrigation should be introduced along with the canal irrigation. When water is pumped out from top aquifer it depresses the water table and decrease water logging.

Q. 137) A land is known as waterlogged

A. When the permanent wilting point is reached
B. When gravity drainage has ceased
C. Capillary fringe reaches the root zone of plants
D. None of the above

Answer C

→The dryer the soil the more difficult it is for the plant roots to extract. The soil water content at the stage where the plant dies, is called **permanent wilting point**. The soil still contains some water, but it is too difficult for the roots to suck it from the soil.

→**Waterlogged soil:-** The soil pores within the root zones of crops become fully saturated, and thus air circulation is completely cut-off.
Water logging is caused by the rise of sub-soil water level upto the ground level, or sometimes upto the root zone of the crops.
The depth of water table at which it tends to make the soil water-logged and harmful to the growth of plant life depends upon the height of capillary fringe, which is the height to which water will rise due to capillary action.

Q. 138) Lining of irrigation channels

A. Increases the water logging area
B. Decreases the water logging area
C. Does not change the water logging area
D. None of the above

Answer B

Canal lining is the process of reducing seepage loss of irrigation water by adding an impermeable layer to the sides and bed of the canal.

Advantages of lining:-

1. Due to reduction in percolation and seepage, decreases the water logging area.
2. Increase in velocity of flow.
3. Increase in stability of banks.
4. Prevention of erosion
5. Increase in canal water power
6. Economical distribution
7. Improvement in water quality

Disadvantages:-

1. High initial cost
2. Difficulty in shifting the position of outlets.

Q. 139) A runoff river plant is

A. A low head scheme
B. A medium head scheme
C. A high head scheme
D. None of the above

Answer A

A water power development scheme is known as hydro-electric scheme Or hydel scheme.

The hydel plants can be classified according to their function

1. **Runoff river plants:-** Which utilize the river flow having no pondage at its upstream. A wier or a barrage is constructed across the river, simply to raise the water level slightly. Such a scheme is essentially a **low head** (which uses head less than 15 metres) scheme, and is adopted in the case of a **perennial river.**

2. **Storage plants:-** Such a plant has a storage reservoir at its upstream. A dam is constructed across the river and water is stored during the periods of excess supply.

3. **Pumped storage plants:-** A pumped storage plant stores power in the form of potential energy of water. The scheme is used to generate power only during the peak hours.

Depending upon the available head, the hydel schemes may be classified as under

1. **Low head scheme:-** which uses head of less than about 15 metres. It is essentially a run off river scheme.

2. **Medium head scheme:-** uses head between 15 to 60 metres. Such a scheme is essentially a storage scheme.

3. **High head scheme:-** uses a head of more than 60 metres.

Q. 140) The net speed under which the turbine reaches its peak efficiency is called

A. Design speed
B. Rated speed
C. Gross speed
D. Operating speed

Answer A

Hydraulic Efficiency:-

It is the ratio of the power developed by the runner of a turbine to the power supplied at the inlet of a turbine.

Q. 141) A runoff river plant

A. Is a medium head scheme
B. Generates power during peak hours only
C. Is suitable only on a perennial river
D. Has no pondage at all

Answer C

Q. 142) The net head under which the turbine reaches its peak efficiency in synchronous speed is called

A. Design speed
B. Rated speed
C. Gross speed
D. Operating speed

Answer A

Q. 143) The ratio of the average load to the installed capacity of the plant whose reserve capacity is zero will be equal to

A. Load factor
B. Plant factor
C. Utilisation factor
D. Both A and B

Answer D

1.Load factor:- is defined as the ratio of the average load over a certain period to the peak load occurring during the same time.
If period chosen is one day, the load factor is known as the daily load factor and similarly annual load factor.
2. Capacity factor or plant factor:- is the ratio of the average output of the plant to the plant capacity. i.e.
Plant capacity factor = average load output/installed capacity
= average load output/1.1 (peak load)
if we take the reserve capacity as 10% of the peak load.
If the reserve capacity is zero, load factor on a particular day = capacity factor for that day.
3. Utilization factor:- is the ratio of water actually utilized for power to that available in the river.

Q. 144) A hydroelectric scheme operating under a head of 80 m will be classified as

A. Low head scheme
B. Medium head scheme
C. High head scheme
D. None of the above

Answer C

Depending upon the available head, the hydel schemes may be classified as under

1. Low head scheme:- which uses head of less than about 15 metres. It is essentially a run off river scheme.

2. Medium head scheme:- uses head between 15 to 60 metres. Such a scheme is essentially a storage scheme.

3. High head scheme:- uses a head of more than 60 metres.

Q. 145) A hyetograph is a graphical representation of

A. Rainfall intensity and time
B. Rainfall depth and time
C. Discharge and time
D. Cumulative rainfall and time

Answer A

A. **Hyetograph** is a graphical representation of rainfall intensity and time.

B. **Rainfall intensity** is a measure of the amount of rain that falls over time. It is expressed in depth units per unit time, usually as mm per hour (mm/h).

C. **Hydrograph** is a graphical representation of the rate of flow versus time.

D. **Mass Curve** is plot of accumulated rainfall against time

Q. 146) Variability of rainfall is
i) Largest in regions of high rainfall
ii) largest in coastal areas
iii) largest in regions of scanty rainfall

The correct answer is
A. Only (i)
B. (i) and (ii)
C. Only (iii)
D. (ii) and (iii)

Answer C

Regions of high rainfall: More than 200 cm average annual rainfall.
Regions of scanty rainfall: Less than 50 cm average annual rainfall.
→Variability is high in the regions of scanty rainfall.

Rainfall variability:- The degree to which rainfall amounts vary across an area or through time.
There are two types of rainfall variability, areal and temporal.
1. **Areal variability:-** The variation of rainfall amounts at various locations across a region for a specific time interval. (Time does not vary.)
Example: Annual average precipitation.
2. **Temporal variability:-** The variation of rainfall amounts at a given location across a time interval. (Area does not vary.)

Q. 147) In India, which is the following is adopted as a standard recording raingauge

A. Symon’s raingauge
B. Tipping bucket type
C. Natural syphon type
D. Weighing bucket type

Answer C

Types of Raingauges:-

1. Non-Recording Type Raingauge
a) Symon's Raingauge

2. Recording Type Raingauges
a) Weighing bucket type
b) Tipping bucket type
c) Floating or natural syphon type raingauge

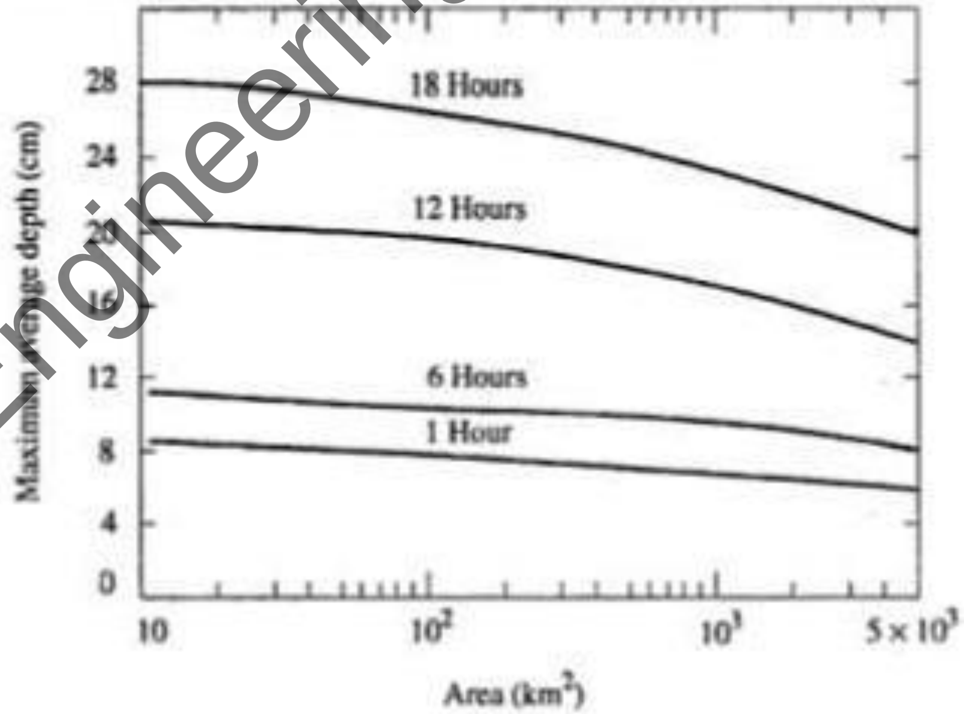
Q. 148) The maximum average depth due to one day storm over an area of 100 km^2 is 100 mm. Depth area duration (DAD) curves indicate that for the same area of 100 km^2 the maximum average depth of for 3 hours storm will be

A. 100 mm
B. More than 100 mm
C. Less than 100 mm
D. None of the above

Answer C

Depth-Area-Duration relationships

- The development of maximum depth-area-duration relationship is known as DAD analysis.
- It is an important aspect of hydro-meteorological study.



Typical DAD curves

Q. 149) The maximum rainfall depth of 300 mm in 24 hours has a return period of 100 years. The probability of 24 hours rainfall equal to or greater than 300 mm occurring at least once in 10 years is given by

A. $(0.99)^{10}$
B. $1 – (0.99)^{10}$
C. $(0.9)^{100}$
D. $1 – (0.9)^{100}$

Answer B

Probability of happening the event atleast once in 'n' successive years $= 1 - q^n$

$$= 1 - (1-p)^n$$

$$= 1 - \left(1 - \frac{1}{T}\right)^n$$

Where

q = Probability of non-occurance or failure

p = Probability of occurance

T = return period

$$= 1 - \left(1 - \frac{1}{100}\right)^{10}$$

$$= 1 - (0.99)^{10}$$ ← Answer

Q. 150) The most suitable chemical which can be applied to the water surface for reducing evaporation is

A. Methyl alcohol
B. Ethyl alcohol
C. Cetyl alcohol
D. Butyl alcohol

Answer C

The important factors affecting the natural evaporation such as Temperature, Relative Humidity, Wind Velocity, Sunshine Hours, etc.

Cetyl and Stearyl Alcohols were selected to reduce the evaporation.

Different concentrations of Cetyl and Stearyl alcohols were used in different pans.

The Cetyl alcohol individually gives the average reduction is 27% and the Stearyl alcohol gives 27% and Both Cetyl and Stearyl Alcohol combine gives the average reduction is 30%.

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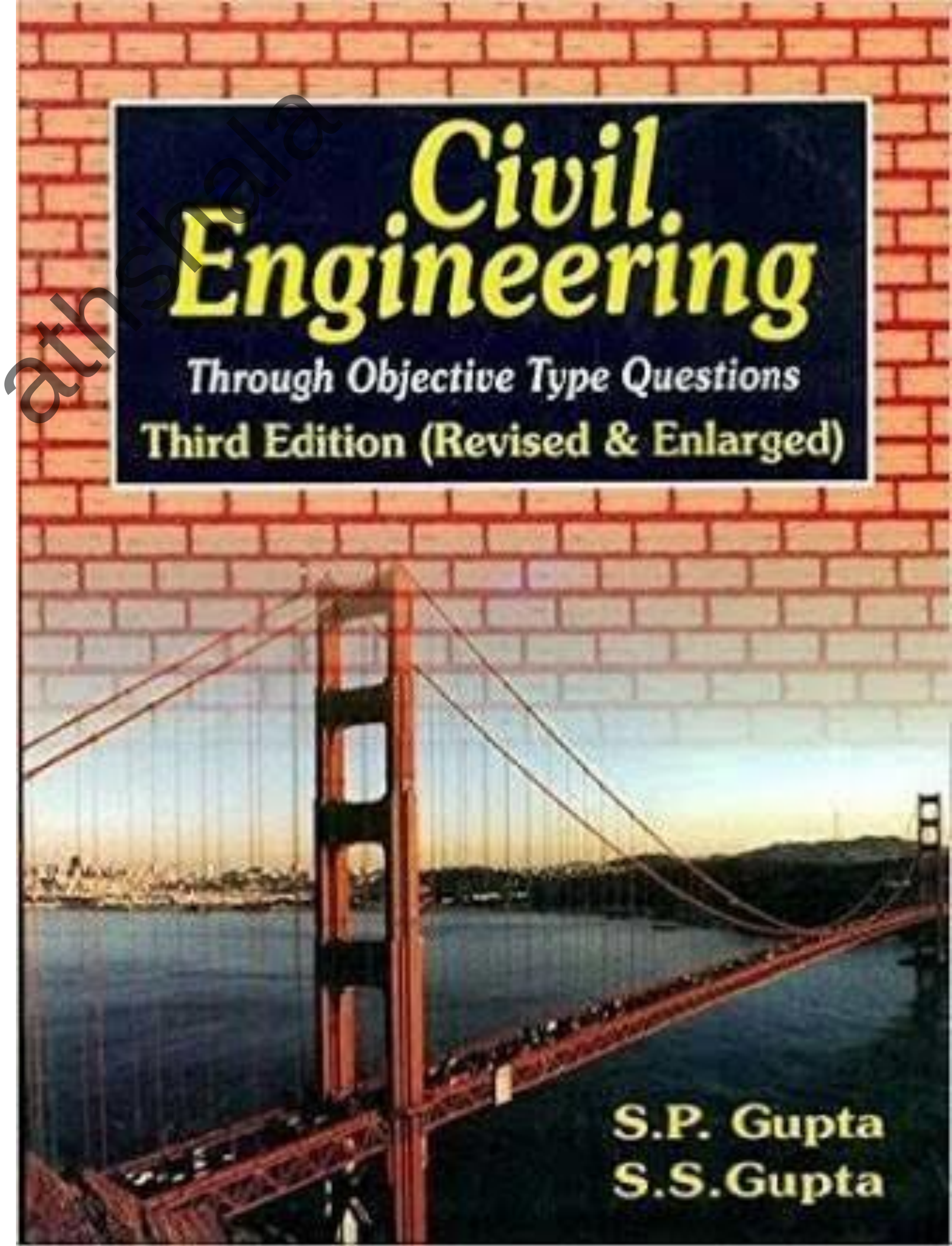
Objective Questions
(151 to 165)

Irrigation & Hydrology



Q. 151) Interception losses are due to
i) Evaporation
ii) transportation
iii) stream flow

The correct answer is

A. Only (i)
B. (i) and (ii)
C. (ii) and (iii)
D. (i), (ii) and (iii)

<u>Answer A</u>

Interception loss is that part of the precipitation that falls on plants and doesn't reach the ground and returned to the atmosphere by evaporation, this is termed as interception loss.

Q. 152) A 6 hours storm had 4 cm of rainfall and the resulting runoff was 2 cm. If Φ index remains at the same value, the runoff due to 10 cm of rainfall in 12 hours in the catchment is

A. 4.5 cm
B. 6.0 cm
C. 7.5 cm
D. 9.0 cm

Answer B

① $\phi\text{-Index} = \dfrac{P-R}{t} = \dfrac{4-2}{6} = \dfrac{1}{3}$ cm/hour

② $\phi\text{-Index} = \dfrac{P-R}{t}$

$$\frac{1}{3} = \frac{10-R}{12}$$

$$\boxed{R = 6 \text{ cm}}$$

Q. 153) Which of the following methods is used to estimate flood discharge based on high water marks left over in the past?

A. Slope-area method
B. Area-velocity method
C. Moving boat method
D. Ultra-sonic method

Answer A

Slope-area method is frequently used to estimate peak discharges following a flood event, observation of high-water marks after the passage of a flood is important.

Q. 154) In the moving boat method of stream flow measurements, the following measurements are required
i) Velocity and direction of current metre
ii) Speed of the boat
iii) Depths and time interval between depth readings
The correct answer is

A. (i) and (iii)
B. (ii) and (iii)
C. Only (ii)
D. (i), (ii) and (iii)

Answer A

Q. 155) To determine the discharge at a section in a stream from its rating curve, the required data are
are
i) Slope of water surface at a section
ii) Stage at the section
iii) Current metre readings at the section
The correct answer is

A. (i) and (ii)
B. (ii) and (iii)
C. Only (ii)
D. Only (iii)

Answer C

Rating curve is a graph of discharge versus stage for a given point on a stream, usually at gauging stations, where the stream discharge is measured across the stream channel with a flow meter.

The rating curve is usually plotted as discharge on x-axis versus stage (surface elevation) on y-axis.

Q. 156) The stage of river carrying a discharge of Q m^3/sec at a point is 10 m and slope of water surface is 1/4000. The discharge of a flood at the same point and same stage of 10 m with a water surface slope of 1/1000 will be

A. $\sqrt{2}Q$ m^3/sec
B. 0.5Q m^3/sec
C. 2Q m^3/sec
D. 4Q m^3/sec

Answer C

For given stage $Q \propto \sqrt{S}$

$$\frac{Q_1}{Q_2} = \sqrt{\frac{S_1}{S_2}}$$

$$\frac{Q}{Q_2} = \sqrt{\frac{1/4000}{1/1000}}$$

$$Q_2 = Q\sqrt{4}$$

$$\boxed{Q_2 = 2Q}$$

Q. 157) The stream which does not have any base flow contribution is called

A. Perennial stream
B. Intermittent stream
C. Ephimeral stream
D. None of the above

<u>Answer C</u>

Base flow:- is the delayed subsurface flow at shallow depth (above GWT), joining a nearby stream.

Ground water flow:- is the deep subsurface flow of ground water (below GWT), joining a nearby stream or spring.

Perennial streams are different to **intermittent** streams; which normally stop flowing for weeks or months each year.
They are also different to **ephemeral** streams that flow only for hours or days after rainfall.

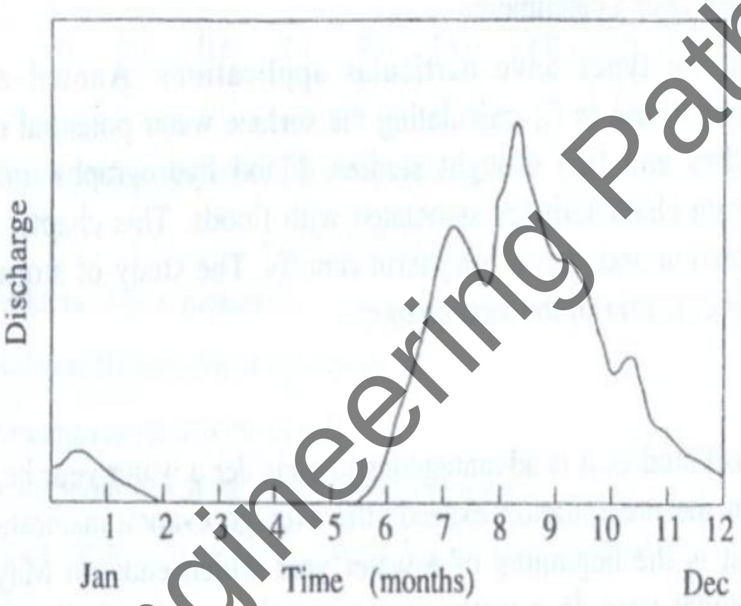


Fig. 5.3 Intermittent Stream

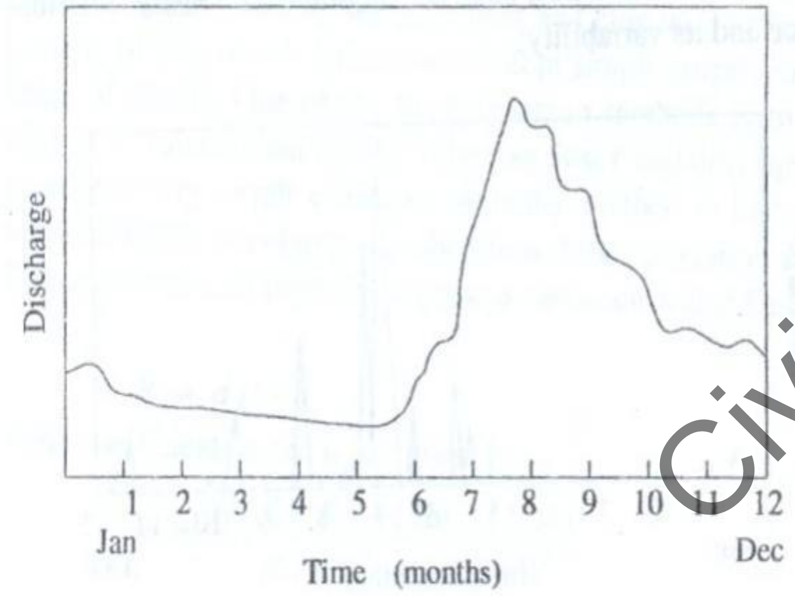


Fig. 5.2 Perennial stream

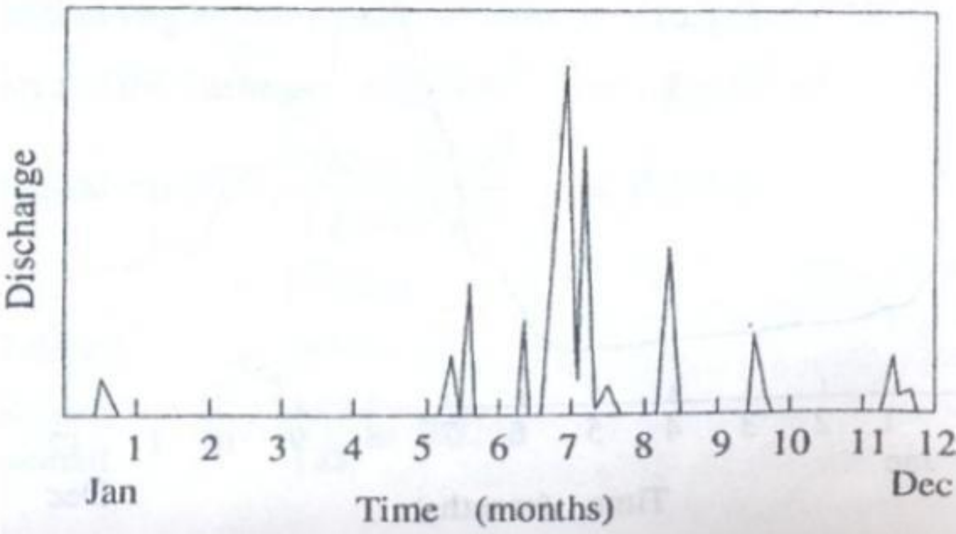


Fig. 5.4 Ephemeral stream

Q. 158) The flow mass-curve is graphical representation of

A. Cumulative discharge and time
B. Discharge and percentage probability of flow being equalled or exceeded
C. Cumulative discharge, volume and time in chronological order
D. Discharge and time in chronological order

Answer C

Q. 159) If the demand line drawn from a ridge in a flow mass curve does not intersect the curve again, it indicates that

A. Demand cannot be met by inflow
B. Reservoir was not full at the beginning
C. Both (A) and (B)
D. None of the above

Answer A

The demand cannot be met by the inflow as the reservoir will not refill.

Q. 160) The shape of recession limb of hydrograph depends upon

A. Basin characteristics only
B. Storm characteristics only
C. Both (A) and (B)
D. None of the above

Answer A

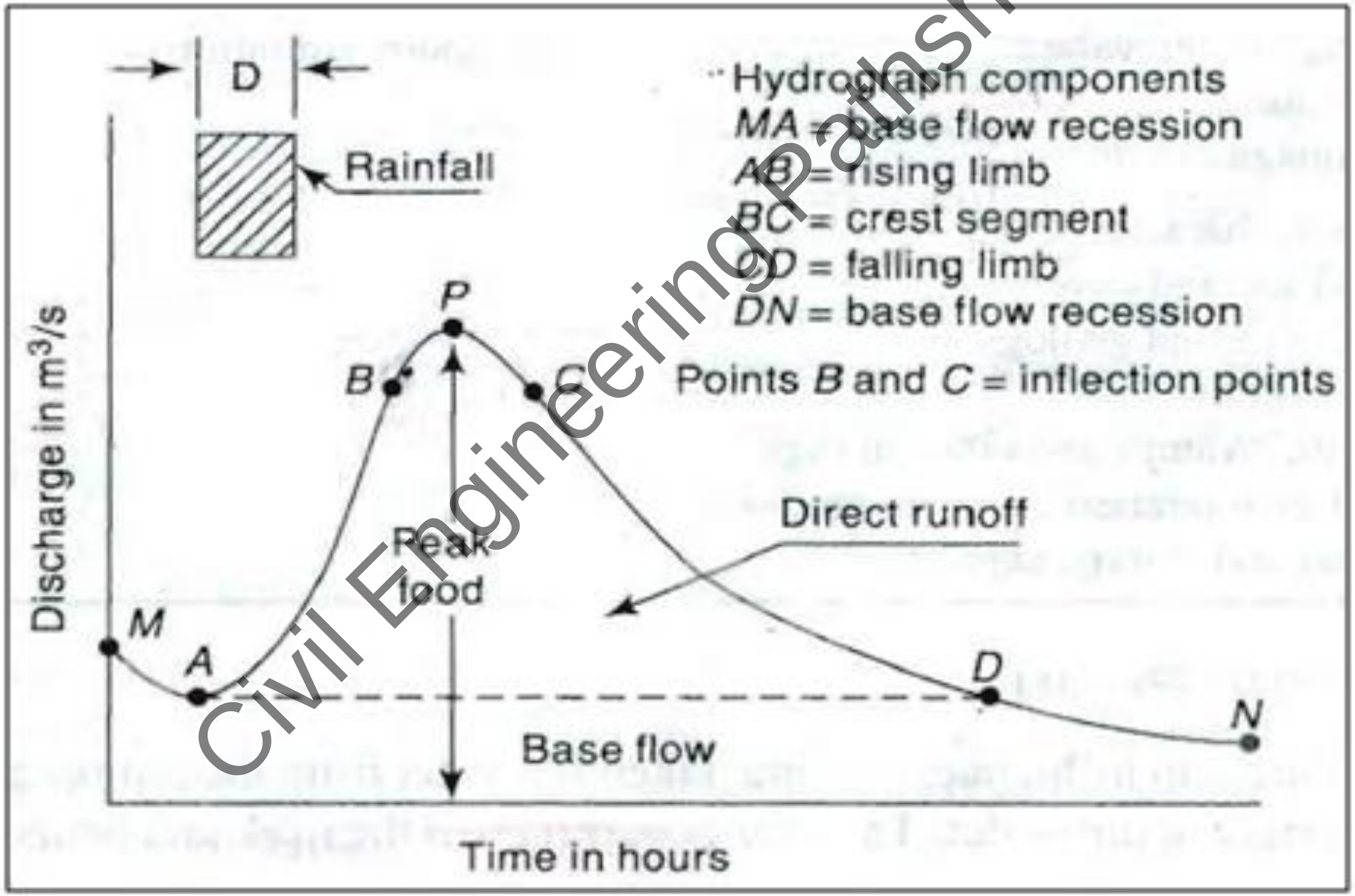
A **hydrograph** of a catchment produced by a storm is a graphical representation of discharge rate of a stream with respect to the time from the start of storm. It is an inverted U shaped diagram.

Hydrograph generally contains the following three parts.
1. Rising Limb
2. Peak (or Crest) Segment
3. Falling (or Recession) Limb

1. Rising Limb:- It is the ascending curved portion of the hydrograph. The rising limb rises slowly in the early stage of the flood but more rapidly toward the end portion. The shape of rising limb depends on duration and intensity distribution of rainfall. This is because in early stages the losses is more and water reaches to the stream faster.

2. Peak Segment (or Crest Segment) : Peak segment is shown by inverted U in the hydrograph. This is the part which is taken as matter of interest by hydrologists. Peak of hydrograph occurs when all parts of basins contribute at the outlet simultaneously at the maximum rate. Depending upon the rainfall-basin characterstics, the peak may be sharp, flat or may have several well defined peaks.

3. Falling Limb (or Recession Limb) : Recession Limb represents the withdrawal of water from the storage built up during the early phase of hydrograph. It extends from the point of inflection at the end of the crest to the beginning of the natural groundwater flow.
The shape of recession limb depends upon basin characteristics only and independent of the storm.



D
Rainfall
Hydrograph components
MA = base flow recession
AB = rising limb
BC = crest segment
CD = falling limb
DN = base flow recession
Points B and C = inflection points
P
B
C
Peak flood
Direct runoff
M
A
D
N
Base flow
Discharge in m3/s
Time in hours
Civil Engineering Pathshala

Q. 161) Instantaneous unit hydrograph is a hydrograph of
i) Unit duration
ii) Unit rainfall excess
iii) Infinitely small duration
iv) Infinitely small rainfall excess
The correct answer is

A. (i) and (ii)
B. (i) and (iv)
C. (ii) and (iii)
D. (iii) and (iv)

Answer C

The instantaneous unit hydrograph is defined as a unit hydrograph produced by an effective rainfall of 1 mm and having an infinitesimal reference duration (in other words the duration tends towards zero).

Q. 162) For a catchment area of 120 km^2, the equilibrium discharge in m^3/hour of an S-curve obtained by the summation of 6 hour unit hydrograph is

A. 0.2×10^6
B. 0.6×10^6
C. 2.4×10^6
D. 7.2×10^6

Answer A

The equilibrium discharge

$$Q = \frac{A}{D} \times 1\,cm = \frac{120 \times 10^6}{6} \times \frac{1}{100}\ m^3/h = 0.2 \times 10^6\ m^3/h$$

Where, A = Area of catchment

D = duration

Q. 163) A unit hydrograph has one unit of

A. Rainfall duration
B. Rainfall excess
C. Time base of direct runoff
D. Discharge

Answer B

The Unit Hydrograph of the catchment is defined as hydrograph of direct runoff (DRH) results from 1cm depth of effective rainfall occurring uniformly over the catchment at a uniform rate during a specified period of time (D-hr).

Thus we can have 6-Hr Unit Hydrograph, 12-Hr Unit Hydrograph, etc.

6-Hr unit hydrograph will have an effective rainfall intensity of 1/6 cm/hr.

Q. 164) The peak of a 4 hour flood hydrograph is 240 m^3/sec. If the rainfall excess is 80 mm and base flow which is constant is 40 m^3/sec, then the peak of 4 hours unit hydrograph will be

A. 20 m^3/sec
B. 25 m^3/sec
C. 30 m^3/sec
D. 35 m^3/sec

Answer B

Storm/flood hydrograph = Direct runoff + ground water runoff/Base flow

Peak of direct runoff = Peak of Flood Hydrograph − Base flow

$$= 240 - 40 = 200\ m^3/sec$$

Peak of 4-hour unit hydrograph (Given rainfall exess = 80 mm)

$$= \frac{200}{8} = 25\ m^3/sec$$

Q. 165) A 4-hour direct runoff hydrograph of catchment is triangular in shape with a time base of 100 hours and peak flow of 50 m^3/sec. The catchment area is 360 km^2. The peak flow of this catchment area for a 4-hour unit hydrograph is

A. 10 m^3/sec
B. 20 m^3/sec
C. 25 m^3/sec
D. 50 m^3/sec

Answer B

$$\text{Rainfall excess} = \frac{\text{Volume}}{\text{Area}} = \frac{\frac{1}{2} \times 100 \times 60 \times 60 \times 50}{360 \times 1000 \times 1000}$$

$$= 0.025 \text{ m or } 2.5 \text{ cm}$$

$$\text{Peak of 4-hour Unit Hydrograph} = \frac{\text{Peak of DRH}}{\text{Rainfall excess}}$$

$$= \frac{50}{2.5} = 20 \text{ m}^3/\text{sec}$$

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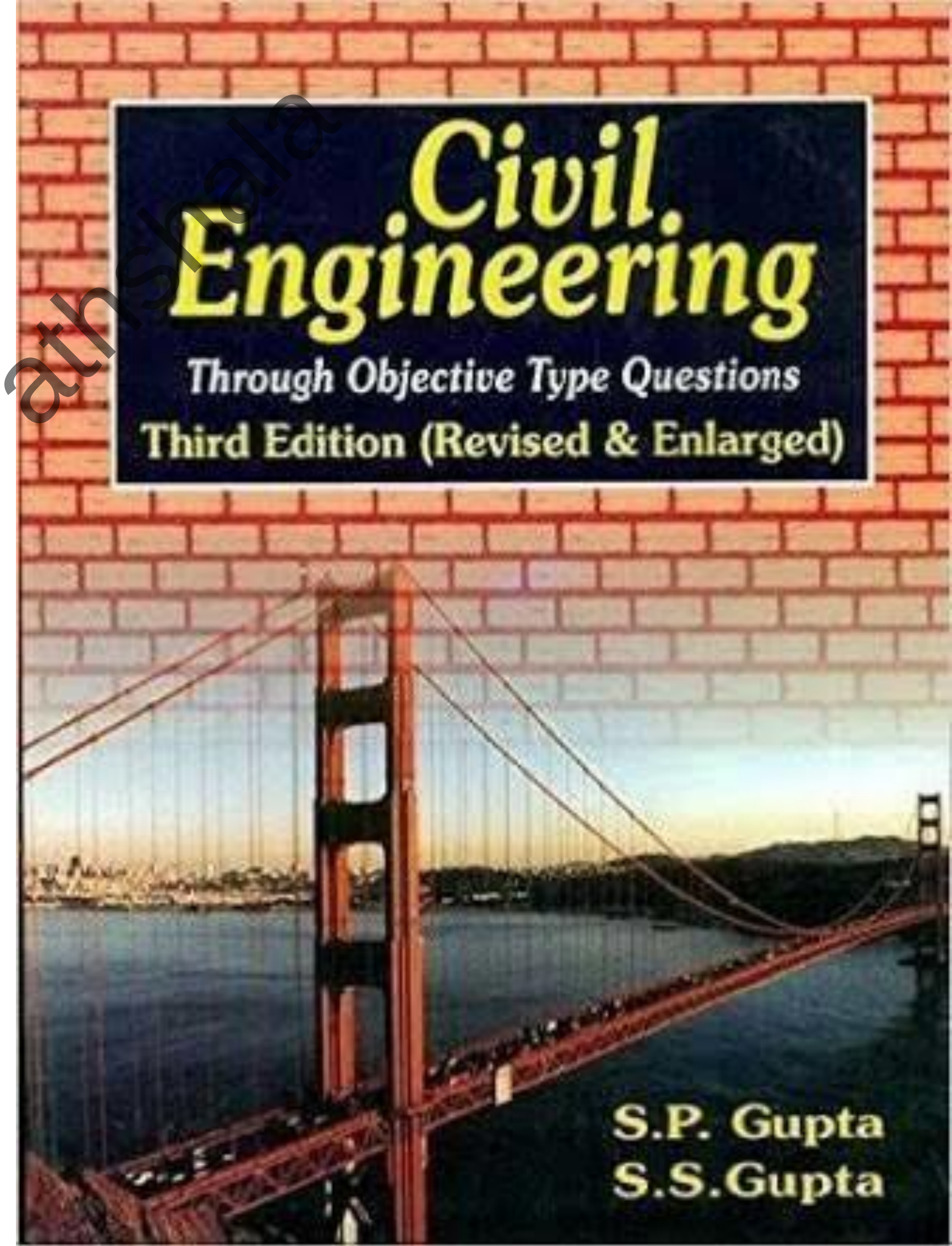
Objective Questions (166 to 180)

Irrigation & Hydrology



Q. 166) To estimate the magnitude of flood with a return period of T years, Gumbel's distribution method requires the following data pertaining to annual flood series

i) Mean value

ii) Standard deviation

iii) Length of record

iv) Coefficient of skew

The correct answer is

A. (i) and (ii)

B. (i), (ii) and (iii)

C. (i), (ii) and (iv)

D. (i), (ii), (iii) and (iv)

Answer B

Gumbel's method :

It is one of the most widely used probability distribution functions for extreme values in hydrologic and meterologic studies for prediction of flood peaks, maximum rainfall, maximum wind speed etc.

According to his theory of extreme events, the probability of occurance of an event equal to or greater than a value x_0 is

$$P(X \geq x_0) = 1 - e^{-e^{-y}} \quad \text{——— (i)}$$

y is a dimensionless variable, $y = \alpha(x - a)$

$$a = \bar{x} - 0.45005\sigma_x$$

$$\alpha = 1.2825/\sigma_x$$

$$y = \frac{1.285(x - \bar{x})}{\sigma_x} + 0.577$$

Where, $\bar{x}$ = mean , σ_x = Standard deviation

Equation (i) is transposed as

$$y_p = -\ln[-\ln(1-p)]$$

Q. 167) For an annual flood series arranged in descending order of magnitude, the return for a magnitude listed at position period m in a total data N is

A. N/(m+1)
B. m/(N+1)
C. m/N
D. (N+1)/m

Answer D

The values of the annual maximum flood from a given catchment area for large number of successive years constitute a hydrological data series called the annual series.
The data are then arranged in decreasing order of magnitude and the probability (P) of each being equal to or exceeded is calculated by the plotting position formula

$$P = m/(N+1)$$

Where,
m = Order number of event
N = Total number of events in the data

Q. 168) If the risk of a flood occurring in the next 10 years is accepted to 10%, then the return period for design should be

A. $1 + (0.9)^{0.10}$
B. $1 – (0.9)^{0.10}$
C. $1/(1 – 0.9^{0.10})$
D. $1/(1 + 0.9^{0.10})$

Answer C

Probability of an event occuring at least once in n successive years is <u>Risk</u>

$$R = 1 - (1-P)^n$$

$$\frac{10}{100} = 1 - (1-P)^{10}$$

$$0.10 = 1 - (1-P)^{10}$$

$$(1-P)^{10} = 0.90$$

$$1-P = 0.90^{1/10}$$

$$1 - \frac{1}{T} = 0.90^{0.1}$$

$$\boxed{\frac{1}{P} = T = \frac{1}{1-0.9^{\cdot 1}}}$$

probability

$$\left[P = \frac{1}{T}\right]$$

reccurance period

Q. 169) Partial duration series is mostly used for

A. Rainfall analysis
B. Flood analysis
C. Both A and B
D. None of the above

<u>Answer A</u>

Because conditions of independency of events are easy to establish in rainfall analysis.

Q. 170) If storage, inflow rate and outflow rate are denoted by S, I and Q respectively, then the values of S in Muskingham method of flood routing is given by the expression

A. K(XI – XQ + Q)
B. K(XI + XQ – Q)
C. K(-XI + XQ + I)
D. KX(I – XQ – Q)

Where K and X are coefficients.

Answer A

Muskingum method

- flood routing is channel routing method.
- In case of channels the total storage is a function of both Inflow and outflow.
- According to Muskingum the total Storage (S) is given as

$$S = K[XI^m + (1-X)Q^m]$$

Where,

K = Storage time constant which have same dimension of time.

X = Weightage factor which lies b/w 0 and 0.5

If X=0, the storage is function of outflow only and such reservoirs are called Linear reservoirs.

X=0.5, storage depends equally on outflow & Inflow

m = Constant and it depends on type of channel

m = 0.6 for Artificial Rectangular channel

m = 1 for natural channels

That mean for a natural channel Muskingum Equation is

$$\boxed{S = K[XI + (1-X)Q]}$$

Q. 171) Which of the following are Saint Venant’s equations for unsteady open-channel flow?
i) Continuity equation
ii) Momentum equation
iii) Energy equation

The correct answer is

A. Only (i)
B. (i) and (ii)
C. (i) and (iii)
D. (i), (ii) and (iii)

Answer B

1. Continuity equation, outflow + change in storage = inflow

2. The momentum equation is derived from Newton’s second law, Rate of change of momentum = net force

Q. 172) In case of channel routing, the storage is a function of

A. Inflow discharge only

B. Outflow discharge only

C. Both A and B

D. None of the above

Answer C

In reservoir routing, storage is a function of outflow discharge only.

Q. 173) Muskingham method of flood routing is

A. Reservoir routing method
B. Channel routing method
C. Hydraulic method of flood routing
D. None of the above

Answer B

Q. 174) Which of the following equations are used in hydrological flood routing method

i) Continuity equation

ii) Equation of motion

iii) Energy equation

The correct answer is

A. Only (i)

B. (i) and (ii)

C. (i) and (iii)

D. (i), (ii) and (iii)

Answer A

In hydraulic method of flood routing, both the equation of motion and continuity equation are used.

Q. 175) In linear reservoir, storage varies linearly with

A. Time
B. Inflow rate
C. Outflow rate
D. None of the above

Answer C

Muskingum method

- → flood routing is channel routing method.
- → In case of channels the total storage is a function of both Inflow and outflow.
- → According to Muskingum the total Storage (S) is given as

$$S = K[XI^m + (1-X)Q^m]$$

Where,

K = Storage time constant which have same dimension of time.

X = Weightage factor which lies b/w 0 and 0.5

If X=0, the storage is function of outflow only and such reservoirs are called Linear reservoirs.

X=0.5, storage depends equally on outflow & Inflow

m = Constant and it depends on type of channel

m = 0.6 for Artificial Rectangular channel

m = 1 for natural channels

That mean for a natural Channel Muskingum Equation is

$$\boxed{S = K[XI + (1-X)Q]}$$

Q. 176) The dimensions of storage coefficient is

A. $M^0 L^1 T^{-1}$
B. $M^0 L^2 T^{-1}$
C. $M^0 L^3 T^{-2}$
D. Dimensionless

Answer D

Storage coefficient (storativity):- The volume of water given up per unit horizontal area of an aquifer and per unit drop of the water-table. It is a dimensionless ratio and always greater than 0 and less than unity.

Q. 177) The porosity of a sand sample is 50%. The specific yield of an aquifer for containing this sand will be

A. Equal to 50%
B. Less than 50%
C. More than 50%
D. None of the above

Answer B

Specific yield is defined as the volume of water released from groundwater storage per unit surface area of aquifer per unit decline of the water table.
Thus, specific yield, which is sometimes called effective porosity, is less than the total porosity.

Q. 178) Discharge per unit drawdown at a well is called

A. Specific storage
B. Specific yield
C. Specific capacity
D. None of the above

Answer C

A. Specific storage:- The specific storage is the amount of water that a portion of an aquifer releases from storage

B. Specific Yield of Wells:- rate of water percolation in the well or yield of a well in m^3/hr under a head of one metre is called the specific yield of the well.

C. Specific capacity:- is a quantity that which a water well can produce per unit of drawdown.
A well specific capacity equals the discharge rate (in gpm) divided by the water level drawdown (in feet).
For example a well with a pumping rate of 200gpm (Gallons per minute) with a 10 foot drawdown has aspecific capacity of 20gpm/ft of drawdown.

Q. 179) Permeability of a soil sample a temperature of 20°C is 0.5 mm/sec. If the temperature is decreased to 15°C , the permeability of the same soil sample is

A. 0.5 mm/sec
B. Less than 0.5 mm/sec
C. More than 0.5 mm/sec
D. None of the above

Answer B

The property of the soil that permits the flow of water through its voids with ease is known as permeability.

An decrease in temperature of the permeant (pore fluid) decreases the density marginally and increase the viscosity significantly and vice versa.
Thus, decrease in temperature of the pore fluid decreases the permeability of the soil.

Q. 180) Due to decrease in pressure, the water level in a well penetrating a confined aquifer will

A. Decrease
B. Increase
C. Note change
D. None of the above

<u>Answer B</u>

Aquifer:- is an saturated geological formation, underground layer of water-bearing permeable and porous or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well.

In **un-confined aquifer** cone of depression represent the drawdown water table but in **confined aquifer** it represent the pressure drop (change in piezometric head) around the well.
Drop in water table from previous static water table is termed as drawdown depth or simply drawdown.

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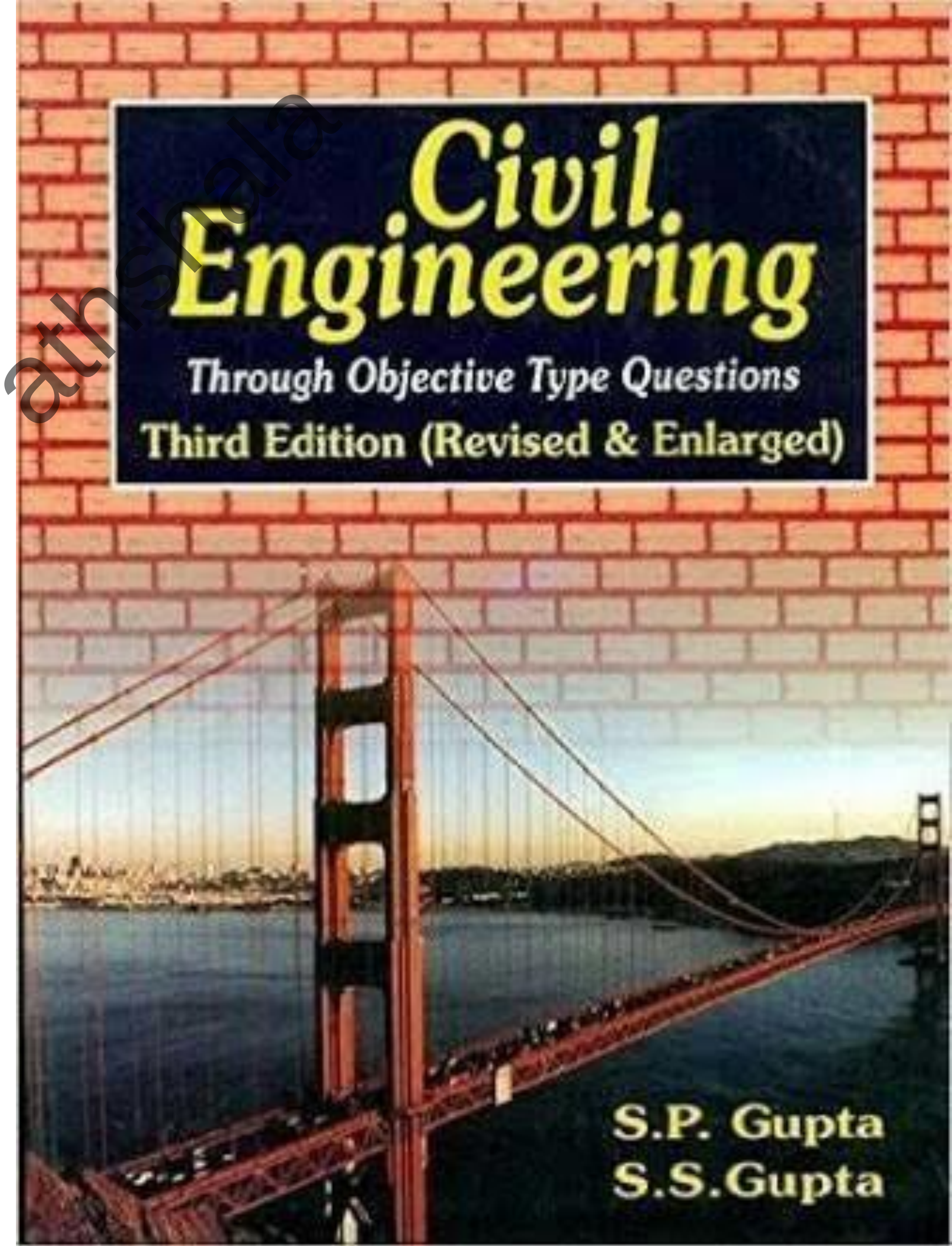
Objective Questions (181 to 195)

Irrigation & Hydrology



Q. 181) According to Indian standards, the number of raingauge station for an area of 5200 km^2 in plains should be

A. 10
B. 15
C. 20
D. 40

Answer A

According to Indian standards:

1. In Plains – 1 station for every 520 sq.km.
2. In region with average elevation 1000 m – 1 station per 260-390 sq.km.
3. In hilly areas with heavy rainfall – 1 station for every 130 sq.km
4. In arid polar zone – 1 station for every 1500 – 10000 sq.km.

10% of the raingauges should be self recording raingauge.

Q. 182) For a storm of given duration, if the intensity of storm corresponding to a return period of T is I, then the intensity of storm for the same duration but corresponding the return period of T1 (where T1 > T) will be

A. Less than I
B. Equal to I
C. Greater than I
D. None of the above

Answer C

Intensity of storm ↑ with ↓ Storm duration.
Intensity of storm ↑ with ↑ Return period.

Q. 183) What is the probability of flood equal to or greater than 25 years flood occurring twice in the next three years

A. 24/625
B. 72/3125
C. 72/15625
D. 24/15625

Answer C

Probability of an Event occuring r times out of n trials is given as

$$P_{n,r} = {}^nC_r \, p^r \, q^{n-r}$$

Where

p = Probability of occurance $= \frac{1}{T} = \frac{1}{25}$

q = Probability of non-occurance $= 1-p$

$$P_{3,2} = {}^3C_2 \left(\frac{1}{25}\right)^2 \left(1-\frac{1}{25}\right)^{3-2} = \frac{3!}{2!\,(3-2)!} \times \frac{1}{625} \times \frac{24}{25}$$

$$\boxed{P_{3,2} = \frac{72}{15625}}$$

Q. 184) The rainfall in four successive 12 hours period on a catchment are 40, 80, 90 and 30 mm. If the infiltration index Ø for the storm is 5 mm/hour, then the total surface runoff will be

A. 0
B. 50 mm
C. 120 mm
D. 180 mm

Answer B

Infiltration index ϕ :- This is the average rainfall above which rainfall volume is equal to runoff volume

Rainfall intensity is $\frac{40}{12}, \frac{80}{12}, \frac{90}{12}, \frac{30}{12}$ mm/hour

3.33, 6.67, 7.5, 2.5 mm/hour

And infiltration ϕ index is 5 mm/hour

It will be observed from above data that rainfall is less than average infiltration in 1st and last.

$$\text{Infiltration } \phi \text{ Index} = \frac{P - R}{t}$$

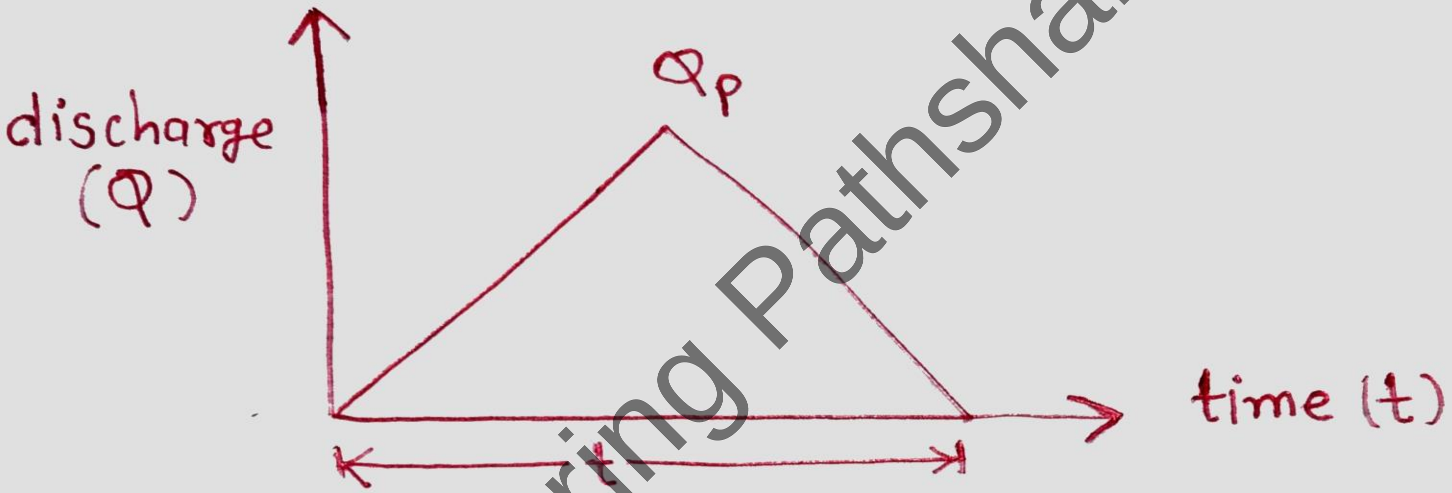
$$5 = \frac{80 + 90 - R}{12 + 12}$$

$$\boxed{R = 50 \text{ mm}}$$

Q. 185) The 6-hour unit hydrograph of a catchment of area 180 km^2 is triangular in shape. If the peak ordinate of this hydrograph is 10 m^3/sec, then the time base is

A. 50 hours
B. 75 hours
C. 100 hours
D. 120 hours

Answer C



$$\frac{1}{2} \times t \times Q_p = \text{catchment area} \times 1\,\text{cm}$$

$$\frac{1}{2} \times t \times 10 = 180 \times 10^6 \times \frac{1}{100}$$

$$t = 360000 \text{ sec}$$

$$t = \frac{360000}{60 \times 60} \text{ hours}$$

time base, $\boxed{t = 100 \text{ hours}}$

Q. 186) Percentage of raingauge stations which should be equipped with self recording gauges for knowing the intensity of rainfall should be about

A. 5%
B. 10%
C. 15%
D. 20%

Answer B

World Meteorological Organization (WHO) recommendation:

1. In Plains – 1 station for every 520 sq.km.
2. In region with average elevation 1000 m – 1 station per 260 to 390 sq.km.
3. In hilly areas with heavy rainfall – 1 station for every 130 sq.km
4. In arid polar zone – 1 station for every 1500 to 10000 sq.km.

10% of the raingauges should be self recording raingauge.

Q. 187) If the same catchment area is situated in three zones X, Y, Z where X, Y and Z represent flat regions of tropical zone, mountaneous region of tropical zone and arid zone respectively, then the relation between the desirable number of raingauge stations in these three zones N_x, N_y and N_z respectively

A. $N_x > N_y > N_z$
B. $N_y > N_z > N_x$
C. $N_y > N_x > N_z$
D. $N_z > N_y > N_x$

Answer C

Q. 188) If the coefficient of variation of rainfall values at 4 raingauge stations is 30% and permissible error in the estimation of mean rainfall is 10%, then the additional number of raingauge stations required in the catchment is

A. 3
B. 4
C. 5
D. 9

$$\text{Additional number of stations} = \left(\frac{\text{Coeff. of variation}}{\text{Allowance \% of error}}\right)^2 - \text{Existing number of stations.}$$

<u>Answer C</u>

$$= (30/10)^2 - 4$$

$$= 9 - 4$$

$$= 5$$

Q. 189) Assertion A: Under identical conditions, the evaporation from sea water is less than that from fresh water.
Reason R: Vapour pressure of sea water is less than that of pure water

Select your answer based on the coding system given below

A. Both A and R are true and R is the correct explanation of A
B. Both A and R are true but R is not the correct explanation of A
C. A is true but R is false
D. A is false but R is true

Answer A

Q. 190) In a siphon aqueduct the most severe condition of uplift on the floor occurs when

A. Canal runs full, drain is dry but the water table is at stream bed
B. Canal is dry and drain is at high flood level
C. Canal runs dry and the drain also runs dry
D. Both the canal and the drain run full

Answer B

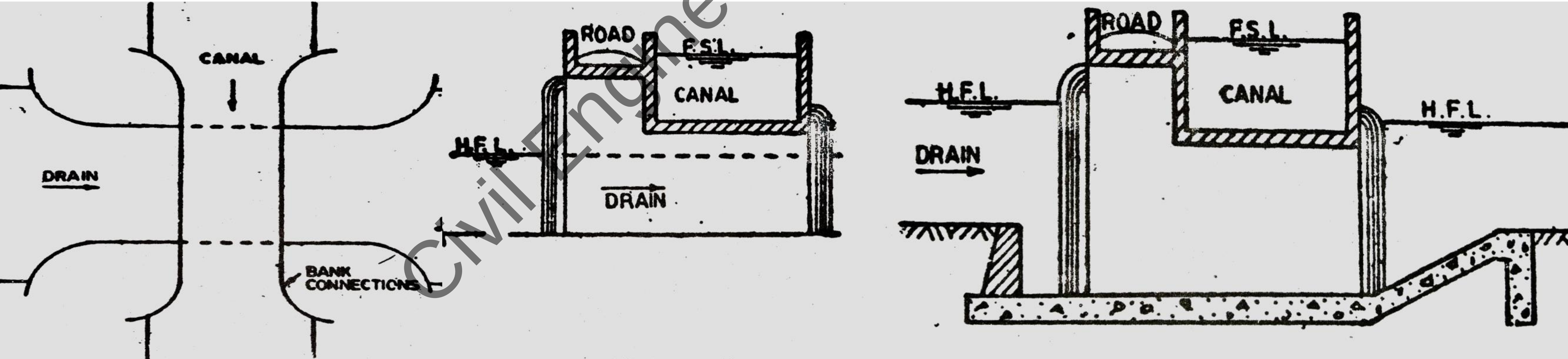
A cross drainage work is a structure carrying the discharge of a natural stream across a canal intercepting the stream.

Types of cross-drainage works

A. CD work carrying canal over the drainage:-

1. Aqueduct:- The HFL (high flood level) of drain is much below the bottom of the canal, and water flows freely under gravity.

2. Syphon aqueduct:- The HFL of the drain is much higher above the canal bed, and the water runs under syphonic action through the aqueduct barrels.

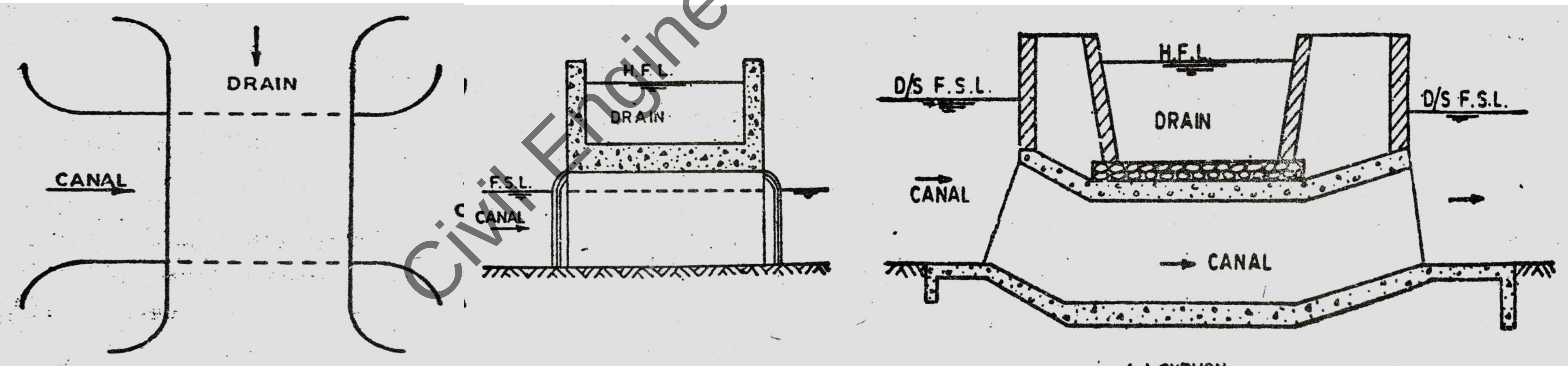


(a) PLAN OF CROSSING (b) AQUEDUCT (c) SYPHON AQUEDUCT

B. CD work carrying drainage over the canal

1. Super-passage:- is similar to an aqueduct except that in this case the drain is over the canal. The FSL (full supply level) of the canal is lower than the underside of the trough carrying drainage water. Thus, the canal water runs under gravity.

2. Canal syphon:-The FSL of the canal is much above the bed level of the drainage trough, so that canal is runs under syphonic action under the throug.



(a) CROSSING (b) SUPERPASSAGE (c) SYPHON

Q. 191) The double mass analysis is adopted to

A. Estimate the missing rainfall data
B. Open intensities of rainfall at various duration
C. Check the consistency of data
D. Obtain the amount of storage needed to maintain a demand pattern

Answer C

A. The most common method used to estimate missing rainfall data is Normal Ratio method. This method is based only on past observations of that rain gauge and surrounding gauges.

C. Double-mass curve can be used to detect changes in the consistency of precipitation records and to determine the amount of adjustment to be applied to make them consistent.

Q. 192) Retrogression of downstream levels, generally considered in the design of weirs or barrages, is

A. Higher at high foold stage then it low water levels
B. Same at high flood stage and at low water levels
C. Higher at low water levels stage than at high flood stage
D. Independent of the stage of flow

<u>Answer C</u>

Retrogression:- It is a temporary phenomenon which occurs after the construction of weirs or barrages in the river flowing through alluvial soil. As a result of back water effect and increase in the depth, the velocity of water decreases resulting in deposition of sedimentation load. The water flowing through the weirs or barrages have less silt, so water picks up silt from downstream bed. This results in lowering d/s river bed to a few miles. This is known as retrogression.

Retrogression value is minimum for flood discharge and maximum for low discharge. The values vary (2 - 8.5) ft.

Q. 193) Cross-regulators in main canals are provided to

A. Regulate water supply in the off-taking channel
B. Regulate water supply in the main channel
C. Regulate excessive flood water
D. Head up water for adequate supply into the off-taking channel

Answer D

Cross Regulator:- It is a hydraulic structure constructed across the canal to regulate the irrigation water supplies. It may be constructed across any type of canal main, branch or a distributary.

Functions:-

(i) When due to inadequate supply the water level is lowered the off-taking channels do not get their proper share. A cross regulator is provided to raise the water level.

(ii) Sometimes it becomes necessary to carry out some necessary to carry out some repair works on a canal. The cross regulator if existing above that reach of the canal, it can be closed and repairs can be done efficiently.

(iii) Sometimes it is necessary to close the canal below a particular point. Say when there is no demand for irrigation water during a particular period

(iv) When the costly headwork's are not constructed in the initial stages, the cross-regulator helps in regulating the canal supplies.
(v) Cross regulators divide long canal reach into smaller ones and make it possible to maintain the reach successfully and efficiently. For efficient functioning they should be spaced 10 to 13 km apart on the main canal and 7 to 10 km on the branches.

2. Head Regulators:- It is a structure constructed at the entrance (head) of the canal where it takes off from the river.
Functions:-
i. It regulates the flow of irrigation water entering into the canal.
ii. To shut out river flood.
iii. It regulates and prevents excessive silt entry into the canal.

3. Distributary Head Regulator:- It is a hydraulic structure constructed at the head of a distributary. This regulator performs the same functions as that of a head regulator.

Q. 194) For a barrage, the exit gradient is independent of

A. The applied head of water
B. The horizontal length of floor
C. The depth of upstream cutoff
D. The depth of downstream cutoff

Answer C

Q. 195) For the upstream slope of in earth dam, the most critical condition is

A. Sudden draw down condition
B. Steady seepage condition
C. Neither sudden draw down nor steady seepage condition
D. During construction when the reservoir is allowed to be filled

Answer A

The most critical stage for the

1. Upstream slope:- Sudden drawdown condition

2. Downstream slope:- Steady seepage when the resevoir is full

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Objective Questions (196 to 210)

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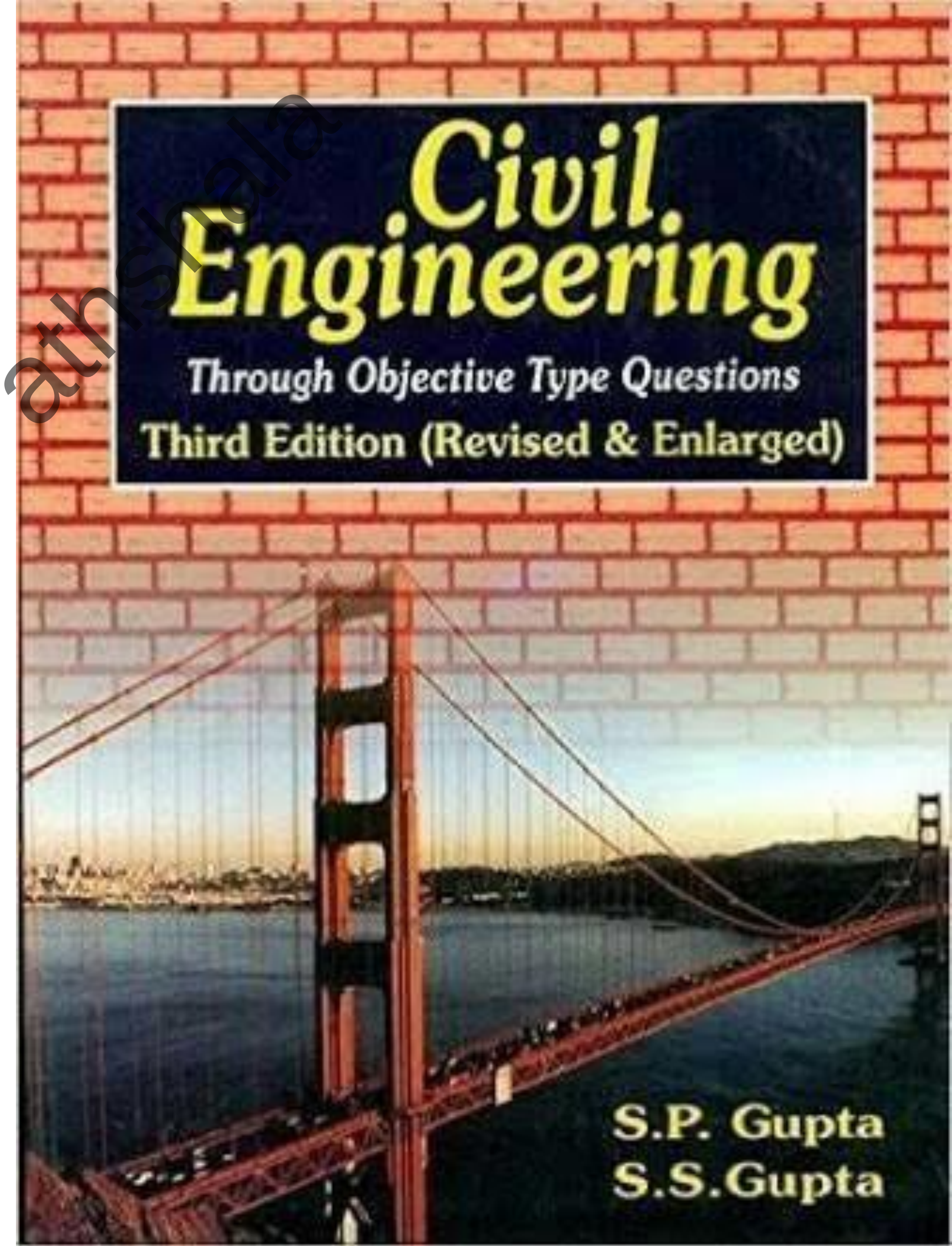

Q. 196) Bligh's creep theory of seepage assumes

A. Equal weightage to horizontal and vertical creeps
B. More weightage to horizontal creep than vertical creep
C. Less weightage to horizontal creep than vertical creep
D. Loss of head follows sine curve

Answer A

Concept of Bligh's theory:-

Bligh assumed that the water which percolates into the foundation creeps through the joint between the profile of the base of weir and the subsoil. Of course water also percolates into the subsoil. The seeping water finally comes out at the downstream end.
According to Bligh water travels along vertical, horizontal or inclined path without making any distinction.
The total length covered by the percolating water till it emerges out at the downstream end is called a creep length.

Bligh's creep theory of seepage assumes equal weightage to horizontal and vertical creeps.

Q. 197) The sequent peak algorithm is a method used in the estimation of the

A. Maximum possible precipitation in a basin
B. Maximum possible flood peak in a catchment
C. Minimum Evapotranspiration from a catchment
D. Minimum reservoir capacity needed to meet a given demand

Answer D

Probable maximum precipitation (PMP):-

-PMP is used in the design of major hydraulic structures such as spillways in large dams.

-There appears to be a physical upper limit to the amount of precipitation that can occur over a given area in a given time.

Probable maximum flood:-

-An extremely large but physically possible flood in the region.

-Used in situation where failure of structure cause life and severe damage

Evapotranspiration:- Evapotranspiration (ET) is an important component of the water cycle and is composed of two subprocesses **evaporation** from soil and vegetation surfaces and **transpiration** that consists of the exchange of moisture between the plant and atmosphere.

Q. 198) The probable maximum flood is

A. The standard project flood of an extremely large river
B. A flood adopted in the design of all kinds of spillways
C. A flood adopted in all hydraulic structures
D. An extremely large but physically possible flood in the region

Answer D

Spillway design flood:-
-Design flood specific for designing spillway of storage structure.
-Maximum discharge that can be passed in hydraulic structure without causing change or threat to the stability of the structure.

Probable maximum flood:-
-An extremely large but physically possible flood in the region
-Used in situation where failure of structure cause life and severe damage.

Standard project flood:-
-Used in situation where failure would cause less damage.
-40% to 60% of PMF for same basin.

Q. 199) The probable maximum precipitation at a station is

A. The greatest rainfall for a given duration that is physically possible
B. The rainfall of a given duration with maximum probability of occurance
C. The rainfall for a given duration that is impossible to occur
D. None of the above

Answer A

Probable maximum precipitation (PMP):-

-PMP is used in the design of major hydraulic structures such as spillways in large dams.

-There appears to be a physical upper limit to the amount of precipitation that can occur over a given area in a given time.

Q. 200) The flow duration curve is a plot of

A. Accumulated flow against time
B. Discharge against time in chronological order
C. The base flow against the percentage of time the flow is equalled or exceeded
D. The stream discharge against the percentage of the time the flow is equalled or exceeded

<u>Answer D</u>

B. A plot of the discharge in a stream plotted chronologically against time is called a Hydrograph

D. A flow duration curve is a plot of discharge vs. percent of time that a particular discharge was equalled or exceeded. The area under the flow duration curve (with arithmetic scales) gives the average daily flow, and the median daily flow is the 50% value.

Q. 201) The DAD (Depth Area Duration) analysis for a catchment would indicate that

A. For a given storm, the maximum depth increses with area
B. For a given area, the maximum average depth of rainfall increases with strom duration
C. For a given area, the maximum average depth of rainfall decreases with storm duration
D. None of the above

Answer B

The purpose of a DAD analysis was to determine the maximum precipitation amounts over various area sizes during the passage of storms of say 6-, 12, or 24-hour durations to help in the computation of probable maximum precipitation (PMP) estimates.

The x-axis of a DAD plot indicates the maximum average depth of precipitation. The y-axis is the area size.

For a given area, the maximum average depth of rainfall increases with strom duration

Q. 202) Permanent wilting point is

A. A characteristics of the plant
B. A soil characteristics
C. A soil characteristics modified by the crop
D. Dependent on soil water plant fertilizer interaction

Answer B

Field Capacity:- The maximum quantity of water which a soil can retain against the force of gravity is known as field capacity.
The quantity of water greater than the field capacity simply passes away.

Permanent wilting Point:- is the moisture content at which the moisture is no longer available in sufficient quantity so that the plants can sustain. Even though the soil contains some moisture but it was so held by the soil that roots of plants cannot uptake it and results in wilting of plant.

Available water:- The difference between two moisture contents (field capacity and permanent wilting point) is known as available water.
It is the moisture content which is available for plants.

Q. 203) Conjunctive use of water in a basin means

A. Combined use of water for irrigation and for hydropower generation
B. Combined use of surface and ground water resources
C. Use of irrigation water for both rabi and kharif season
D. Use of irrigation water by cooperative of farmers

Answer B

Conjunctive use of water relates to the combined use of ground and surface water.

Q. 204) The tractive force method of designing stable channels is applicable to channels

i) In coarse non-cohesive material

ii) In cohesive material

iii) Carrying clear water

iv) Carrying water containing suspended load

Of these statements

A. (i) and (iii) are correct

B. (ii) and (iii) are correct

C. (i) and (iv) are correct

D. (ii) and (iv) are correct

Answer A

The force exerted by flowing water on bottom and sides of the channel is called tractive force.

Q. 205) As per Shield's criteria for the initiation of bed motion, the entertainment function is a unique function of

A. Reynolds number
B. Shear Reynolds number
C. Froude number
D. Both B and C

Answer B

Sediment transport is the movement of solid particles (sediment), typically due to a combination of gravity acting on the sediment, and/or the movement of the fluid in which the sediment is entrained.

For a fluid to begin transporting sediment that is currently at rest on a surface, the boundary (or bed) shear stress exerted by the fluid must exceed the critical shear stress for the initiation of motion of grains at the bed.

As per Shield's criteria for the initiation of bed motion, the entertainment function is a unique function of Shear Reynolds number.

Q. 207) In which of the following section a breast wall is usually provided

A. Main canal
B. Under-sluice
C. Head regulator
D. Weir

Answer C

Canal Head Regulator:- Structure at the head of canal taking off from a reservoir may consist of number of spans separated by piers and operated by gates.
Regulators are normally aligned at 90° to the weir.

Q. 208) The most ideal condition for energy dissipation for the design of spillways is when the tail water curve

A. Lies above jump height curve at all discharge
B. Coincides with jump height curve at all discharges
C. Lies below the jump height curve at all discharges
D. Lies above or below the jump height curve, depending upon the discharge

Answer B

The water flowing over the spillways acquires a lot of kinetic energy by the time it reaches near the toe of spillway. The dissipate this huge energy of water and reduce the large scale of the scouring the structural arrangement is made is called as energy dissipiators.

Hydraulic jump:- is the jump of water that takes place when a super-critical flow changes into a sub-critical flow.

Tail water level:- Water located immediately downstream from a hydraulic structure, such as dam.

Depending upon the relative position of TWC and jump height curve energy dissipation arrangement can be provided below the spillway as follow

A. Tail water curve coincides with jump height curve at all discharges
- This is most critical condition for jump formation.
- The hydraulic jump will form at the toe of jump formation.

B. Tail water curve lies above jump height curve at all discharge
- In this case jump height curve is always below tail water.
- Little energy will dissipated.

C. Tail water curve lies below the jump height curve at all discharges
- If the tail water is very low

D. Tail water curve lies above or below the jump height curve, depending upon the discharge.

Q. 209) The ordinate of the Instantaneous Unit Hydrograph (IUH) of a catchment at any time t, is

A. The slope of the 1-hour unit hydrograph at that time
B. The slope of the direct runoff unit hydrograph at that time
C. Difference in the slope of the S-curve and 1-hour unit hydrograph
D. The slope of the S-curve with effective rainfall intensity of 1cm/hour

Answer D

The limiting case of a unit hydrograph of zero duration is known as instantaneous unit hydrograph (IUH).
The ordinate of IUH of a catchment at any time 't' is the slope of S-curve of with effective rainfall intensity 1 cm/hr.

Q. 210) The leaching requirement of a soil is 10%. If the consumptive use requirement of the crop is 90 mm, then the depth of water required to be applied to the field is

A. 80 mm
B. 90 mm
C. 100 mm
D. 110 mm

Answer C

Leaching requirement

The total amount of water required to bring the soil salinity from an initially high value down to an acceptable value in accordance with the salt tolerance of the crops to be grown.

Leaching requirement in % is given by

$$LR\% = \frac{D_i - C_u}{D_i} \times 100$$

Where, D_i = total irrigation water depth to be applied

C_u = Consumptive use

$$10 = \frac{D_i - 90}{D_i} \times 100$$

$$\boxed{D_i = 100\,mm}$$

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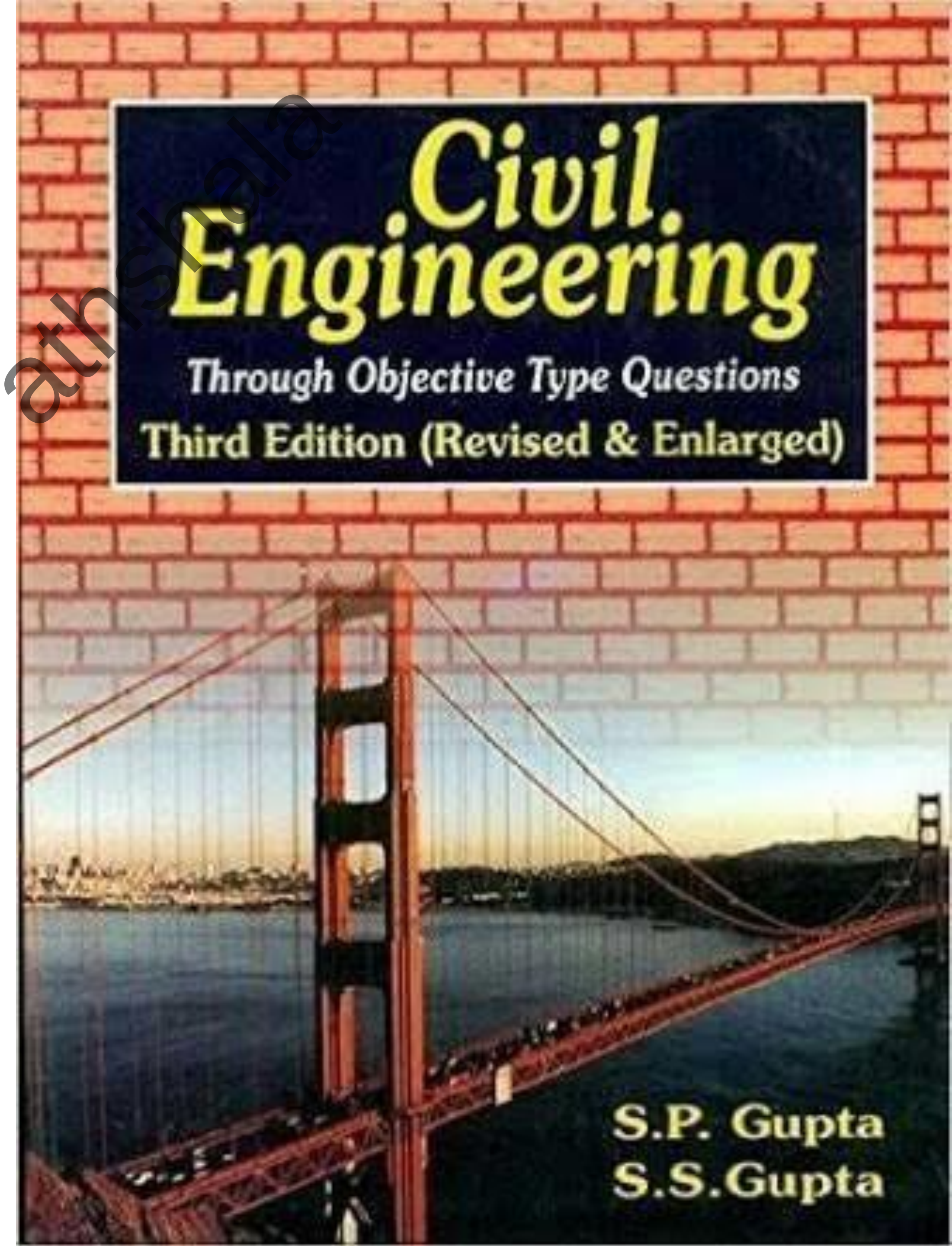
Objective Questions (206 & 211 to 225)

Irrigation & Hydrology



Q. 206) Rigid boundary canals, whose bed and banks are made with non-erodibe materials, are in

A. True regime
B. Permanent regime
C. Final regime
D. None of the above

Answer B

A channel is said to in regime, if there is neither silting nor scouring.
According to Lacey's there may be three regime conditions

A. True regime:- A channel shall be in true regime if the following conditions are satisfied

1. Discharge is constant, 2. Flow is uniform,
3. Silt charge is constant i.e. the amount of the silt is constant
4. Silt grade is constant i.e. the type and size of silt is always the same
5. Channel is flowing through a material which can be scoured as easily as it can be deposited and is of the same grade as is transported.

But in practice, all these conditions can never be satisfied. And therefore artificial channels can never be in "true regime" They can either be in "initial regime" or "final regime"

B. Initial regime:-

1. Bed slope of a channel varies,
2. Cross-section or wetted perimeter remains unaffected.

C. Final regime:- All the variables such as perimeter, depth, slope etc. are equally free to vary and achieve permanent stability, called final regime.

Permanent regime:- Rigid boundary canals, whose bed and banks are made with non-erodibe materials.

211. Which of the following pairs are correctly, matched?

1.	Device to receive and eject drainage from canal	Inlet and outlet
2.	Cross-drainage structure when canal bed level and drain bed level are same	Canal siphon
3.	Cross-masonry work to facilitate road transport	Bridge

Select the correct answer using the codes given below.

Codes:

a) 1, 2 and 3

b) 1 and 3

c) 2 and 3

d) 1 and 2 [ES 93]

Answer B

Siphon aqueduct:- The hydraulic structure in which irrigation canal is passing over the drainage, but the drainage water cannot pass clearly below the canal is known as siphon aqueduct.
In siphon aqueduct the H.F.L. of the drain is above the bed of the canal.

Canal siphon:- If two canals cross other and one of the canals is siphoned under the other, then the hydraulic structure at crossing is called canal siphon.
In canal siphon the F.S.L. of the canal is much above the bed level to the drain.

212. The ordinates of a 3-hour unit hydrograph for a small catchment are given below:

Time: (hour)	Unit graph ordinates: (m^3/s)
0	0
3	1.5
6	4.5
9	18.6
12	12.0
15	9.4
18	4.6
21	2.3
24	0.8
27	0

If the design storm produces net rainfall depths of 4.6 cm and 3.5 cm in successive unit periods, and if the base flow is 2 m^3/s, then the peak flood flow (in m^3/s) will nearly be

a) 270
b) 130
c) 90
d) 86

[ES 93]

Answer B

Time (hour)	UH ordinates (m^3/s)	UH X 4.6	UH X 3.5	DRH
0	0	0	—	0
3	1.5	6.9	0	6.9
6	4.5	20.7	5.25	25.95
9	18.6	85.56	15.75	104.31
12	12.0	55.2	65.1	120.3
15	9.4	43.24	42	85.24
18	4.6	21.16	32.9	54.06
21	2.3	10.58	16.1	26.68
24	0.8	3.68	8.05	11.73
27	0	0	2.8	2.8
			0	0

Peak of flood flow = Peak of DRH + Base flow

= 120.3 + 2

$\approx$ 122 m^3/s

Q. 213) A 4-hour rainfall in a catchment of 250 km^2 produces rainfall depths of 6.2 cm and 5.0 cm in successive 2-hour unit periods. Assuming the Ø index of the soil to be 1.2 cm/hour, the run-off volume in ha-m will be

A. 16
B. 22
C. 1600
D. 2200

Answer C

$$\phi\text{-Index} = \frac{P-R}{t}$$

$$1.2 = \frac{6.2+5.0-R}{4}$$

$$\boxed{1\,Km^2 = 100\,Ha}$$

$$R = 6.4\,cm$$

$$\text{Runoff volume} = 250 \times 100 \times \frac{6.4}{100}$$

$$= 1600 \text{ ha-m}$$

Q. 214) A 3-hour unit hydrograph (UH) differs from a 6-hour UH, for any catchment, in that

A. Both the time of rise and the peak ordinate for the former are less than that for the latter
B. Both the time of rise and the peak ordinate for the former are greater than that of the letter
C. The time of rise is less but the peak ordinate is greater for the former as compared to that of the latter
D. The time of rise is greater but the peak ordinate is less for the former as compared to that of the latter

Answer C

3-hour UH

6-hour UH

$$\boxed{Q_{p1} > Q_{p2}}$$

$$\text{Peak ordinate} \propto \frac{1}{\text{time base}}$$

Q. 215) As per the recommendations of the ISI (NBS), the shape of a lined canal is

A. Trapezoidal
B. Semicircular
C. Parabolic
D. Elliptic

Answer A

1. It is easier to build. As trapezoidal cross section does not need vertical walls made of concrete and the lining can be easily done.

2. The trapezoidal section offers least frictional resistance.

3. It is easy to maintain.
Etc.

216. Figure 3.1 shows the curve of a hydrograph.

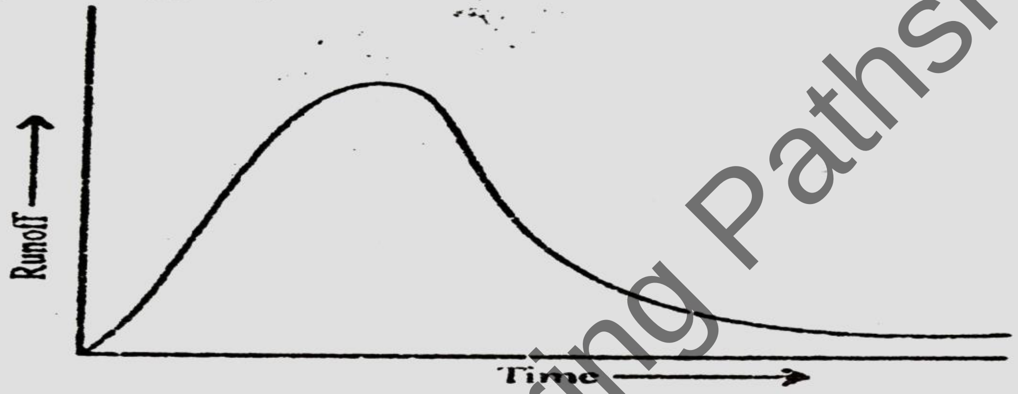


Fig.3.1

Which of the following would cause the peak of the curve to shift to the right?

1. When the length of the overland flow is more.
2. When the slope of the land surface is less.
3. When the run-off is more.
4. When the rainfall is moderate.

Select the correct answer using the codes given below.

Codes:

a) 3 and 4
b) 2 and 4
c) 1 and 2
d) 2, 3 and 4 [ES 94]

Answer C

217. Match List I with List II and select the correct answer using the codes given below the Lists:

List I		List II	
A.	Land capability	1.	Drip irrigation
B.	Sandy soil	2.	Parshall flume
C.	Consumptive use of a crop	3.	Contour strip cropping
D.	Water flow measurement	4.	Blaney-Criddle formula
		5.	U.S. Bureau of Reclamation Classification

Codes:

	A	B	C	D
a)	5	1	4	2
b)	1	2	4	3
c)	5	3	1	2
d)	1	2	5	3

[ES 94]

Answer A

B. Drip irrigation is used for Sandy soil.

C. Consumptive water use is water removed from available supplies without return to a water resource system (e.g., water used in manufacturing, agriculture, and food preparation that is not returned to a stream, river, or water treatment plant).

D. The Parshall flume is an economical and accurate way of measuring the flow of water in open channels and non-full pipes.

Q. 218) A tropical cyclone in the northern hemisphere is a zone of

A. Low pressure with clockwise wind
B. Low pressure with anticlockwise wind
C. High pressure with clockwise wind
D. High pressure with anticlockwise wind

Answer B

A cyclone's center (often known in a mature tropical cyclone as the eye), is the area of lowest atmospheric pressure in the region because of the Coriolis effect, the wind flow around a large cyclone is anticlockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Q. 219) If one wants to be 90% sure that the design flood in a dam project will not occur during the design life period of 100 years, the recurrence interval for such a flood would be

A. About 90 years
B. Equal to 100 years
C. About 110 years
D. Roughly 1000 years

Answer D

The probability of non-occurrence of a flood in next n years is given by, $q = (1-p)^n$

$$0.90 = (1-p)^{100}$$

$$(0.90)^{1/100} = 1 - \frac{1}{T}$$

$$T \approx 950 \text{ years}$$

Q. 220) A channel designed by Lacey’s theory has a mean velocity of one m/s. The silt factor is unity. The hydraulic mean radius will be

A. 2.5 m
B. 2 m
C. 1 m
D. 0.5 m

Answer A

Lacey's channel design procedure:-

1. Calculate the velocity from equation, $V = (Qf^2/140)^{1/6}$

Where, Q in cumecs, V in m/sec, f is silt factor, $f = 1.76\sqrt{m_r}$

where m_r is mean particle diameter of silt in mm

2. Workout the hydraulic mean depth, $R = 5/2(V^2/f) = 5/2(1\times1/1) = 2.5$ m

Where, V in m/sec and R in metre

3. Computer area of channel section, $A = Q/V$

4. Compute wetted perimeter, $P = 4.75\sqrt{Q}$

5. Knowing these value, the channel section is known and finally the bed slop S is determined by the equation, $S = f^{5/3}/3340Q^{1/6}$

Q. 221) Which one of the following constitutes the basic assumption of unit-hydrograph theory?

A. Non-linear response and time invariance
B. Non-linear time invariance and linear response
C. Linear response and linear time invariance
D. Time invariance and linear response

Answer D

Time Invariance and linear response are the two basic assumptions of UH-theory.

Other assumptions are:-

1. Rainfall excess occurs uniformly over the basin.
2. The distribution of storm over the basin is uniform.

Q. 222) The following parameters relate to the design of weirs on permeable foundations:

1. Scour depth
2. Exit gradient
3. Uplift pressure
4. Unbalanced head

Design of the downstream end pile of the weir depends upon

A. 1 and 2
B. 1 and 4
C. 2 and 3
D. 3 and 4

Answer C

Design principles for weirs on permeable foundation:-

(i) To counteract uplift pressure it is necessary to provide suitable thickness of the floor at different points.

(ii) The exit gradient can be kept within permissible limit by providing suitable depth of the sheet pile at downstream end of the floor.

Q. 223) Given that the base period is 100 days and the duty of the canal is 1000 hectares per cumec, the depth of water will be

A. 0.864 cm
B. 8.64 cm
C. 86.4 cm
D. 864 cm

Answer C

Duty is the area of land that can be irrigated with a unit volume of water supplied across the base period.

Delta is the total depth of water required to raise a crop over a unit area.

Relation between Duty (D), Delta (Δ) and Base Period (B)

$$\boxed{\Delta D = 8.64 B}$$

Where, Δ = Delta in metres

D = Duty in Hectares/cumec

B = Base periods in days

$$\Delta \times 1000 = 8.64 \times 100$$

$$\Delta = 0.864\ m \text{ or } 86.4\ cm$$

Q. 224) A pumped storage plant is a

A. High head plant
B. Run-off river plant
C. Peak load plant
D. Base load plant

Answer C

The hydel plants can be classified according to their function as follows:

1. Runoff river plants (Low head scheme, head < 15 m):-

Which utilize the river flow having no pondage at its upstream. A weir or barrage is constructed across the river.

2. Storage plants (Medium head scheme, head between 15 to 60 m) :-

Such a plant has a storage reservoir at its upstream. A dam is constructed across the river and water is stored during the periods of excess supply.

3. Pumped storage plants:-

The scheme of a storage reservoir at a higher level, and a turbine-cum-pump installation. The scheme is used to generate power only during the peak hours of demand. During the peak demand, water flows from the reservoir to the turbine and power is generated.

225. If p is the precipitation, a is the area represented by a rain gauge, and n is the number of rain gauges in a catchment area, then the weighted mean rainfall is

a) $\dfrac{\Sigma a p^3}{\Sigma a^2}$

b) $\dfrac{\Sigma a p}{n}$

c) $\dfrac{\Sigma a p}{\Sigma a}$

d) $\dfrac{\Sigma a p^5}{\Sigma a^3}$ [ES 96]

Answer C

If basin or catchment area contains more than one raingauges station, the computation of average precipitation or rainfall may be done by the following methods

1. Arithmetic Average method,

$$P_{avg} = \frac{P_1 + P_2 + \cdots + P_n}{n} = \frac{\Sigma P}{n}$$

2. Thiessen Polygon method

$$P_{avg} = \frac{A_1P_1 + A_2P_2 + \cdots + A_nP_n}{A_1 + A_2 + \cdots + A_n} = \frac{\Sigma AP}{\Sigma A}$$

3. Isohyetal method

$$P_{avg} = \frac{\Sigma A \times \left(\frac{P_1 + P_2}{2}\right)}{\Sigma A}$$

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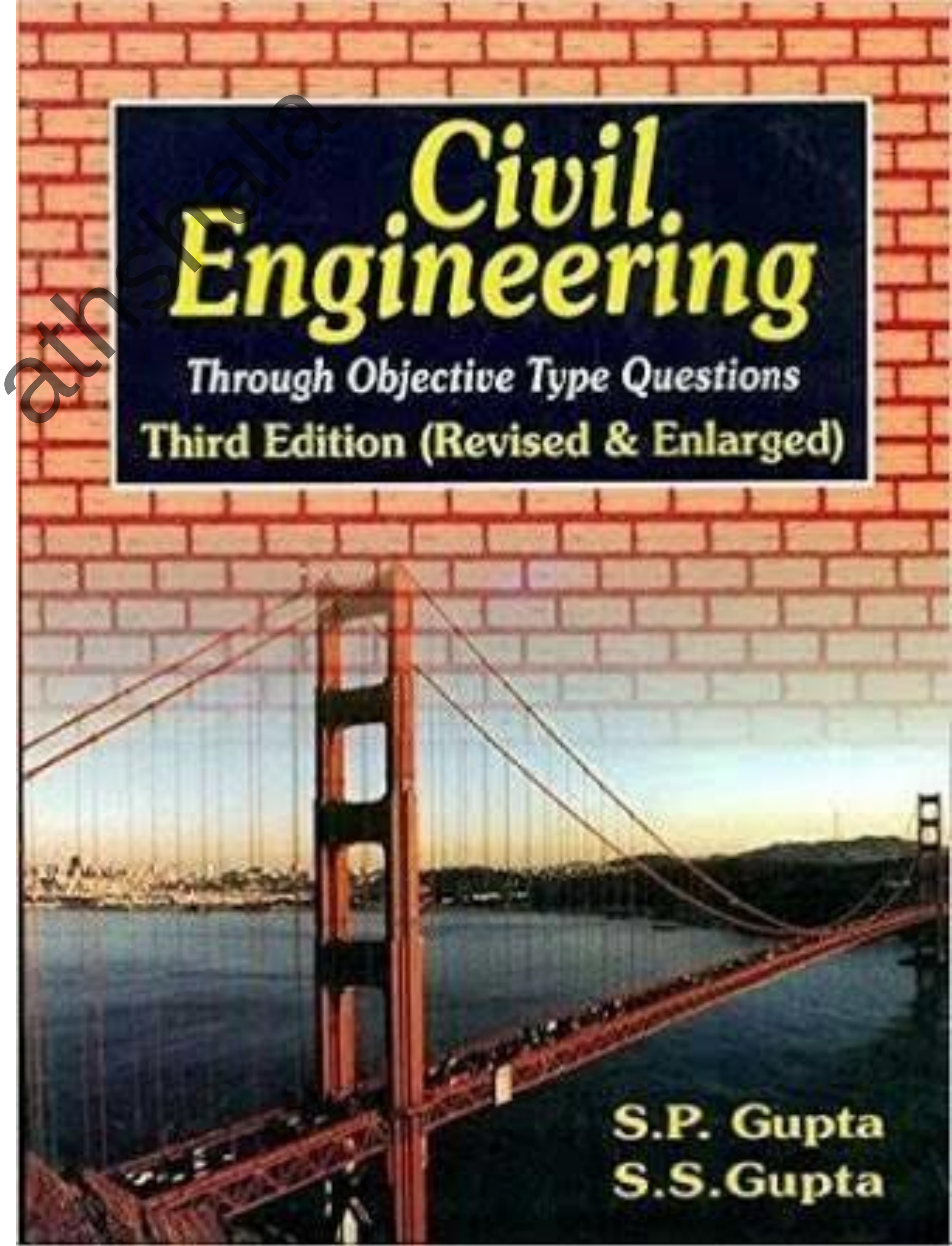
Objective Questions (226 to 240)

Irrigation & Hydrology



Q. 226) Depth-Area-Duration curves of precipitation are drwan as

A. Minimising envelopes through the appropriate data points
B. Maximizing envelopes through the appropriate data points
C. Best fit mean curves through the appropriate data points
D. Best fit mean straight lines through the appropriate data points

Answer B

The maximum depth area curve for a given duration D is prepared by assuming the area distribution of rainfall for smaller duration to be similar to the total storm. The procedure is then repeated for different storms and the envelope curve of maximum depth area for duration D is obtained. A similar procedure for various values of D results in a family of envelope curves of maximum depth vs area, duration as the third parameter. These curves are called DAD curves.

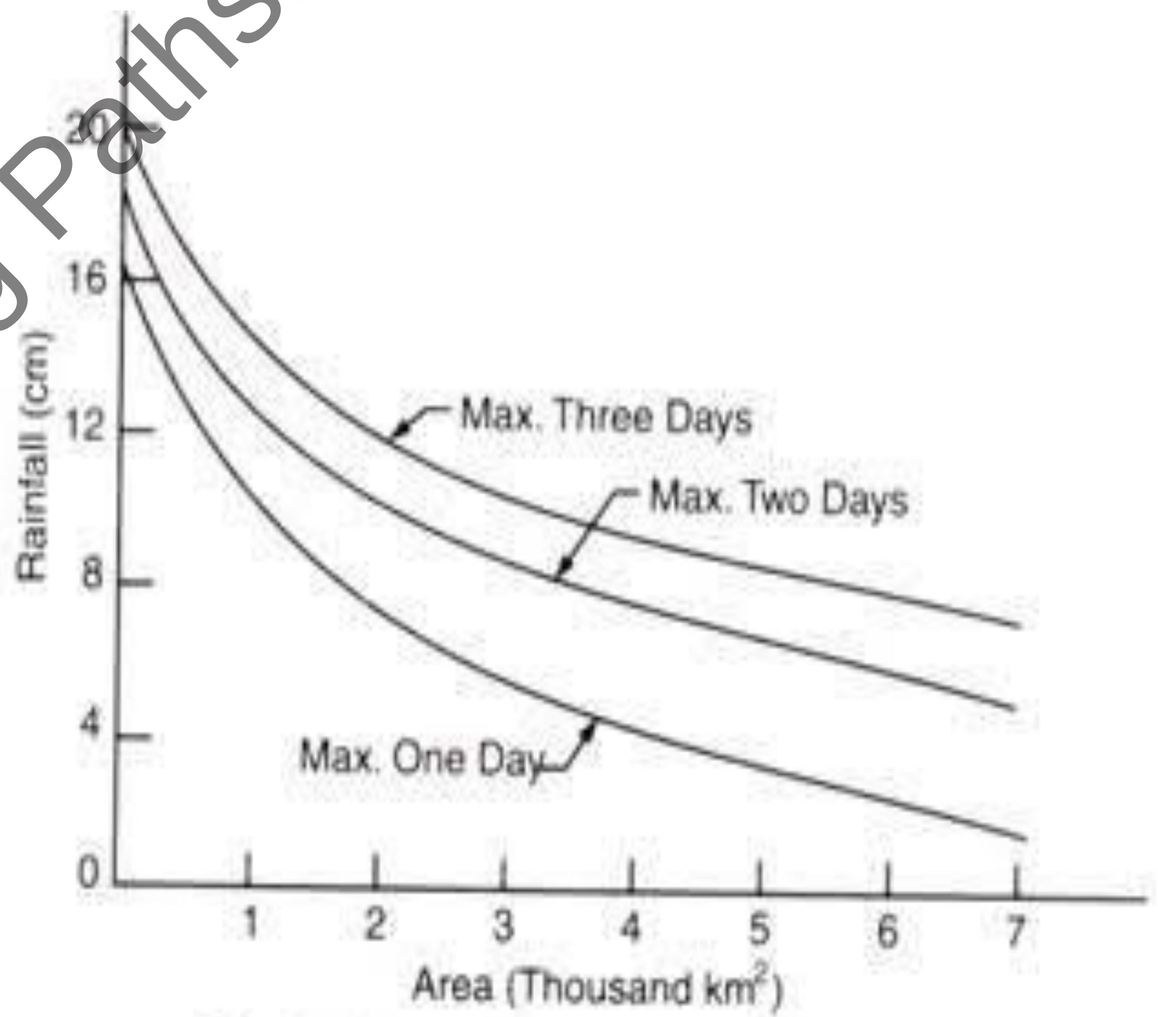


Fig. 2.12. Depth-area-duration curves

227. Match List I with List II and select the correct answer using the codes given below the lists:

List I		List II	
A.	Conservation reservoirs	1.	Uncontrolled outlets
B.	Retarding basins	2.	Flood-fighting
C.	Flood plains	3.	Temporary storage of flood water
D.	Flood walls	4.	Controlled outlets

Codes:

	A	B	C	D
a)	1	4	3	2
b)	1	4	2	3
c)	4	1	3	2
d)	4	1	2	3

[ES 96]

Answer C

Q. 228) The following four hydrological features have to be estimated or taken as inputs before one can compute the flood hydrograph at any catchment outlet:

1. Unit hydrograph
2. Rainfall hydrograph
3. Infiltration index
4. Base flow

The correct order in which they have to be employed in the computation is

A. 1,2,3,4
B. 2,1,4,3
C. 2,3,1,4
D. 4,1,3,2

Answer C

First determine the rainfall hydrograph and then infiltration index. The effective rainfall can be determined from the rainfall hydrograph and infiltration index. Now multiply the ordinates of unit hydrograph by effective rainfall. This will give direct runoff hydrograph (DRH). Finally add base flow to the DRH and flood hydrograph can be obtained.

Table 5·3 (n=3 cm)

Date	*Hour*	*Ordinate of unit hydrograph*	*Base flow*	*Ordinates of direct run off*	*Total discharge ordinates*
(1)	(2)	(cumecs) (3)	(cumecs) (4)	(5)=(3)×n	(6)
22 August	2600	0·00	4·0	0	4
	0900	0·12	3·5	1·0	4·5
	1200	0·35	3 0	2·8	5·8
	1500	0·88	2·5	7·1	9·6
	1800	1·50	2·0	12·0	14·0
	2100	2·80	1·5	22·4	23·9
	2400	2·00	1·8	16·0	17·8
	0300	1·85	2·1	14 8	16·9
	0600	1·53	2·4	12·2	14·6
	0900	1·26	2·7	10·1	12·8
	1200	0·84	3·0	6·7	9·7
	1500	0·50	3 3	4·0	7·3
	1800	0·35	3·6	2·8	6·4
	2100	0 12	3·8	1·0	4·8
	2400	0·00	4·0	0·0	4·0

229. Match List I with List II and select the correct answer using the codes given below the lists:

List I		List II	
A.	Tailwater curve much above jump height curve	1.	Basin at bed level
B.	Tailwater curve slightly above jump height curve	2.	Sunk basin
C.	Tailwater curve coinciding with jump height curve	3.	Ski jump bucket
D.	Tail water curve below the jump height curve	4.	Sloping apron

Codes:

	A	B	C	D
a)	4	3	2	1
b)	3	4	1	2
c)	4	3	1	2
d)	3	4	2	1

[ES 96]

Answer C

Q. 230) The Standard Project Flood is

A. Derived from the probable maximum precipitation in the region
B. Derived from the severemost metrological conditions anywhere in the country
C. The flood with return period of 1000 years
D. The same as the probable maximum flood

Answer B*

The flood that would result from a severe combination of meteorological and hydrological factors that are reasonably applicable to the region. Extremely rare combinations of factors are excluded.

231. Match List I (Control structures) with List II (Functions of the Control structures) and select the correct answer using the codes given below the Lists:

	List I		List II
A.	Canal drop	1.	Control of flow depth
B.	Canal escape	2.	Control of bed grade
C.	Canal cross-regulator	3.	Control of full supply level
D.	Canal outlets	4.	Control of discharge

Codes:

	A	B	C	D
a)	2	3	4	1
b)	2	3	1	4
c)	3	2	1	4
d)	3	2	4	1

[ES 97]

Answer B

A. Canal fall or drop is an irrigation structure constructed across a canal to lower down its bed level to maintain the designed slope.

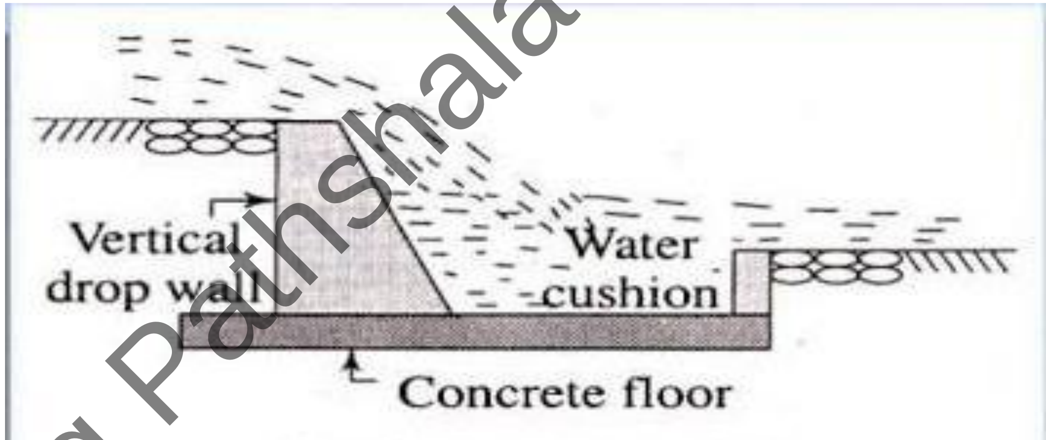


Fig: Vertical Drop Fall

B. Canal Escape:- It is a side channel constructed to remove surplus water from an irrigation channel (main canal, branch canal, or distributary etc.)

C. A cross regulator is a structure constructed across a canal to regulate the water level in the canal upstream of itself.

D. A canal outlet or a module is a small structure built at the head of the water course so as to connect it with a minor or a distributary channel. It acts as a connecting link between the system manager and the farmers.

Q. 232) For medium silt whose average grain size is 0.16 mm, Lacey’s silt factor is likely to be

A. 0.30
B. 0.45
C. 0.70
D. 1.32

Answer C

Lacey's silt factor is given by

$$f = 1.76\sqrt{\text{Avg. size of particle in mm}}$$

$$= 1.76\sqrt{0.16}$$

$$\approx 0.70$$

233. Match List I (Main provision) with List II (Surplussing arrangement) and select the correct answer using the codes given below the Lists:

	List I		List II
A.	Minor irrigation work	1.	Saddle spillway
B.	Medium irrigation project in interior area	2.	Syphon spillway
C.	Earth dam across main river	3.	Ogee spillway
D.	Masonry dam on good rock	4.	Surplus weir

Codes:

	A	B	C	D
a)	4	2	1	3
b)	4	2	3	1
c)	2	4	3	1
d)	2	4	1	3

Answer A

Q. 234) Mean precipitation over an area is best obtained from gauged amounts by

A. Arithmetic mean method
B. Thiessen method
C. Linearly interpolated ishoyetal method
D. Orographically weighted ishoyetal method.

Answer D

Isohyets are contours of equal rainfall.
The orographically weighted isohyets are prepared by tracing paper for mountainous areas and therefore they are more accurate than linearly interpolated isohyets.

Q. 235) The following steps are involved in arriving at a unit hydrograph:
1. Estimating the surface runoff in depth
2. Estimating the surface runoff in volume
3. Separation of base flow
4. Dividing surface runoff ordinates by depth of runoff.

The correct sequence of these steps is:

A. 3,2,1,4
B. 2,3,4,1
C. 3,1,2,4
D. 4,3,2,1

Answer A

1. Separate the baseflow from the observed streamflow hydrograph in order to obtain the Direct Runoff Hydrograph (DRH).

2. Compute the volume of Direct Runoff (V_{DRH}).

3. Surface runoff in depth = V_{DRH}/A_{basin}

4. Obtain a Unit Hydrograph by normalizing the DRH.

5. Normalizing implies dividing the ordinates of the DRH by the Surface runoff in depth.

Q. 236) Probability of a 10-year flood to occur at least once in the next 4 years is

A. 25%
B. 35%
C. 50%
D. 65%

Answer B

The probability of occurrence of a flood at least once in next n years is given by

$$P = 1 - q^n$$

$$= 1 - (1-P)^n$$

$$= 1 - \left(1 - \frac{1}{T}\right)^n$$

$$= 1 - \left(1 - \frac{1}{10}\right)^4$$

$$\approx 0.35$$

Q. 237) The following data were recorded from an irrigated field:
1. Field capacity:20%
2. Permanent wilting point:10%
3. Permissible depletion of available soil moisture:50%
4. Dry unit weight of soil:1500kgf/m^3
5. Effective rainfall:25mm
Based on these data, the net irrigation requirement per metre depth of soil will be

A. 75 mm
B. 125 mm
C. 50 mm
D. 25 mm

Answer C

Field Capacity:- The maximum quantity of water which a soil can retain against the force of gravity is known as field capacity.
The quantity of water greater than the field capacity simply passes away.

Permanent wilting Point:- is the moisture content at which the moisture is no longer available in sufficient quantity so that the plants can sustain. Even though the soil contains some moisture but it was so held by the soil that roots of plants cannot uptake it and results in wilting of plant.

Available water:- The difference between two moisture contents (field capacity and permanent wilting point) is known as available water.
It is the moisture content which is available for plants.

Available moisture $= 0.5 \times (20-10) = 5\%$

Deficiency due to the fall of moisture is

$$= \frac{\gamma_d}{\gamma_w} \times d \times \text{Available moisture}$$

$$= \frac{1500}{1000} \times 1000 \times \frac{5}{100} = 75 \text{ mm}$$

25 mm depth of water is available from precipitation so net irrigation needed is

$$= 75 - 25 = 50 \text{ mm}$$

Q. 238) Depth-area-duration curves would seem to resemble

A. Arcs of a circle concave upwards with duration increasing outward
B. First quadrant limbs of hyperbolae with duration increasing outward
C. Third quadrant limbs of hyperbolae with duration decreasing outward
D. First quadrant limbs of hyperbolae with duration decreasing outward

Answer A

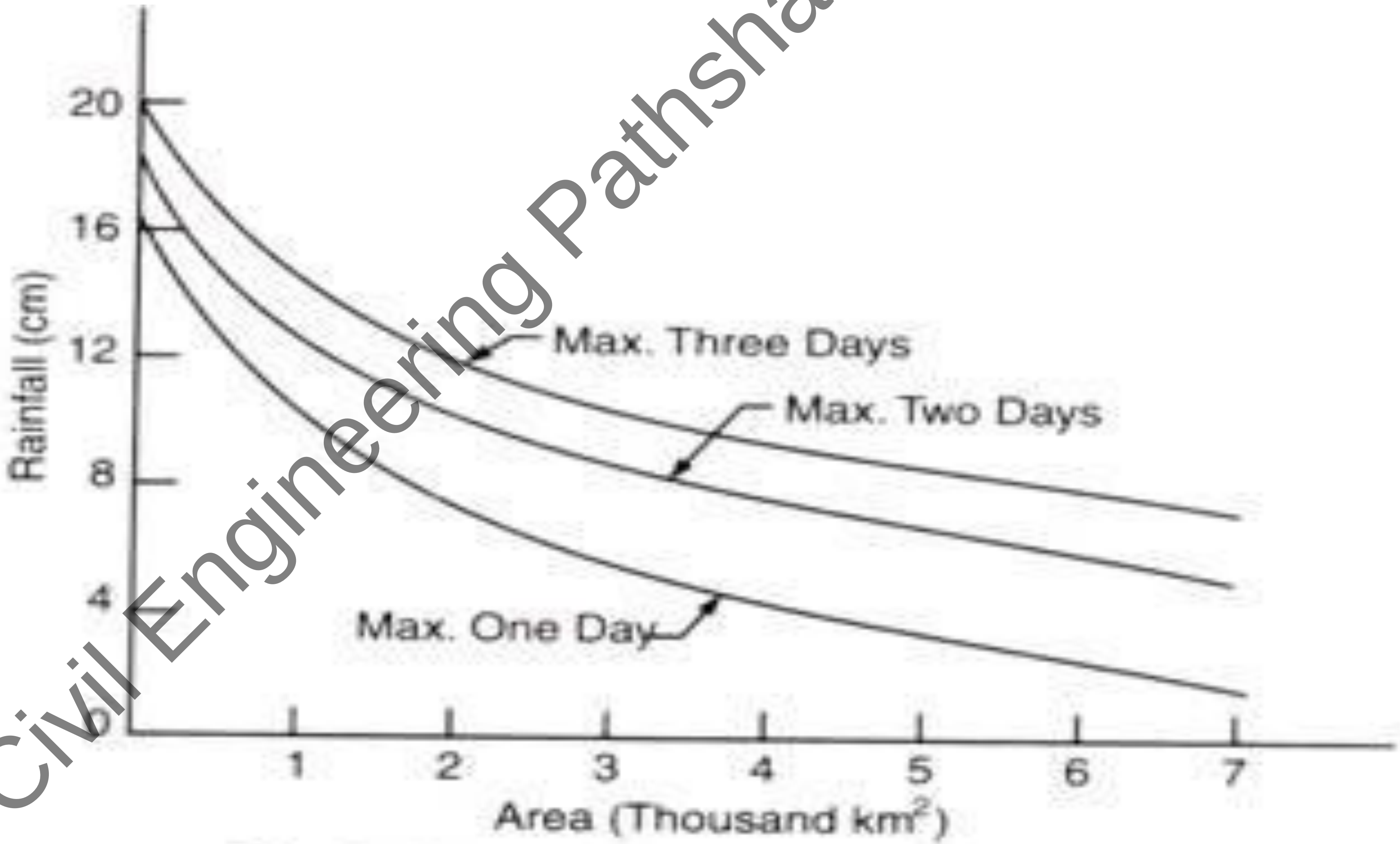


Fig. 2.12. Depth-area-duration curves

Q. 239) The spacing of tile drains to relieve waterlogged land is directly proportional to the

A. Depth of drain below the ground surface
B. Depth of impervious strata from the drain
C. Depth of drain below the water level
D. Coefficient of permeability of the soil to be drained

Answer D

Tile drainage is a type of drainage system that removes excess water from soil below its surface.
The spacing of tile drains to relieve waterlogged land is directly proportional to the coefficient of permeability of the soil.

Q. 240) The maximum permissible suction lift for centrifugal pump in practice (at sea level and at 30°C) is

A. 12 m
B. 10 m
C. 6 m
D. 3 m

Answer C

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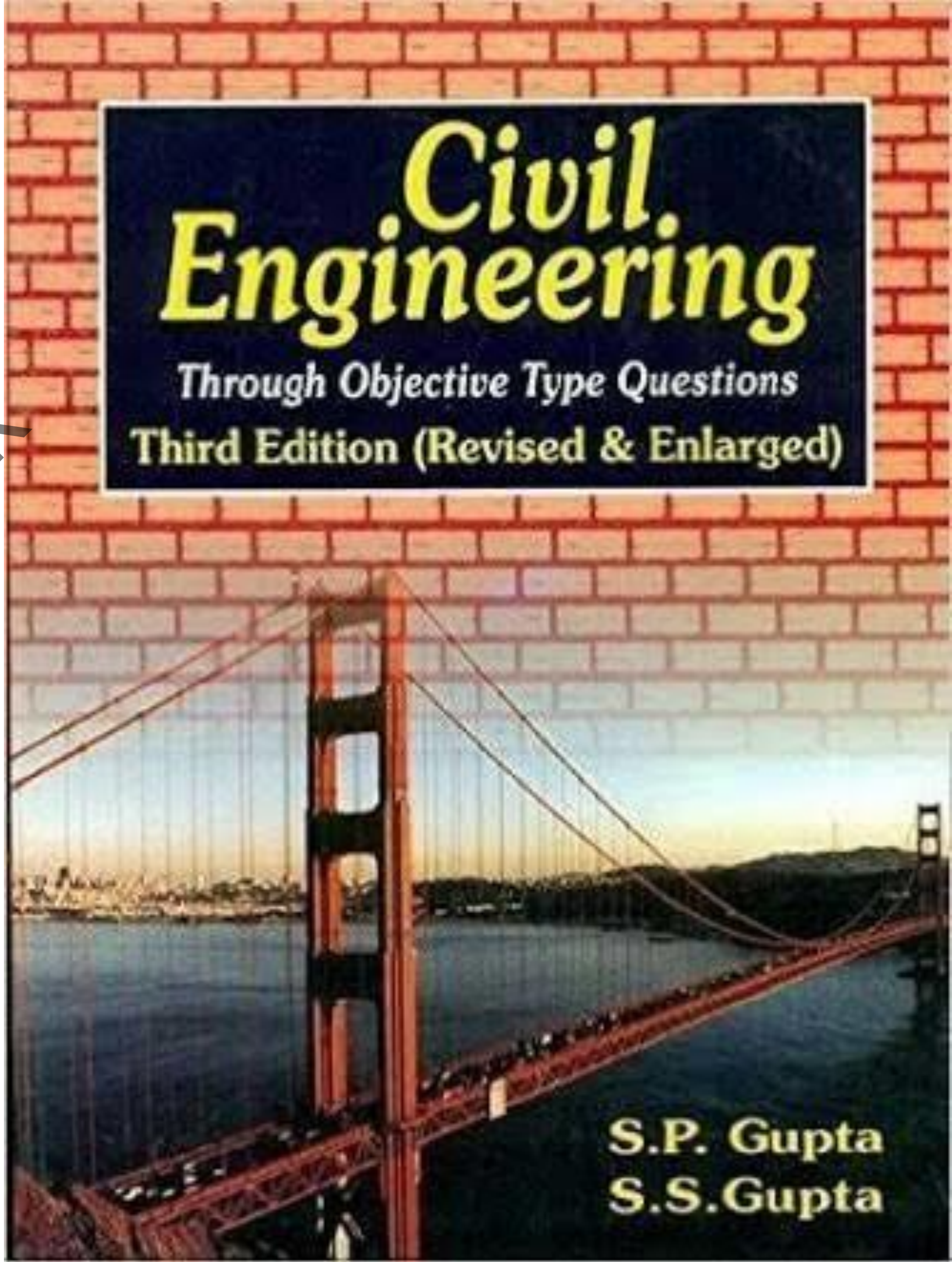
(241 to 248 END)

LAST PART

Irrigation & Hydrology



241. An aquifer confined at top and bottom by impermeable layers is stratified into three layers as follows:

Layer	Thickness (m)	Permeability (m/day)
Top layer	4	30
Middle layer	2	10
Bottom layer	6	20

The transmissivity (m^2/day) of the aquifer is

a) 260
b) 227
c) 80
d) 23

[ES 99]

Answer A

Transmissivity, $T = \Sigma Kd$

$= 30 \times 4 + 10 \times 2 + 20 \times 6$

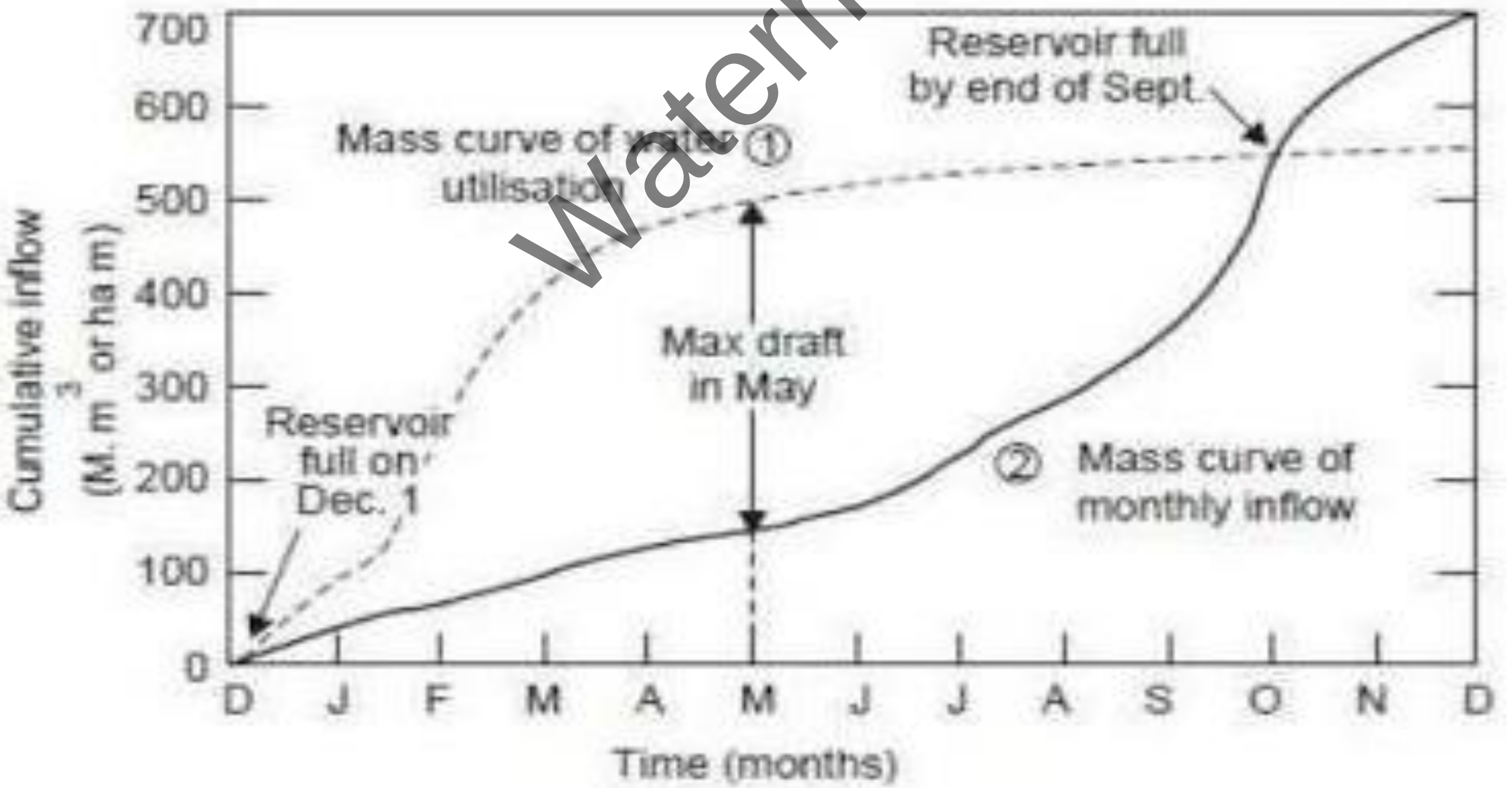
$= 260 \ m^2/day$

Q. 242) In a flow mass curve study, the demand line drawn from a ridge does not intersect the mass curve again. This implies that

A. The reservoir is not full at the beginning
B. The storage is not adequate
C. The demand cannot be met by the inflow as the reservoir will not refill
D. The reservoir is wasting water by spill

Answer C

Mass Curve:- It is a plot of cumulative volume of water that can be stored from a stream flow versus time in days, weeks or months.



243. The following rainfall data refers to stations A and B which are equidistant from station 'X' :

	Station 'A'	Station 'X'	Station 'B'
Long-term normal annual rainfall in mm	200	250	300
Annual rainfall in mm for the year 1940	140	P	270

The value of P will be

a) 250
b) 220
c) 205
d) 200 [ES 99]

Answer D

Since the normal annual rainfall at stations A and B does not lie within 10% of the normal annual rainfall at station X.

So, using normal ratio method, we get

$$\frac{P}{250} = \frac{\left(\frac{140}{200} + \frac{270}{300}\right)}{2} \qquad \boxed{P = 200\,mm}$$

If the normal annual rainfall at non-missing station lie within 10% of that at missing station then arithmetic average method can be used.

Q. 244) Consider the following statements:
1. A 100-year flood discharge is greater than a 50-year flood discharge.
2. 90% dependable flow is greater than 50% dependable flow.
3. Evaporation from salt-water surface is less than that from fresh-water surface.
Which of these statements are correct?

A. 1 and 2
B. 2 and 3
C. 1 and 3
D. 1,2 and 3

Answer D

Evaporation from salt-water surface is less than that from fresh-water surface because vapour pressure of salt-water is less than that of fresh-water.

Q. 245) If a 4-hour unit hydrograph of a certain basin has a peak ordinate of $80 m^3/sec$, the peak ordinate of a 2-hour unit hydrograph for the same basin will be

A. Equal to $80 m^3/sec$
B. Greater than $80 m^3/sec$
C. Less than $80 m^3/sec$
D. Between $40 m^3/sec$ to $80 m^3/sec$

Answer B

With the reduction of unit hydrograph duration, 1 cm excess rainfall will occur in reduced period. So peak ordinate of UH will increase and time base will decrease. Thus the peak ordinate of 2 hr UH will be greater than 80 m^3/s

246. Match List I (Name of scientist) with List II (Contribution to field of hydrology) and select the correct answer using the codes given below the Lists :

	List I		List II
A.	Dalton	1.	Unit hydrograph
B.	Snyder	2.	Evaporation
C.	Blaney Criddle	3.	Empirical flood formula
D.	Sherman	4.	Synthetic unit hydrograph
		5.	Consumptive use equation

Codes:

	A	B	C	D
a)	2	3	5	1
b)	1	4	3	2
c)	2	4	5	1
d)	1	3	4	5

[ES 99]

Answer C

Q 247) A culvert is design for a peak flow Q_p on the basis of rational formula. If a storm of the same intensity as used in the design and twice the duration occurs, then the resulting peak discharge will be

A. Q_p
B. $Q_p/2$
C. $\sqrt{2}Q_p$
D. $2Q_p$

Answer A

Rational formula, $Q_p = KiA$

There is no term for duration of rainfall In the rational formula so peak discharge will not change.

248. Match List I with List II and select the correct answer using the codes given below the Lists :

List I		List II	
A.	Specific yield	1.	Volume of water retained per unit volume of aquifer
B.	Specific capacity	2.	Volume of water drained by gravity per unit volume of aquifer
C.	Specific retention	3.	Difference of porosity and specific storage
D.	Specific storage	4.	Well yield per unit drawdown
		5.	Volume of water released from unit volume of aquifer for unit decline in piezometric head

Codes:

	A	B	C	D
a)	2	4	1	5
b)	4	2	3	5
c)	2	5	1	4
d)	4	2	3	1

[ES 99]

Answer A

THE END

Thank You For Watching

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