5 CHAPTER

Surface Water Hydrology (Runoff)

Q.1 A mean annual runoff of 1 m^3/s from a catchment of area 31.54 km^2 represents an effective rainfall of
(a) 100 cm (b) 1.0 cm
(c) 100 mm (d) 3.17 cm

Q.2 Direct runoff is made up of
(a) Surface runoff, prompt interflow and channel precipitation
(b) Surface runoff, infiltration and evapotranspiration
(c) Overland flow and infiltration
(d) Rainfall and evaporation

Q.3 The term base flow denotes
(a) delayed groundwater flow reaching a stream
(b) delayed groundwater and snowmelt a stream
(c) delayed groundwater and interflow
(d) the annual minimum flow in a stream

Q.4 The water year in India starts from the first day of
(a) January (b) April
(c) June (d) September

Q.5 The total rainfall in a catchment of area 1200 km^2 during a 6 h storm is 16 cm while the surface runoff due to the storm is 1.2×10^8 m^3. The ϕ-index is
(a) 0.1 cm/h
(b) 1.0 cm/h
(c) 0.2 cm/h
(d) cannot be estimated with the given data

Q.6 In India, a meteorological subdivision is considered to be affected by moderate drought if it receives a total seasonal rainfall which is
(a) less than 25% of normal value
(b) between 25% and 49% of normal value
(c) between 50% and 74% of normal value
(d) between 75% and 99% of normal value

Q.7 An area is classified as a drought prone area the probability P of occurrence of a drought is
(a) $0.4 < P \leq 1.0$ (b) $0.2 \leq P \leq 0.40$
(c) $0.1 \leq P < 0.20$ (d) $0.0 < P < 0.20$

Q.8 Runoff increases with
(a) increase in infiltration capacity
(b) increase in intensity of rain
(c) increase in permeability of soil
(d) all of these

Q.9 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 the storm is 3 cm, then the value of f-index will be
(a) 2.212 cm/hr (b) 2.331 cm/hr
(c) 2.412 cm/hr (d) 2.533 cm/hr

Q.10 A 6 hours storm had 4 cm of rainfall and the resulting runoff was 2 cm. If f 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

Q.11 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 run-off volume in ha-m will be
(a) 16 (b) 22
(c) 1600 (d) 2200

Q.12 Khosla's formula for monthly runoff R_m due to a monthly rainfall P_m is $R_m = P_m - L_m$, where L_m is
(a) a constant
(b) monthly loss and depends on the mean monthly catchment temperature
(c) a monthly loss coefficient depending on the antecedent precipitation index
(d) a monthly loss depending on the infiltration characteristics of the catchment

Q.13 If in a flow-mass curve, a demand line drawn tangent to the lowest point in a valley of the curve does not intersect the mass curve at an earlier time period, it represents that
(a) the storage is inadequate
(b) the reservoir will not be full at the start of the dry period
(c) the reservoir is full at the beginning of the dry period
(d) the reservoir is wasting water by spill

Q.14 The drainage area of a basin is
(a) the surface area of the land enclosed within the divide
(b) the vertical projection of the area enclosed within the divide
(c) the horizontal projection of the area enclosed within the divide
(d) is a fictitious area arbitrarily assigned to a stream

Q.15 The drainage density is the
(a) average length of the streams per unit drainage area within the basin
(b) stream discharge per unit drainage area
(c) annual runoff per unit drainage area
(d) number of streams per unit drainage area

Q.16 When an accumulated mass of snow melts, the resulting flow entering a stream is classified as
(a) direct runoff (b) base flow
(c) subsurface flow (d) interflow

Q.17 An intermittent river
(a) carries water only after rains
(b) carries water only after snowmelt
(c) carries water most of the time but ceases to flow occasionally
(d) carries water all the time except during extreme droughts

Q.18 In an influent stream
(a) there is a contribution from the groundwater to the stream due to seepage
(b) there is a contribution from the stream to the groundwater due to percolation
(c) there is a seepage of groundwater into the stream at the sides and percolation of stream flow water at the bed
(d) there will be neither seepage into the stream nor percolation from the stream to the groundwater

Q.19 In an effluent stream
(a) there will be contribution from the groundwater into the stream due to seepage
(b) there is a contribution from the stream to the groundwater
(c) there will be neither an inflow of groundwater into the stream nor an outflow of stream water by percolation
(d) the water surface is always above the water table

Q.20 Streams intersecting the water table, and receiving flow from the groundwater are known as
(a) influent streams
(b) effluent streams
(c) ephemeral streams
(d) subsurface streams

Q.21 The rainfall is 10 mm/hr on an area of one hectare. The runoff value will be equal to
(a) 100 m^3/hr (b) 10 m^3/hr
(c) 1000 m^3/hr (d) 1 m^3/hr

Q.22 The peak of a 6-hr unit hydrograph for a particular basin is 36 m^3/s. The flood peak observed due to a 6-hr storm was 150 cumecs. Assume a constant base flow of 6 cumecs and an average storm loss of 6 mm/hr. The depth of storm rainfall is:
(a) 3.6 cm (b) 4.3 cm
(c) 5.2 cm (d) 7.6 cm

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Answers Surface Water Hydrology (Runoff)

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

Explanations Surface Water Hydrology (Runoff)

1. (a)
Effective rainfall

$$= \frac{1\times24\times60\times60\times365}{31.54\times10^6}$$

$$= 0.999\ \text{m} \simeq 1\ \text{m} = 100\ \text{cm}$$

5. (b)

$$P = 0.16\ \text{m}$$

$$R = \frac{1.2\times10^9}{1200\times10^6} = 0.1\ \text{m}$$

$$\phi = \frac{0.16-0.1}{6} = 0.01\ \text{m/h} = 1\ \text{cm/h}$$

8. (b)
If infiltration capacity or permeability of soil increases, then run-off will decrease. But if intensity of rain increases then run-off will increase.
Hence option (b) is correct.

9. (d)
Total rainfall = 3.5 + 4.2 + 2.9 = 10.6 cm

$$\therefore\ \phi\text{-index} = \frac{10.6-3}{3} = 2.53\ \text{cm/hr}$$

10. (b)

$$\phi\text{-index} = \frac{4-2}{6} = \frac{1}{3}\ \text{cm/hr}$$

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

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

$$\therefore\ \text{Runoff} = 6\ \text{cm}$$

11. (c)
Total rainfall = 6.2 + 5 = 11.2 cm
∴ Runoff = 11.2 – 1.2 × 4 = 6.4 cm
Hence, runoff volume

$$= \frac{6.4}{100}\times250\times10^2\ \text{ha-m}$$

$$= 1600\ \text{ha-m}$$

12. (b)
L_m is a monthly loss coefficient and is equal to 0.48 T_m for $T_m > 4.5°C$.

18. (b)
If the bed of the stream is below the groundwater table, during period of low flows in the stream, the water surface may go down below the general water table elevation and the groundwater contributes to the flow in the stream such stream which receive groundwater flow are called effluent stream water percolates to the groundwater storage and a hump is formed in the groundwater table. Such streams which contribute to the groundwater are known as influent streams.

21. (a)

$$\text{Runoff} = 10\ \text{mm/hr} \times 1 \times 10^4\ \text{m}^2$$

$$= 10 \times 10^{-3} \times 10^4 = 100\ \text{m}^3\text{/hr}$$

22. (d)
Direct run-off peak = Flood peak – Base flow
= 150 – 6 = 144 cumecs

$$P_{net} = \frac{DRO_{peak}}{UG_{peak}} = \frac{144}{36} = 4\ \text{cm}$$

Depth of storm rainfall,

$$P = P_{net} + \text{losses}$$

$$P = 4 + 0.6 \times 6 = 7.6\ \text{cm}$$

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