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Objective Questions of Engineering Services Exams.

Year 1993 (*Objective Paper II of Engg. Services*)*

Q. 1. The ordinates of a 3-hour 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.

Q. 2. 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 ϕ-index of the soil to be 1.2 cm/hour, the runoff volume in ham will be:

(*a*) 16 (*b*) 22

(*c*) 1600 (*d*) 2200.

* U.P.S.C. has, with effect from the year 1993, allowed students to take back home the Objective Papers, which it was not allowing earlier.

Q. 3. *A 3-hour unit hydrograph (UH) differs from a 6-hour U.H., 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 that that of the latter

(*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.

Q. 4. *As per the recommendations of the ISB (NBS), the shape of a lined canal is:*

(*a*) trapezoidal (*b*) semicircular
(*c*) parabolic (*d*) elliptic.

Q. 5. *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-masonary work to facilitate road transport.	bridge

Codes :

(*a*) 1, 2 and 3 (*b*) 1 and 3
(*c*) 2 and 3 (*d*) 1 and 2.

Q. 6. Application efficiency of irrigation is best defined as the ratio of:

(*a*) water for normal consumptive requirement to water depleted from the root zone

(*b*) water actually stored in the root zone to water delivered to the farm

(*c*) water reaching the farm to water released from the head works

(*d*) water actually delivered to the farm to water actually reaching the farm.

Q. 7*. Match List I with List II and select the correct answer using the codes given below the lists :

List I	*List II*
A. Contour bunding	1. High rainfall
B. Bench terrace with outward slope	2. Low rainfall
C. Land slope = 100%	3. 45°
D. Drop inlet spillway	4. 90°
	5. Gully control.

Codes :

	A	*B*	*C*	*D*
(*a*)	1	2	3	4
(*b*)	3	5	2	1
(*c*)	2	1	3	5
(*d*)	3	4	5	1.

ANSWERS

1. (*b*) **2.** (*c*) **3.** (*c*) **4.** (*a*)
5. (*b*) **6.** (*b*) **7.** (*c*).

Year 1994 *(Objective Paper II of Engineering Services)*

Q. 1. Consider the following statements regarding confined aquifers :

1. The aquifer is bound at top and below by impervious strata
2. The pressure of water is greater than atmospheric pressure
3. A tubewell sunk in such an aquifer starts flowing always by itself.
4. The aquifer is fully saturated .

Of the above statements :

(*a*) 1, 2 and 3 are correct (*b*) 2, 3 and 4 are correct
(*c*) 1, 2 and 4 are correct (*d*) 1, 3 and 4 are correct.

Q. 2. The given diagram I shows the curve of a hydrograph. Which of the following would cause the peak of the curve to shift to the right ?

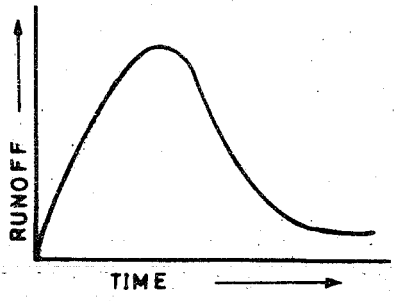

Diagram I. (Fig. 32.1)

(1) When the length of the overland flow is more
(2) When the slope of the land surface is less
(3) When the runoff 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.

Q. 3. 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.

Q. 4. 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.

Q. 5.* For the estimation of a flood with a return period of T years by Gumbel's method, which of the following sets of data regarding the annual flood series would be required ?

(*a*) Mean and Standard deviation (SD) of the flood flow series

(*b*) Mean flood flow, SD of the flood flow series, and the Length of record

(*c*) SD of the flood flow series and Length of record

(*d*) Mean, SD, and coefficient of skew of the flood flow series.

Q. 6.* 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.

Q. 7. If D = scour depth measured below high flood level, and d = depth of scour below the original bed level, then the width of the launching apron at toe of guide bank will generally be :

(*a*) 1.5*D* (*b*) 1.5*d*

(*c*) 2.0*D* (*d*) 2.0*d*.

Q. 8. 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. Blanly 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

ANSWERS

1. (*c*) **2.** (*c*) **3.** (*b*) **4.** (*d*)

5. (*d*) **6.** (*a*) **7.** (*b*) **8.** (*a*)

Hints for Solving Starred Questions of Year 1994

Q. 5. Gumbel's method uses the eqn :

$$Q_p = \overline{Q}_p + k\,\sigma$$

where $\overline{Q}_p$ = Mean flood flow

k = Coefficient of skew

σ = Standard Deviation.

Hence for estimation of flood, we need Mean flood flows, S.D. (Standard Deviation) and Coefficient of skew (k). Hence, choice (d) is correct.

Q. 6. Use eqn. 4.15 as :

$$R = \frac{5}{2}\left(\frac{v^2}{f}\right) = \frac{5}{2}\left(\frac{1^2}{1}\right)$$

$$= 2.5 \text{ m}.$$

Hence choice (a) is correct. **Ans.**

Year 1995 *(Objective Paper II of Engineering Services)*

Q. 1. Which one of the following constitutes the basic assumption of the unit hydrograph theory :

(a) Non-linear response and time invariable.

(b) Non-linear time variance and linear response

(c) Linear response and linear time variance

(d) Time invariance and linear response.

Q. 2. The following parameters relate to the design of weirs of 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.

Q. 3. 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.

Q. 4. The most economical method of soil conservation is to :

(a) construct check dams (b) construct contour bunds

(c) drain the soil (d) aforest the soil.

Q. 5. A pumped storage plant is a

(a) high head plant (b) runoff river plant

(c) peak load plant (d) base load plant.

ANSWERS

1. (*d*) **2.** (*a*) **3.** (*c*) **4.** (*d*) **5.** (*c*).

Year 1996 (*Objective Paper II of Engineering Services*)

Q. 1. The percentage standard error of precipitation averages is often expressed functionally or graphically in terms of (*i*) precipitation gauge network density expressed as area per gauge ; and (*ii*) total area of catchment. The percentage standard error

(*a*) increases with area per gauge as well as with total area

(*b*) decreases with area per gauge as well as with total area.

(*c*) increases with area per gauge but decreases with total area.

(*d*) decreases with area per gauge but increases with total area.

Q. 2. If '*p*' the precipitation, '*a*' is the area represented by a raingauge, and *n* is the number of rainguages in the catchment area, then the weighted mean rainfall is :

(*a*) $\frac{\Sigma ap^3}{\Sigma a^2}$ (*b*) $\frac{\Sigma ap}{n}$

(*c*) $\frac{\Sigma ap}{\Sigma a}$ (*d*) $\frac{\Sigma ap^5}{\Sigma a^3}$

Q. 3. Depth-Area-Duration curves of precipitation are drawn as

(*a*) Minimising envelopes through the appropriate data points.

(*b*) Maximising 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.

Q. 4. Match the 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*)	A	B	C	D
	1	4	3	2
(*b*)	A	B	C	D
	1	4	2	3
(*c*)	A	B	C	D
	4	1	3	2
(*d*)	A	B	C	D
	4	1	2	3

Q. 5. 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. Iufiltration index 4. Base flow.

The correct order in which they have to be employed in the computations is

(*a*) 1, 2, 3, 4 (*b*) 2, 1, 4, 3
(*c*) 2, 3, 1, 4 (*c*) 4, 3, 2, 1

Q.6. In the alignment of an irrigation channel, wherefrom off-takes have to be provided at regular intervals, changes in the given channel parameters are made use of. The correct sequence of the decreasing order of preference of these parameters is

(*a*) width, slope, depth (*b*) width, depth, slope
(*c*) depth, slope, width (*d*) depth, width, slope.

Q.7. Match List I will List II and select the correct answer using the codes given below the lists

List I (*Indications of terms*)		*List II* (*Terms*)
A.	Tail water 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. roller bucket
D.	Tailwater 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

Q. 8. The yield of a well depends upon

(*a*) permeability of soil
(*b*) area of aquifer opening into the wells
(*c*) actual flow velocity
(*d*) all of the above

Q. 9. The construction of impounding reservoir is required when

(*a*) average annual flow in the stream is lower than average demand
(*b*) the rate of flow in the stream in dry season is more than the demand
(*c*) the rate of flow in the stream in dry season is less than the demand
(*d*) the rate of flow in the stream is equal to the demand.

ANSWERS

1. (*a*) **2.** (*c*) **3.** (*c*) **4.** (*c*) **5.** (*c*)
6. (*b*) **7.** (*c*) **8.** (*a*) **9.** (*c*)

Year 1997 (*Objective Paper II of Engineering Services*)

Q. 1*. A channel of bed slope 0.0009 carries a discharge of 30 m^3/s when the depth of flow is 1.0 m. What is the discharge carried by an exactly similar channel at the same depth of flow if the slope is increased to 0.0001 ?

(*a*) 10 m^3/s (*b*) 15 m^3/s
(*c*) 60 m^3/s (*d*) 90 m^3/s

Q. 2*. At a hydraulic jump, the depths at the two sides are 0.4 m and 1.4 m. The head loss in the jump is nearly

(*a*) 1.0 m (*b*) 0.9 m
(*c*) 0.7 m (*d*) 0.45 m

Q. 3. Which one of the following pairs relating to flumes carrying open channel flow is correctly matched ?

(*a*) Non-modular flume ... Flow is unaffected by drowning
(*b*) Venturi flume ... Standing wave forms at the throat.
(*c*) Venturi flume ... Flow at the throat is less than critical velocity.
(*d*) Standing wave flume ... Hump is not provided at the throat.

Q. 4*. Mean precipitation over an area is best obtained from gauged amounts by

(*a*) arithmetic mean method
(*b*) Thiessen method
(*c*) linearly interpolated isohyetal method
(*d*) Orographically weighed isohyetal method.

Q. 5. 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

Q. 6*. 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%

Q. 7. The standard Project flood is

(*a*) derived from the probable maximum precipitation in the region
(*b*) derived from the severemost meteorological conditions any where in the country.
(*c*) the flood with return period of 100 years.
(*d*) the same as the probable maximum flood.

Q. 8. 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

Q. 9*. 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

Q. 10. 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

Q. 11. While considering weir designs on permeable soils, the correction for mutual interference of sheet piles is NOT applicable on an intermediate pile if the outer pile :

(*a*) goes deeper than the intermediate pile and is farther from the intermediate pile by more than twice its own length

(*b*) goes only just as deep as the intermediate pile and is within a distance of one and half times its own length

(*c*) does not go as deep as the intermediate pile, no matter what the horizontal distance between them is

(*d*) is safe against deleterious exit gradient

Q. 12*. The following data were recorded from an irrigation field ;

1. Field capacity = 20%
2. Permanent wilting point = 10%
3. Permissible depletion of available soil moisture = 50%
4. Dry unit weight of soil = 1500 kgf/m^3
5. Effective rainfall = 25 mm

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

Q. 13. The correct sequence, in the direction of the flow of water for installations in a hydropower plant is

(*a*) reservoir, surgetank, turbine, penstock
(*b*) reservoir, penstock, surge tank, turbine
(*c*) reservoir, penstock, turbine, surge tank
(*d*) reservoir, surge tank, penstock, turbine

ANSWERS

1. (*a*)	**2.** (*d*)	**3.** (*b*)	**4.** (*d*)	**5.** (*a*)	**6.** (*b*)
7. (*b*)	**8.** (*b*)	**9.** (*c*)	**10.** (*a*)	**11.** (*b*)	**12.** (*c*)
13. (*b*)					

Hints for Solving Starred Questions of Year 1997

Q. 1. $Q = \frac{1}{n} \cdot A.R^{2/3} \cdot \sqrt{S}$

$$\therefore \quad Q_2 = \sqrt{\frac{0.0001}{0.0009}} \cdot Q_1 = \frac{1}{3} \times 30\ \text{m}^3/\text{s} = 10\ \text{m}^3/\text{s}\ \text{Ans.}$$

Q. 2. $H_L = \frac{(y_2 - y_1)^3}{4 \cdot y_1 y_2} = \frac{(1.4 - 0.4)^3}{4 \times 0.4 \times 1.4} = 0.45\ \text{m}$ Ans.

Q. 4. The Isohyetal method for determining mean rainfall in a catchment is superior to the arithmetic mean method as well as 'Thiessans' Polygon method, especially when the stations are large in number and the catchment is large (more than 5000 sqkm or so). The isohyetal method also permits consideration of topographic effects, and is therefore more accurate in mountainous areas. In this method, the average value of rainfall indicated by two isohyets is assumed to be acting over the inter isohyet area. The isohyetal method thus considers different rainfalls for different part areas, which amounts to orographical weighing of the part areas.

Q. 5. When the river runoff graph is known, the base flow has to be first of all subtracted from it to obtain S.R.O. graph. The volume of S.R.O. is then computed from the S.R.O. graph. The S.R.O. volume is then divided by catchment area to obtain S.R.O. depth. The S.R.O. ordinates are finally

divided by S.R.O. depth (in cm) to obtain ordinates of unit hydrograph. Hence, the sequence 3, 2, 1, 4 is correct. **Ans.**

Q. 6. $T = 10$ yrs

$$p = \frac{1}{T} = \frac{1}{10} = 0.1$$

$$R = \left[1 - (1 - 0.1)^4\right]$$

$$= 1 - (0.9)^4 = 0.3439 \approx 0.35 \text{ or } 35\% \quad \textbf{Ans.}$$

Q. 9. $f = 1.75 \cdot \sqrt{dmm}$

$$= 1.75\sqrt{0.16} = 1.75 \times 0.4 = 0.70 \textbf{ Ans.}$$

Q. 12. Available m.c. = Field capacity m.c. – wilting Pt. m.c.

$$= 20\% - 10\% = 10\%$$

Readily available m.c. = 50% × Available m.c.

$$= 50\% \times 10\% = 5\%$$

Optimum m.c. = 20% – 5% = 15%

Irrigation water is to be supplied when m.c. falls to 15% and is to be recouped upto 20%

$$= \frac{\gamma_d}{w}\left[\text{Field m.c.} - \text{Optimum m.c.}\right]$$

For 1 m depth of soil, the water reqd. to recoup m.c. from 15% to 20%

$$= \frac{1500}{1000} \times 1 \text{ m } [20\% - 15\%]$$

$$= 1.5 \times 5\% \text{ m} = 1.5 \times 0.05 = 0.075 \text{ m} = 75 \text{ mm}$$

Irrigation water reqd. = Total water reqd. – Effective Rainfall

$$= 75 \text{ mm} - 25 \text{ mm} = 50 \text{ mm} \quad \textbf{Ans.}$$

Year 1998 (*Engineering Services*)

Q. 1. 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

Q. 2. When a river starts meandering, the sediment carrying capacity

(*a*) first decreases and ultimately increases

(*b*) first increases and ultimately decreases

(*c*) remains unaffected as the plan changes continue

(*d*) changes erratically all the time leaving permanent braids

Q. 3. Asubmerged pipe outlet from a minor feeds into a well chamber across the bank. Water from the well chamber overflows a weir- like face into the field channel. The flow into the field channel

(*a*) will increase with any drop in the water level in the minor

(*b*) will not be much affected by any change in the water level in the minor
(*c*) will decrease with any drop in the water level in the minor
(*d*) will be proportional to the flow in the minor when the minor flows between set ranges

Q. 4. Match List-I (Types of turbines) with List-II (Ranges of specific speeds in MKS units) and select the correct answer using the codes given below the lists :

List I	*List II*
A. Francis	1. 10 – 35
B. Kaplan	2. 35 – 60
C. Pelton with one jet	3. 60 – 300
D. Pelton with two jets	4. 300 – 1000

Codes :

	A	B	C	D
(*a*)	3	4	2	1
(*b*)	4	3	2	1
(*c*)	3	4	1	2
(*d*)	4	3	1	2

ANSWERS

1. (*a*) **2.** (*c*) **3.** (*c*) **4.** (*c*)

Year 1999 (*Engineering Services*)

Q. 1.* To generate 10,000 hp under a head of 81 m while working at a speed of 500 rpm, the turbine of choice would be :

(*a*) Pelton (*b*) Kaplan
(*c*) Bulb (*d*) Francis.

Q. 2. Consider the following statements :

1. Run of river plants can be located on any river
2. Runaway speed of a turbine is generally 180% of normal speed.
3. Underground power stations are suited to areas susceptible to land slides.
4. Higher the specific speed, higher will be the discharge and head.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 2 and 3
(*c*) 1 and 4 (*d*) 2 and 4

Q. 3. Match List I and II and select the correct answer using the codes given below the lists

List I (Turbine)		*List II (Specific speed)*	
A	Pelton	1	25
B	Propeller	2	75
C	Kaplan	3	500
D	Francis	4	800
		5	900

Codes

	A	*B*	*C*	*D*
(*a*)	1	4	5	2
(*b*)	3	4	2	5
(*c*)	4	1	5	3
(*d*)	1	5	4	2

Q. 4.* An aquifer confined at top and bottom by impermeable layers is stratified into three layers as follows.

Layer	*Thickness (m)*	*Permeabilaty 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

Q. 5. The spacing of tile drains to relieve water-logged 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.

Q. 6.* 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.

Q. 7.* Consider the following statements :

1. Pumps in series operation allow the head to increase.
2. Pumps in series operation increase the flow rate.
3. Pumps in parallel operation increase the flow rate.
4. Pumps in parallel operation allow the head to increase.

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 1 and 4
(*c*) 2 and 4 (*d*) 3 and 4.

Q. 8. 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.

Q. 9.* 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

Q. 10. 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

Q. 11. The trap efficiency of a reservoir is a function of :

(*a*) inflow in the reservoir (*b*) ratio of inflow to storage capacity

(*c*) ratio of reservoir capacity to inflow. (*d*) reservoir capacity.

Q. 12. If a 4-hour unit hydrograph of a certain basin has a peak ordinate of 80 m^3/s, the peak ordinate of a 2-hour unit hydrograph for the same basin will be :

(*a*) equal to 80 m^3/s (*b*) greater then 80 m^3/s

(*c*) less than 80 m^3/s (*d*) between 40 m^3/s to 80 m^3/s

Q. 13. 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	5	4

Q. 14.* In a linear reservoir, the

(*a*) volume varies linearly with elevation

(*b*) outflow rate varies linearly with storage

(*c*) storage varies linearly with time

(*d*) storage varies linearly with inflow rate

Q. 15. A culvert is designed 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*) $\frac{Q_p}{2}$

(*c*) $\sqrt{2}\,Q_p$ (*d*) $2\,Q_p$.

Q. 16. Match List I with List II and select the correct answer using the codes given below the list

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

Q. 17. The best design of an arch dam is when :

(*a*) All horizontal water loads are transferred horizontally to the abutments.

(*b*) The dam is safe against sliding at various levels

(*c*) The load is divided between the arches and cantilevers, and the deflections at the conjugal points being equal.

(*d*) The deflections of the cantilevers are equal at different points.

ANSWERS

1. (*d*)	**2.** (*b*)	**3.** (*a*)	**4.** (*b*)	**5.** (*d*)	**6.** (*c*)
7. (*a*)	**8.** (*c*)	**9.** (*d*)	**10.** (*c*)	**11**(*c*).	**12.** (*b*)
13. (*c*)	**14.** (*b*)	**15.** (*a*)	**16.** (*a*)	**17.** (*c*)	

Hints for Solving Starred Questions of the Year 1999

Q. 1. From Eq. (24.1), we have

$$N_s = \frac{N.\sqrt{P_t}}{H^{5/4}}$$

where N = Normal speed of turbine in RPM = 500

P_t = Turbine output in metric horse power = 10,000 hp.

H = Effective head in m = 81 m

$$\therefore \quad N_s = \frac{500\sqrt{10,000}}{(81)^{5/4}} = 205.76$$

From Table 24.1, the turbine which is suitable for a head between 25–450 m and N_s of 60 – 300 is Francis turbine; and hence the recommended turbine in this case is Francis type (Reaction type). Hence, choice (*d*) is correct. **Ans.**

Q. 4. For non-homogeneous layered aquifers, we have to determine effective permeability coefficient by using equation (5.20) given in "Soil Mechanics and Foundation Engineering" by the same author, for vertical flow, as :

$$K_v = \frac{d_1 + d_2 + d_3}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3}}$$

$$= \frac{4+2+6}{\frac{4}{30} + \frac{2}{10} + \frac{6}{20}} = 12 \times \frac{60}{38} \text{ m/day}$$

$$T = K.d = 12 \times \frac{60}{38} \times (4+2+6)$$

$$= 12 \times \frac{60}{38} \times 12 \text{ m}^2/\text{day} = 227 \text{ m}^2/\text{day}.$$

Hence, choice (*b*) is correct **Ans.**

Q. 6. The max. permissible suction lift for a centrifugal pump is given by the equation :

$$H_s = H_a - H_f - e_s - NPSH - F_s \qquad ...(32.1)$$

where, H_s = Max. Practical suction lift, *m*

H_a = Atmospheric pressure at the water surface = 10.33 m at sea level, with reduction of 0.36 m for each 300 m rise in altitude above sea level.

e_a = saturated vapour pressure of water = 4.609 kN/m^2 at 30° C(from Standard Physical tables — Appendix Table A–1)

$NPSH$ = Net positive suction head of the pump, including losses in the impeller& vel. head. It is calculated from the characteristic curves of the given pump, supplied by the manufacturer.

F_s = Factor of safety, which is usually taken as 0.6 m.

From the above eqn., we can easily infer that $H_s < H_a$, while $H_a < 10$ m. For this reason, for all practical proposes, the suction lift for centrifugal pumps is usually limited to $6 - 8$ m, as stated in our text. In the given question, the choice below 10m is given to be 6m. Hence, we mark this choice at (*c*) as the correct choice. **Ans.**

Q. 7. When two or more pumps are connected in series, such as in multi-stage pumping operations, the discharge from the first stage is pumped to the second stage, and so on. The same discharge passes through all the stages. This arrangement becomes essential when the reqd. head is more than that can be produced with a single pump. Each stage in such pumping operations, adds an additional head to the flow. Thus, the combined head of two pumps operating in series is equal to the sum of the individual heads, for a specific discharge.

Sometimes, water pumps are installed in parallel as in the case of pumping water from a sump well using more than one pump. The head remains constant. The combined discharge of the two pumps operating in parallel is equal to the sum of the individual discharges, for a specific head.

From the above discussion, it can be very clearly inferred that the statement 1 and 3 are only true, and hence choice (*a*) is correct. **Ans.**

Q. 9. $N_x = 250$

$$10\%\, N_x = 25$$

$$N_x + 10\%\, N_X = 275 < 300\ (N_B)$$

Hence, use weighted mean method to compute the missing rainfall data P_X.

$$\therefore \quad P_x = \frac{1}{2}\left[\frac{N_X}{N_A}\cdot P_A + \frac{N_X}{N_B}\cdot P_B\right]$$

$$= \frac{1}{2}\left[\frac{250}{200}\times 140 + \frac{250}{300}\times 270\right] = 200$$

Hence, choice (*d*) is correct. **Ans.**

Q. 14. Please see chapter on 'Flood Forecasting' in "*Hydrology and Water Resources Engg.*" by the same author, Page 418, 11th edition, to tick the correct choice, which is given at (*b*) **Ans.**

Year 2000 (*Engineering Services*)

Q. 1. If the base period of a 6 hour unit hydrograph of a basin is 84 hours, then a 12 hour unit hydrograph derived from this 6 hour unit hydrograph will have a base period of

(*a*) 72 hours (*b*) 78 hours

(*c*) 84 hours (*d*) 90 hours.

Q. 2*. The stage in a river is 4.8 m; the water surface slope is 1 in 10,000 and the discharge in the stream is 600 m^3/s. If the stage remains the same and the water surface slope is 1 in 14,400, then the discharge in the stream will be :

(*a*) 300 m^3/s (*b*) 400 m^3/s

(*c*) 600 m^3/s (*d*) 500 m^3/s

Q. 3. If a tangent drawn parallel to the demand line from a ridge point of a mass curve dose not intersect the mass curve again, it can be inferred that the :

(*a*)frequency of the flood entering into the reservoir is less.
(*b*) inflow into the reservoir cannot meet the demand.
(*c*) reservoir is overflowing resulting in wastage.
(*d*) reservoir can meet higher demand.

Q. 4*. In order to ensure that no scouring takes place in the bed of a channel of bed slope '*S*' constructed on alluvial soil of particle size '*d*' cm, the flow velocity should be restricted to :

(*a*) $4.85\, d^{\frac{1}{2}} . S^{-\frac{1}{6}}$ (*b*) $4.85\, d^{-\frac{1}{2}} . S^{\frac{1}{6}}$
(*c*) $0.48\, d^{\frac{1}{2}} . S^{\frac{1}{6}}$ (*d*) $0.48\, d^{\frac{1}{2}} . S^{-\frac{1}{6}}$

Q. 5. Which one of the following sets is used to control the seepage through the foundations of an earth dam ?

(*a*) Chimney drain, upstream blanket and cut off trench
(*b*) Cut off sheet piles, upstream blanket and cut off trench.
(*c*) Upstream blanket, cut off sheet piles and chimney drains
(*d*) Relief wells, upstream blanket and chimney drain.

Q. 6. Consider the following statements :

1. In designing the hydraulic structure in permeable foundation by Khosla's theory, the slope correction is applicable to piles located at the ends of the sloped floor only in a structure with one or more sloped floors.
2. Khosla's theory can be correctly applied in alluvium of finite depth.
3. Length of flow has lesser effect on exit gradient than the depth of piles.
4. Intercepts between hydraulic gradient line and free water surface on the glacis and horizontal floor downstream is the unbalanced uplift in a structure.

Which of these statements related to the design of hydraulic structure are correct ?

(*a*) 1, 2 and 3 (*b*) 1, 3 and 4
(*c*) 2, 3 and 4 (*d*) 1, 2 and 4

Q. 7. Match *List-I* (Energy dissipation) with *List-II* (Water level and slope condition) and select the correct answer using the codes given below the lists :

List I	*List II*
A. Roller bucket	1. TWL (tail channel water level) is slightly above JWL (Jump height water level) and the slope of the channel is mild.
B. Ski-jump bucket	2. TWL is considerably above JWL and the slope of the channel is mild.
C. Standing wave basin with depressed floor	3. TWL is slightly below JWL and the slope of the channel is mild
D. Standing wave basin with raised floor	4. TWL is considerably less than JWL and the slope of the channel is steep.

Codes

	A	*B*	*C*	*D*
(*a*)	4	2	1	3
(*b*)	2	4	1	3
(*c*)	2	4	3	1
(*d*)	4	2	3	1

Q. 8. If the depth is 8.64 cm on a field over a base period of 10 days, then the duty is :

(*a*) 10 hectares per cum/s (*b*) 100 hectares per cum/s
(*c*) 864 hectares per cum/s (*d*) 1000 hectares per cum/s

Q. 9. Specific capacity of a well is the :

(*a*) volume of water that can be extracted by the force of gravity from a unit volume of aquifer.
(*b*) discharge per unit drawdown of the well.
(*c*) drawdown per unit discharge of the well.
(*d*) rate of flow through a unit width and entire thickness of aquifer.

ANSWERS

1. (*d*) **2.** (*d*) **3.** (*b*) **4.** (*a*) **5.** (*b*)
6. (*b*) **7.** (*c*) **8.** (*d*) **9.** (*b*)

Hints for Solving Starred Questions of the year 2000

Q. 2. $Q_1 = 600 = K \cdot \sqrt{S_{f_1}} = \frac{K}{\sqrt{10000}}$; $Q_2 = ? = K \cdot \sqrt{S_{f_2}} = \frac{k}{\sqrt{14400}}$

$$\frac{Q_1}{Q_2} = \frac{600}{Q_2} = \frac{\sqrt{14400}}{\sqrt{10000}} = \frac{1}{1.2}; \; Q_2 = 500 \text{ m}^3/\text{sec}$$

Hence, choice (*d*) is correct. **Ans.**

Q. 4. For designing a non scouring alluvial channel, we know from eqn. (4.13) that

$$d \le 11 \text{ RS}$$

or $$R \le \frac{d}{11 S} \quad \text{or} \quad R_{max} = \frac{d}{11 S}$$

Also, $$V = \frac{1}{n} R^{2/3} \cdot \sqrt{S}$$

or $$V_{max} = \frac{1}{n} \cdot R_{max}^{2/3} \cdot \sqrt{S}$$

But $$= n = \frac{1}{24} \cdot d^{1/6} \text{ (Strickler's formula)}$$

$$\therefore \quad V_{max} = \frac{24}{d^{1/6}} \cdot \left(\frac{d}{11 S}\right)^{2/3} \cdot \sqrt{S} = \frac{24}{(11)^{2/3}} \cdot d^{2/3 - 1/6} \cdot S^{1/2 - 2/3}$$

or $$\boxed{V_{max} = 4.85 \cdot d^{1/2} \cdot S^{-\frac{1}{6}}}$$

Hence, velocity in a non scouring channel should be restricted to above eqn., which makes choice (*a*) as the correct choice. **Ans.**

Year 2001 (*Engineering Services*)

Q. 1. Match *List I* (Surface) with *List II* (Approximate range of Manning's n) and select the correct answer using the codes given below the lists :

List I	*List 2*
A. Gravel river bed with 50 mm diameter bed	1. 0.02 to 0.022
B. Badly maintained unlined irrigation channel with weed growth	2. 0.025 to 0.04
C. Concrete lined channel	3. 0.013 to 0.017
D. Channel with brick lining	4. 0.04 to 0.08

Codes :

	A	B	C	D
(*a*)	4	3	2	1
(*b*)	4	2	3	1
(*c*)	1	3	2	4
(*d*)	1	2	3	4

Q. 2. Which of the following principles relate to a unit hydrograph ?

1. The hydrographs of direct run off due to effective rainfall of equal duration have the same time base.
2. Effective rainfall is not uniformly distributed within its duration.
3. Effective rainfall is uniformly distributed throughout the whole area of drainage basin.
4. Hydrograph of direct run off from a basin due to a given period of effective rainfall reflects the combination of all the physical characteristics of the basin.

Select the correct answer using the codes given below :

Codes :

(*a*) 1, 2 and 3 (*b*) 1, 2 and 4

(*c*) 2, 3 and 4 (*d*) 1, 3 and 4.

Q. 3. Match *List I* with *List II* and select the correct answer using the codes given below the lists :

List I	*List II*
A. Anemometer	1. Humidity
B. Rain simulator	2. Evapotranspiration
C. Lysimeter	3. Infiltration
D. Hygrometer	4. Wind speed

Codes :

	A	B	C	D
(*a*)	4	3	1	2
(*b*)	3	4	1	2
(*c*)	4	3	2	1
(*d*)	3	4	2	1

Q. 4. If the life of a reservoir is determined by its capacity (C), volume of annual inflow into the reservoir (I) and concentration of sediment in the incoming flow (C_s). Life will be more if :

(*a*) C, I and C_s are high

(*b*) C and I are high but C_s is low

(*c*) C is high but I and C_s are low

(*d*) C, I and C_s are low.

Q. 5*. The probability that a 100-year flood is equalled or exceeded at least once in 100 years is :

(*a*) 99% (*b*) 64%

(*c*) 36% (*d*) 1%

Q. 6. A 3-hour storm on a small drainage basin produced rainfall intensities of 3.5 cm/hr, 4.2 cm/hr and 2.9 cm/hr in successive hours. If the surface runoff due to storm is 3 cm, then the value of ϕ-index will be :

(*a*) 2.212 cm/hr
(*b*) 2.331 cm/hr
(*c*) 2.412 cm/hr
(*d*) 2.533 cm/hr.

Q. 7. As a flood wave passes a given section of a river, the time of occurrence of the maximum stage and that of the maximum discharge will be such that :

(*a*) the maximum discharge passes down before the maximum stage is attained

(*b*) the maximum stage is attained before the maximum discharge passes down

(*c*) the two events occur simultaneously

(*d*) no specific sequence would be universally assignable.

Q. 8. In a curved reach of a meandering river, both deposition of sediments and erosion of bank occur. Which one of the following statements is true in this regard ?

(*a*) Deposition of sediments occurs in the inner bank while the outer bank is subjected to erosion

(*b*) Deposition of sediments occur in the outer bank while the inner bank is subjected to erosion

(*c*) In the direction of flow, the outer bank undergoes erosion first and the sediment is later deposited on the outer bank downstream

(*d*) In the direction of flow, the inner bank undergoes erosion first and the sediments are subsequently deposited on the inner bank downstream.

Q. 9. Gibb's module is a type of outlet which ensures :

(*a*) Constant discharge even if the water levels in the supply channel and water course fluctuate

(*b*) Variable discharge as per the need

(*c*) Constant discharge into the water course when the water levels in the supply channel vary

(*d*) Constant discharge for varying water levels in the water course for a given water level in the supply channel.

Q. 10. The Lacey's silt factor for a particular alluvium is 2.0. This alluvium would comprise :

(*a*) medium sand of size 0.5 mm (*b*) coarse sand of size 0.75 mm

(*c*) medium bajri of size 1.3 mm (*d*) coarse bajri of size 2.4 mm.

Q. 11. In a barrage on pervious foundation, sheet piles are provided both upstream and downstream of the barrage to reduce uplift pressure and to prevent piping. Which one of the following statements is true in this regard ?

(*a*) Compared to downstream sheet pile, the upstream sheet pile is more effective in reducing uplift and piping

(*b*) Compared to upstream sheet pile, the downstream sheet pile is more effective in reducing uplift and piping

(*c*) Downstream sheet pile is more effective in reducing uplift while the upstream sheet pile is more effective in reducing piping

(*d*) Upstream sheet pile is more effective in reducing uplift while the downstream sheet pile is more effective in reducing piping.

Q. 12. The following data pertains to a natural drain crossing an irrigation canal :

Item	*Canal data*	*Drainage data*
Flow (m^3/s)	5	500
Bed level (m)	120	116
Depth of flow (m)	0.8	10

Which one of the following types of cross-drainage should be recommended in this case ?

(*a*) Aqueduct (*b*) Syphon aqueduct

(*c*) Syphon (*d*) Super passage

Q. 13. Consider the following statements :

The downstream impervious floor of concrete for a barrage has ruptured. This can be due to :

1. insufficient length of upstream impervious floor
2. insufficient length of downstream impervious floor
3. insufficient depth of downstream pile
4. choking of inverted filter.

Which of these statements are correct ?

(*a*) 1 and 2 (*b*) 1 and 4

(*c*) 2, 3 and 4 (*d*) 1, 2, 3 and 4.

Q. 14*. Ten m^3/s of water is diverted to a 32 hectare field for 4 hours. Soil proving after irrigation showed that 0.3 m of water has been stored in the root zone. Water application efficiency in this case would be :

(*a*) 96% (*b*) 66.67%

(*c*) 48% (*d*) 24%.

Q. 15. Which one of the following statements is correct ?
In a river, silt excludes and silt ejector are constructed
(*a*) at a location after the head regulator and at the head of the canal, respectively
(*b*) at the head of the canal and at a location after the head regulator, respectively
(*c*) at the same location
(*d*) at specific locations depending upon diverse factors and their locations do not follow a set pattern.

ANSWERS

1. (*b*)	**2.** (*d*)	**3.** (*c*)	**4.** (*b*)	**5.** (*b*)
6. (*d*)	**7.** (*c*)	**8.** (*a*)	**9.** (*a*)	**10.** (*c*)
11. (*d*)	**12.** (*b*)	**13.** (*d*)	**14.** (*b*)	**15.** (*b*)

Hints for Solving Starred Questions of the year 2001

Q. 5. See Eqn. (7.135) and compute :

$$p = \frac{1}{T} = \frac{1}{100} = 0.01$$

Probability of non-occurrence of this flood in next 100 yrs

$$= p_{o,n} = q^n = (1-p)^n$$
$$= (1-0.01)^{100} = 0.36$$

Probability of occurrence of this flood at least once in 100 successive yrs

$$= R = 1 - q^n$$
$$= 1 - 0.36 = 0.64 \qquad i.e.\ 64\% \quad \textbf{Ans.}$$

Q. 14. Water depth applied to fields

$$= \frac{10\,\frac{\text{m}^3}{\text{s}} \times (4 \times 60 \times 60\ \text{s})}{(32 \times 10^4\ \text{m}^2)} = 0.45\ \text{m}$$

Water depth actually stored in root zone. = 0.3 m

$$\eta_a = \frac{0.3\ \text{m}}{0.45\ \text{m}} = \frac{2}{3} = 66.67\% \quad \textbf{Ans.}$$

Year 2002 (*Engineering Services*)

Q1. The following items relate to hydrologic requirements in a hydropower system. Match List I with List II and select the correct answer using the codes given below the lists :

	List I		*List II*
A	Stream flow in order of magnitude is plotted as ordinate and percent of time as abscissa	1	Mass curve
B	Cumulative value of stream flow is plotted against time for whole period record	2	Flow duration curve
C	Peat of available power against percent of time	3	Hydrograph
D	Plot of flow in stream against time at specific interval	4	Power duration curve

Codes :

	A	B	C	D
(a)	2	3	4	1
(b)	4	1	2	3
(c)	2	1	4	3
(d)	4	3	2	1

Q2. Consider the following statements :

1. An ephemeral stream is one which has a base flow contribution.
2. Flow characteristics of a stream depend upon rainfall and catchment characteristics, and also the climatic factors which influence evapotranspiration.
3. Sequent Peak Algorithm is used for estimating run off from rainfall.

Which of these statements is/are correct ?

(a) 1, 2 and 3 (b) 1 and 3

(c) 2 and 3 (d) 2 clone.

Q3. Match List I with List II and select the correct answer using the codes given below the lists :

List I	*List II*
A ϕ index	1. Used for measurement of evapo-transpiration for given vegetation
B Lysimeter	2. Used for flow measurement
C Dilution technique	3. Average rainfall above which the rainfall volume is equal to the run-off volume
D Snydel's equation	4. Relates the basin lag to the basin characteristics

Codes :

	A	B	C	D
(a)	3	1	2	4
(b)	4	2	1	3
(c)	3	2	1	4
(d)	4	1	2	3

Q4. A 6-hour rainstorm with hourly intensities of 7, 18, 25, 17, 11 and 3 mm/hour produced a run off of 39 mm. Then, the ϕ_{index} is

(a) 3 mm/hour

(b) 7 mm/hour

(c) 8 mm/hour

(d) 10 mm/hour.

Q5.* In a water-shed, four rain gauges I, II, III and IV are installed. The depths of normal annual rainfall at these stations are 60, 75, 80 and 100 cm, respectively. The rain gauge at station II went out of order during a particular year. The annual rainfall for this

year, recorded at the remaining three stations was 90, 60 and 70 cm. The rainfall at station III can be considered as

(*a*) 60 cm (*b*) 70 cm

(*c*) 80 cm (*d*) 120 cm

Q6. The unit hydrograph theory is based on the assumption of

(*a*) Nonlinear response and time invariance

(*b*) Linear response and non-linear time variance

(*c*) Time invariance and linear response

(*d*) Non-linear response and non-linear time variance.

Q7. An effective storage of a flood control reservoir is

(*a*) the amount of water which can be supplied from it in a particular interval of time

(*b*) the storage between the minimum and maximum reservoir levels under ordinary operating conditions

(*c*) the useful storage plus the surcharge storage less the valley storage

(*d*) the storage volume of flood water above the maximum reservoir level.

Q8. The lenman's evapo-transpiration equation is based on

(*a*) water budget method

(*b*) energy balance method

(*c*) mass transfer method

(*d*) energy balance and mass transfer approach.

Q9. The performance of a well is measured by its :

(*a*) specific capacity (*b*) specific yield

(*c*) storage coefficient (*d*) permeability coefficient.

Q10. Regional hydrological cycle is shown in the figure below (Fig. 32.2)

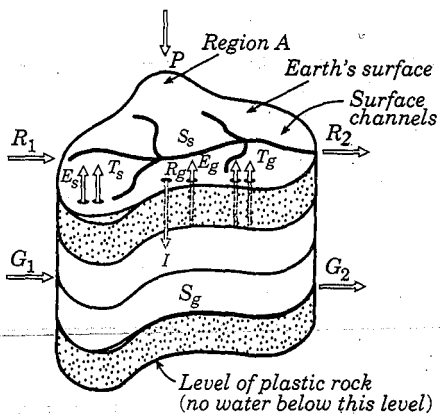

Fig. 32.2.

Identify the correct hydrologic budget equation

(*a*) $P + R_1 - R_2 + R_g - E_s - T_s - I = \Delta S_s$

(*b*) $I + G_1 - G_2 - R_g - E_g - T_g = \Delta S_g$

(*c*) $P-(R_2-R_1)-(E_s+E_g)-(T_s+T_g)-(G_2-G_1)=\Delta(S_s+S_g)$

(*d*) $P-R-G-E-T=\Delta S_s$.

Q11. A two-hour storm hydrograph has 5 units of direct run-off. The two-hour unit hydrograph for this storm can be obtained by dividing the ordinates of the storm hydrograph by

(*a*) 2

(*b*) $\frac{2}{5}$

(*c*) 5

(*d*) $\frac{5}{2}$.

Q12. The slope area method is extensively used in

(*a*) development of rating curve

(*b*) estimation of flood discharge based on high water marks

(*c*) cases where shifting control exists

(*d*) cases where back-water effect is present.

Q13. Consider the following :

Garret's diagram for the design of irrigation channel is based on

1. Kennedy's theory
2. Lacey's theory
3. Kutter's formula
4. Manning's formula.

Which one of these are correct ?

(*a*) 1 and 3 (*b*) 1 and 4

(*c*) 2 and 3 (*d*) 2 and 4.

Q14. The total number of dependent equations that form the Lacey's regime theory is

(*a*) 2 (*b*) 3

(*c*) 4 (*d*) 6.

Q15. Balanced depth of cutting of canal is

(*a*) half the total depth of a canal

(*b*) half of full supply depth

(*c*) the maximum cut that an excavator can take

(*d*) where volume of cutting is equal to volume of filling.

Q16. At a certain point in the floor of weir, the uplift pressure head due to seepage in 4.5 m. If the relative density of concrete is 2.5, the minimum thickness of floor required at this point to counteract the uplift pressure is

(*a*) 1 m (*b*) 2 m

(*c*) 3 m (*d*) 4 m

Q17. A constant angle arch dam when compared to a constant radius arch dam utilizes concrete quantity of about

(*a*) 33% (*b*) 43%

(*c*) 73% (*d*) 143%

Q18. Drowning ratio of canal outlet is the ratio of

(*a*) rate of change of discharge of outlet to that of distributary

(*b*) water depth above outlet crest to the full supply depth of the channel

(*c*) water depth above the crest on downstream to that on upstream of outlet

(*d*) rate of change of discharge of an outlet to the rate of change of water level of the channel.

Q19. A canal was designed to supply the irrigation needs of 1000 *ha* of land growing rice of 140 days base period and having a delta of 130 cm. If the canal water is used to irrigate wheat of base period 119 days and having a delta of of 50 cm, the area that can be irrigated is ;

(*a*) 452 ha (*b*) 904 ha

(*c*) 1105 ha (*d*) 2210 ha

Q20. A canal fall is a control structure

(*a*) located at a place where the country slope is flatter than the canal bed slope

(*b*) located most economically where the depth of cutting is less than the balancing depth

(*c*) the location of which is independent of the command to be served

(*d*) designed to secure raising of water surface on its upstream.

Q21. Match List I (Equation) with List II (Applicability or principle of equation) and select the correct answer using the codes given below the lists :

List I		*List II*	
A	Theim's equation	1	is based on energy conservation principle
B	Dupuit's assumption	2	is based on mass conservation principle
C	Bernoullis equation	3	is applicable to steady flow towards a well in confined aquifer
D	Continuity equation	4	is applicable to steady flow in an unconfined aquifer

Codes :

	A	B	C	D
(*a*)	4	3	2	1
(*b*)	3	4	2	1
(*c*)	4	3	1	2
(*d*)	3	4	1	2

ANSWERS

1. (*c*)	**2.** (*d*)	**3.** (*a*)	**4.** (*c*)	**5.** (*b*)	**6.** (*c*)	**7.** (*c*)
8. (*d*)	**9.** (*a*)	**10.** (*c*)	**11.** (*c*)	**12.** (*b*)	**13.** (*a*)	**14.** (*d*)
15. (*d*)	**16.** (*c*)	**17.** (*b*)	**18.** (*c*)	**19.** (*d*)	**20.** (*b*)	**21.** (*c*)

Hints for Solving Sttared Questions of the Year 2002

Q5. Station I, N_1 = Annual Av. rainfall = 60 cm

Station II, N_2 (N_x) = Annual Av. rainfall = 75 cm

Station III, N_3 = Annual Av. rainfall = 80 cm.

Station IV, N_4 = Annual Av. rainfall = 100 cm.

$P_1 = 90$ cm $\qquad P_3 = 60$ cm

$P_4 = 70$ cm $\qquad P_2 = ?$

Since the value of anyone av. annual ppt. of known stations, *i.e* N_1, N_3 and N_4 or differs from N_2 (*i.e.* N_x) by more than 10%, is applicables as :

$$\therefore \qquad P_x = P_2 = \frac{N_x}{3}\left[\frac{P_1}{N_1} + \frac{P_3}{N_3} + \frac{P_4}{N_4}\right]$$

$$= \frac{75}{3}\left[\frac{90}{60} + \frac{60}{80} + \frac{70}{100}\right] = 25\,[1.5 + 0.75 + 0.7]$$

$$= 25 \times 2.95 = 73.75 \text{ cm} \quad \textbf{Ans.}$$

The nearest choice available in question is 70 cm, at choice (*b*), which is marked as the correct choice. **Ans.**

Q19. Design discharge for canal

Rice Area to be irrigated = 1000 ha, B for Rice = 140 days and Δ for rice = 130 cm

Duty (D) for rice

$$= \frac{864\,B}{\Delta} = \frac{864 \times 140}{130}$$

$$= 930.46 \text{ ha/cumec}$$

Discharge reqd for above duty

$$= \frac{1000}{930.46} \text{ cumec} = \textbf{1.0747 cumec}$$

When the above discharge of canal is used for irrigating wheat crop of

$B = 119$ days $\qquad \Delta = 50$ cm.

Duty for wheat $(D) = \dfrac{864\,B}{\Delta} = \dfrac{864 \times 119}{50} = 2056.32$ ha/cumec.

The ha which can be irrigated by 1.0747 cumec.

$$= 2056.32 \times 1.0747 \text{ ha} = \textbf{2210 ha}$$

Hence, choice at (*d*) is correct. **Ans.**

Year 2003 (*Engineering Services*)

Q1. The worst condition of uplift on the floor of a siphon aqueduct occurs when there is

(*a*) high flood flow in the drainage with canal dry

(*b*) full supply flow in the canal with drainage dry

(*c*) high flood flow in the drainage with canal running full

(*d*) water is at drainage bed and canal is dry.

Q2. A check dam is a

(*a*) flood control structure (*b*) soil conservation structure

(*c*) river training structure (*d*) water storage structure.

Q3. Match List I (Well Hydraulics Parameters) with List II (Definition) and select the correct answer using the codes given below the Lists :

List I (Well Hydraulics Parameters)		*List II (Definition)*	
A	Specific yield.	1	Discharge per unit draw down of well.
B	Safe yield	2	Same as specific retention.
C	Specific capacity	3	Measure of water that can be removed by pumping.
D	Field capacity	4	Limit of withdrawal from well without depletion of the aquifier
		5	Water bearing capacity of aquifer.

Codes :

	A	B	C	D
(*a*)	4	3	2	2
(*b*)	3	4	1	2
(*c*)	4	3	1	2
(*d*)	3	4	2	5

Q4. Consider the following statements :

A well development

1. involves reversal of flow through the well screen
2. increases permeability towards the well
3. decreases permeability towards the well
4. is continued till sand/silt free water is pumped out

Which of these statements is/are correct ?

(*a*) 1, 3 and 4 (*b*) 1, 2 and 4

(*c*) 3 only (*d*) 1 and 4.

Q5. Leaching is a process

(*a*) by which alkali salts present in the soil are dissolved and drained away

(*b*) by which alkali salts in soil come up with water

(*c*) of draining excess water of irrigation

(*d*) which controls water-logging.

Q6. Directions

The following items consist of two statements, one labelled as the 'Assertion A' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

Codes :

(*a*) Both A and R are individually true and R is the correct explanation of A

(*b*) Both A and R are individually true but R is not the correct explaination of A

(*c*) A is true but R is false

(*d*) A is false but R is true.

(i) *Assertion (A)* : With tile lining of canals, permissible velocity of flow is lower than that with concrete lining.

Reason (R) : The surface of the lining becomes rough due to loss of surface material with high velocity.

(ii) *Assertion (A)* : Canal escape serves as a safety valve for a canal.

Reason (R) : Canal escape discharges the excess water in the parent canal due to sudden closure of outlets by farmers.

Q7. Which one of the following phenomena in a pipe flow is termed as water hammer ?

(*a*) The sudden rise of pressure in a long pipe due to sudden closure of valve

(*b*) the rise of a pressure in a pipe flow due to gradual closure of valve

(*c*) The rise of negative pressure

(*d*) The zero pressure in a pipe flow.

Q8. Flow duration curve is a plot of

(*a*) Flow against its time of occurrence in chronological order

(*b*) Flow in ascending order against percentage time in chronological order

(*c*) Flow that equalled or exceeded against percentage time

(*d*) Flow against duration of time for which it is sustained.

Q9*. Pondage in a hydropower station is defined as :

(*a*) impounding of considerable amount of excess water during seasons of surplus flow

(*b*) A regulating body of water in the form of relatively small amount of run-off to regulat flow variation in daily or weekly power requirements

(*c*) Excess run off to last for years

(*d*) Excess run off for a few hours only.

Q10. The specific speed of a turbine under a head of 150 m to develop 2000 HP while running at 300 rpm is

(*a*) 10—35 (*b*) 35—60

(*c*) 60—300 (*d*) 300—1000.

Q11. The moving average of annual precipitation record is carried out to determine

(*a*) Trend (*b*) Annual mean

(*c*) Extreme annual variation (*d*) Extreme seasonal variation.

Q12. Match List I (Hydrological Terms) with List II (Relationship/Nature of Curve) and select the correct answer using the codes given below the Lists :

List I (Hydrological Terms)		*List II (Relationship/Nature of Curve)*	
A	Theissen Polygon	1	Average depth of rainfall over an area
B	Mass Curve	2	Relationship of rainfall intensity and time
C	Hyetograph	3	Relationship of accumulated rainfall and time
D	DAD curve	4	Relationship of river run-off and time
		5	Always a falling curve.

Codes :	A	B	C	D
(*a*)	1	3	2	5
(*b*)	1	5	3	2
(*c*)	4	3	2	5
(*d*)	4	5	3	2

Q13. Match List I (Type of Precipitation) with List II (Principal Causes) and select the correct answer using the codes given below the Lists :

List I (Type of Precipation)		*List II (Principal Causes)*	
A	Convective	1	Atmospheric disturbance
B	Cyclonic	2	Mountain barrier
C	Frontal	3	Pressure difference
D	Orographic	4	Temperature difference
		5	Warm and cold air masses

Codes :

	A	B	C	D
(*a*)	1	4	5	2
(*b*)	4	3	5	2
(*c*)	1	4	2	5
(*d*)	4	3	2	5

Q14. Which one of the following characteristics describes a watershed system in system's parlance ?

(*a*) Linear (*b*) Non-linear

(*c*) Linear and time-invariant (*d*) Non-linear and time-variant.

Q15. A 6-hour storm with hourly intensities of 7, 18, 25, 12, 10 and 3 mm per hour produced a run-off of 33 mm. Then the ϕ_{index} is

(*a*) 7 mm/h (*b*) 3 mm/h (*c*) 10 mm/h (*d*) 8 mm/h.

Q16. A catchment area of 90 hectares has a run-off coefficient of 0.4. A storm of duration larger than the time of concentration of the catchment and of intensity 4.5 cm/hr creates a peak discharge rate of

(*a*) 11.3 m^3/s (*b*) 0.45 m^3/s (*c*) 450 m^3/s (*d*) 4.5 m^3/s.

Q17. Consider the following statements :

1. Time-area histogram method aims at developing an IUH
2. Isochrone is a line joining equal rainfall on a map
3. Linear reservoir is a reservoir having straight boundaries
4. Linear channel is a fictitious channel in which an inflow hydrograph passes through, with only translation and no attenuation.

Which of these statements are correct ?

(*a*) 1, 2 and 3 (*b*) 1 and 4

(*c*) 2, 3 and 4 (*d*) 1, 2, 3 and 4.

Q18. Match List I (Floods) with List II (Parameters) and select the correct answer using the codes given below the Lists :

	List I (Floods)		*List II (Parameters)*
A	Standard Project Flood (SPF)	1	Includes catastrophic floods
B	Maximum Probable Flood (MPF)	2	Includes floods of severe conditions
C	Design Flood	3	Peak flow obtained from observed data
D	Maximum Flood	4	Flood of desired recurrence interval

Codes :

	A	B	C	D
(*a*)	2	1	4	3
(*b*)	1	2	3	4
(*c*)	2	1	3	4
(*d*)	1	2	4	3

Q19. Which of the following pairs are correctly matched ?

1. Silt factor : Average size of silt particle.
2. Silt load : Volume of suspended sediments flowing with water in unit time.
3. Silt charge : Weight of silt per unit volume of water
4. Silt grade : Gradation between different silt particles

Select the correct answer using the codes given below :

Codes

(*a*) 1 and 4 (*b*) 3 and 4 (*c*) 2 and 3 (*d*) 1 and 2.

Q20. Consider the following statements :

The function of a cut-off in an earth dam is to

1. Reduce uplift pressures on the dam
2. Prevent undermining of foundation
3. Reduce loss of stored water
4. Support the dam

Which of these statements are correct ?

(*a*) 1 and 3 (*b*) 2 and 4 (*c*) 2 and 3 (*d*) 3 and 4.

Q21. Match List I (Theory) with List II (Propounded By) and select the correct answer using the codes given below the Lists :

List I (Theory)	*List II (Propounded By)*
A Exit gradient	1 G. Lacey
B Alluvial canal	2 L.K. Sherman
C Unit hydrograph	3 A.N. Khosla
D Boundary layer	4 C. Inglis
	5 T.V. Karman
	6 L. Prandtl

Codes :

	A	B	C	D
(*a*)	1	3	2	6
(*b*)	6	2	3	5
(*c*)	3	1	2	6
(*d*)	3	1	4	2

Q22. The ideal condition for energy dissipation in the design of spillways is the one when the tail water rating curve

(*a*) Lies above jump curve at all discharges

(*b*) Coincides with the jump rating curve at all discharges

(*c*) Lies below jump rating curve at all discharges

(*d*) Lies either above or below the jump rating curve depending upon discharge.

ANSWERS

1. (*d*)	**2.** (*b*)	**3.** (*b*)	**4.** (*b*)	**5.** (*a*)
6. (*i*)-(*a*), (*ii*)-(*a*)		**7.** (*a*)	**8.** (*c*)	**9.** (*b*)
10. (*a*)	**11.** (*a*)	**12.** (*a*)	**13.** (*b*)	**14.** (*c*)
15. (*d*)	**16.** (*d*)	**17.** (*b*)	**18.** (*a*)	**19.** (*c*)
20. (*c*)	**21.** (*c*)	**22.** (*b*)		

Hints for Solving Starred Quetions of the Year 2003

Q9. As pointed out in article 24.2.1, run-off river plants installed on main rivers or on diversion canals are usually provided with a small storage to meet the short term fluctuations of the water requirement of the plant. A balancing reservoir to store excess stream flow during periods of low consumption in the power house during off peak hours or days, and for its release during excess load periods, is essentially required in all such low head power development schemes. Such a balancing reservoir of small capacity, called a *pond*, is hence required near the power house.

In case of a power plant located on the river, the main weir itself provides on its upstream side the required pondage ; while in the case of a plant located on a diversion canal (power canal) the pond is required to be created at the end of the canal in the form of a **foreway reservoir**, from which the penstock pipes shall lead the water into the power house, as shown in Fig. 24.2 (*b*). No matter where the pond is located, its capacity has to be worked out considering the inflow and outflow patterns, just as in the case of

storage reservoirs. As a matter of fact, the storage reservoirs provide storage of water for long term requirements, whereas, the *pondage* takes care of the hour to hour fluctuations over a day, or occassionally, day to day fluctuations over a weekly cycle. Provision of pondage ensures that the desired instantaneous rate of flow into the turbines under day to day changing conditions of power load as well as of inflow.

Short term fluctuations may arise due to the following reasons :

(*i*) The power consumption and hence the load on turbines may suddenly increase or decrease, needing in a few seconds either excess or lesser water, respectively. This change in water demand of the power house can be immediately met by the stored water available in the pond created for this purpose. This pond would provide extra water when needed, and retain excess flow when not needed in the plant.

(*ii*) The power load and, thus, the water demand of the power house, may be steady, but the supply of water may undergo a change. In natural streams, where some other power house is located on the upstream, the available flow may change depending upon the quantity of water released from the upstream power house.

Similarly, if the power house in question is located on a diversion channel, the inflow into the power house may get affected due to some breach(es) that may occur in the said diversion canal.

(*iii*) The water demand of turbines and the natural flow (supply) may change from time to time.

The pondage, in some cases, may also be provided for weekly demands. In most of the advanced countries, the free weekends result in decreased demand of power, reducing the water need of the given power house. The inflow during this period could be ponded for use during week days.

Year 2004 (*Engineering Services*)

Q1.* Which one of the following defines aridity index (*AI*) ?

(*a*) $AI = \frac{PET - AET}{PET} \times 100$ (*b*) $AI = \frac{PET}{AET} \times 100$

(*c*) $AI = \frac{AET}{PET} \times 100$ (*d*) $AI = \frac{AET - PET}{AET} \times 100$

Q2. In Snyder's method of synthetic unit hydrograph development, basin lag is taken as

(*a*) the time interval between centroid of the rainfall excess and surface runoff
(*b*) the time interval from mid point of the unit rainfall excess to the peak of the unit hydrograph
(*c*) independent of rainfall duration
(*d*) independent of catchment characteristics.

Q3. Which one of the following is the correct sequence in the increasing order of the Froude number of flow assumed by the bed form of an alluvial stream with movable bed material ?

(*a*) Ripple — Plane bed — Dune — Plane bed — Antidune
(*b*) Dune — Ripple — Plane bed — Antidune — Plane bed
(*c*) Plane bed — Ripple — Dune — Plane bed — Antidune
(*d*) Plane bed — Ripple — Antidune — Dune — Plane bed.

Q4. A bridge has an expected life of 50 years and is designed for a flood magnitude of return period 100 years. What is the risk associated with this hydrologic design ?

(*a*) $1 - (0.99)^{50}$ (*b*) $(0.5)^{50}$ (*c*) $(0.99)^{50}$ (*d*) $(0.99)^{100}$

Q5. Match List-I with List-II and select the correct answer using the codes given below the lists :

	List I		*List II*
A	Rising limb of a hydrograph.	1	Depends on intensity of rainfall
B	Falling limb of a hydrgraph	2	Function of total channel length
C	Peak rate of flow	3	Function of catchment slope
D	Drainage density	4	Function of storage characteristics

Codes :

	A	B	C	D
(*a*)	3	4	1	2
(*b*)	1	4	3	2
(*c*)	3	2	1	4
(*d*)	1	2	3	4

Q6. Match List-I with List-II and select the correct answer using the codes given below the lists :

	List I		*List II*
A	Unit hydrograph	1	Design flood
B	Synthetic unit hydrograph	2	Pemeability
C	Darcy's law	3	Ungauged basin
D	Rational method	4	1 cm runoff

Codes :

	A	B	C	D
(*a*)	2	3	4	1
(*b*)	2	1	4	3
(*c*)	4	3	2	1
(*d*)	4	1	2	3

Q7. Which one of the following statements is correct in respect of the two important aspects of flood forecast — (1) reliability of the forecast, and (2) the time available in between the forecast and the occurrence of flood ?

(*a*) Meteorological forecast is least reliable and time available is also the least

(*b*) Hydrological forecast is most reliable but the time available is the least

(*c*) River forecast is least reliable and the time available is the maximum

(*d*) River forecast is most reliable but the time available is the least.

Q8. The delta for a crop having base period 120 days is 70 cm. What is the duty ?

(*a*) 2480 hectare/cumec (*b*) 1481 hectare/cumec

(*c*) 148 hectare/cumec (*d*) 1.481 hectare/cumec.

Q9. For a culturable command area of 1000 hectare with intensity of irrigation of

50%, the duty on field for a certain crop is 2000 hectare/cumec. What is the discharge required at head of water course with 25% losses of water ?

(*a*) 3/16 cumec (*b*) 1/4 cumec
(*c*) 1/3 cumec (*d*) 1/2 cumec.

Q10. What is the moisture depth available for evapotranspiration in root zone of 1 m depth soil, if dry weight of soil is 1.5 gm/cc, field capacity is 30% and permanent wilting point is 10% ?

(*a*) 450 mm (*b*) 300 mm
(*c*) 200 mm (*d*) 150 mm.

Q11. Which one of the following correctly defines aquiclude ?

(*a*) A saturated formation of earth material which not only stores water but also yields it in sufficient quantity

(*b*) A formation through which only seepage is possible and thus the yield is insignificant compared to an aquifer

(*c*) A geological formation which is neither porous nor permeable

(*d*) A geological formation which is essentially impermeable to the flow of water.

Q12. What is the regime scour depth for a channel in soil with silt factor of unity and carrying 8 m^2/s of discharge intensity in accordance with Lacey's regime theory ?

(*a*) 3.6 m (*b*) 4 m
(*c*) 5.4 m (*d*) 25.6 m.

Q13. Which one of the following equations represents the downstream curve of the "Ogee" spillway (where x and y are the co-ordinates of the crest profile measured from the apex of the crest and H is the design head) ?

(*a*) $x^{1.85} = 2H^{0.85}y$ (*b*) $x = 2H^{1.85}\, y^{0.85}$
(*c*) $x^{0.85} = 2H^{1.85}y$ (*d*) $x = 2H^{0.85}y^{1.85}$.

Q14.* Clark's method aims at which one of the following :

(*a*) Developing an IUH due to an instantaneous rainfall excess over a catchment

(*b*) Developing stage-discharge relationship

(*c*) Measurement of infiltration

(*d*) Flood routing through channels.

Q15.* For a saddle siphon, the maximum operative head is 6.25 m. The width and height of the throat of the siphon are 4 m and 2 m respectively. The coefficient of discharge is 0.90. How many units are required to pass a flood of 300 cumec ? (Take $g = 10$ m/s^2)

(*a*) One (*b*) Two
(*c*) Three (*d*) Four.

ANSWERS

1. (*a*)	**2.** (*b*)	**3.** (*c*)	**4.** (*a*)	**5.** (*a*)
6. (*c*)	**7.** (*d*)	**8.** (*b*)	**9.** (*c*)	**10.** (*b*)
11. (*d*)	**12.** (*c*)	**13.** (*a*)	**14.** (*a*)	**15.** (*d*).

Hints for Solving Sterred Questions of the Year 2004

Q1. Aridity Index, as its name implies, is an indicator of the dryness (aridness) of a soil/crop, due to which the plants do not get their full required quantity of water upto the field capacity. The max. available moisture [*i.e.* Field capacity *mc* – Wilting point *mc*], thus, does not become available to the crops, which reduces their actual evapotranspiration (*AET*) in comparison to the potential (*i.e.* maximum) evapotranspiration (*PAT*). The deficiency in evapotranspiration [*i.e.* (*PAT* – *AET*)] when expressed as the ratio with *PAT* is, hence, defined as the *Aridity Index*. Thus,

$$\text{Aridity Index} = AI = \frac{PAT - AET}{PAT}\ (\%)$$

Thus, if *PAT* is 80 mm and *AET* is 20 mm, then, naturally, the crops will be facing $\frac{80-20}{80} = 75\%$ dry conditions, since the aridity index is 75%.

Hence, choice (*a*) is correct. **Ans.**

Q14. Clark's method is one of those methods, which are used for computing an *Instantaneous Unit Hydrograph (IUH)*. Since an *IUH* is a concept of advanced Hydrology, we have not discussed it in our text. However, an IUH is explained below in brief.

Instantaneous Unit Hydrograph (IUH). The ordinary *UH*, as you know by now, is obtained from an excess rainfall (*ER*) of 1 cm magnitude uniformally falling during a time period of *T* hour, with an intensity equal to $\frac{1}{T}$ cm/h. If this rain duration (*T*) is progressively decreased, its intensity will go on increasing, and the resulting unit hydrograph will become more skewed, as shown in Fig. 32.3 by hydrograph marked 2. The hydrographs will go on becoming more skewed with progressively reduced value of *T*, as shown by unit graphs marked 3 and 4. A more skewed but certainly of finite shape unit hydrograph will finally be obtained, when the rainfall duration *T* is made infinitely small ($T \to 0$). This limiting case of a unit hydrograph produced by a rainfall of 1 cm in zero hr time, is called an *instantaneous unit hydrograph (IUH)*. Of course, this is only a theoretical concept, because 1 cm of rain cannot fall in zero hr time on any catchment, *but is useful because such a unit graph represents the watershed response to any amount of rainfall excess without reference to the duration of the*

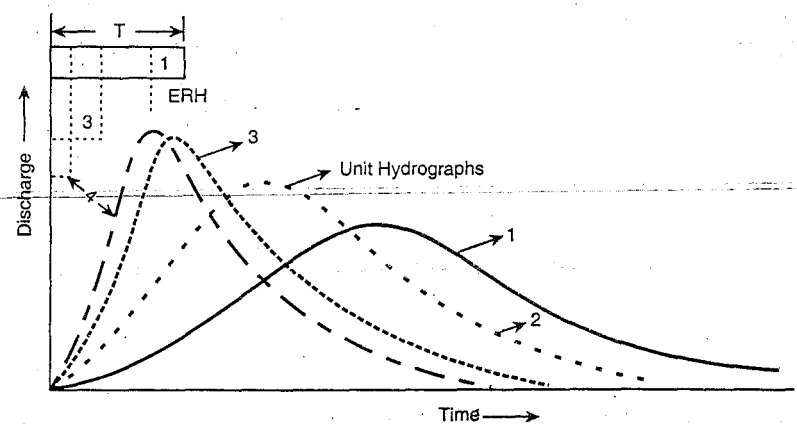

Fig. 32.3. Some Typical Unit Hydrographs.

rainfall. An *IUH*, being independent of rainfall characteristics, is indicative of the storage characteristics of a catchment, and is eminently suitable for theoretical analysis of effective rainfall-runoff relationship of a catchment.

The ideal shape of an IUH resembles that of a single-peaked direct runoff hydrograph (*DRH*) with a finite base width ; yet however, an *IUH* can have negative and undulating ordinates.

The *IUH* for a catchment can be derived from a given *ERH* (Excess rain hydrograph) and *DRH* (Direct runff hydrograph) by several methods. Say for example, the ordinate of an *IUH* at any time *t* has been shown to be equal to the slope at time *t* of the *S*-curve caused by an excess rain of intensity 1 cm/h (*i.e. S*-curve derived from a *UH* of 1-h duration). The *IUH* so obtained is, infact, an approximate one, because the slope of *S*-curve is difficult to be measured accurately.

Mathematical solutions evolved for determining *IUH* include. Laplace transform (chow 1964), Fourier transform (Black and others, 1971) and *Z*-transform (Bree 1978). These methods involve mathematical modelling related to watershed geomorphology, harmonic analysis, etc. which are beyond the scope of this book.

A comparatively easier method for developing an *IUH* has been evolved by Clark, and is hence known as the *Clark's method* or **Time-area histogram method.** This method aims at developing an *IUH* due to an instantaneous excess rainfall over a catchment. It is assumed that the rainfall excess first undergoes pure *translation* (channel movement) in the catchment, and then *attenuation* (reduced peak and elongated time base) as in reservoir routing. The translation is computed upto the catchment outlet by a travel time-area histogram (by ignoring the storage of the catchment) ; while the attenuation is computed by routing the result of the above, through a hypothetically available linear reservoir at the catchment outlet, to account for the storage in the catchment. A detailed description of the computations is beyond the scope of this book.

Q15. From Eq. (21.13), discharge through a saddle syphon is given as ;

$$Q = C_d \cdot A \cdot \sqrt{2gH_1}$$

where $C_d = 0.9$

A = Area of flow width × Ht. of Throat

$= 4 \text{ m} \times 2 \text{ m} = 8 \text{ m}^2$ (given)

$g = 10 \text{ m}^3/\text{s}$ (given)

$H_1 = 6.25$ m (given)

$$\therefore \qquad Q = 0.9 \times 8\sqrt{2 \times 10 \times 6.25} = \mathbf{80.5\ m^3/s.}$$

Total discharge = 300 cumec (given)

No. of units of saddle syphon $= \dfrac{300}{80.5} = 3.73$; Say 4.

Hence, choice (*d*) is correct. **Ans.**