CLASS TEST

S.No.: 01_SK_CE_EFGHI_180825

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ENGINEERING HYDROLOGY

CIVIL ENGINEERING

Date of Test : 18/08/2025

ANSWER KEY

1.	(a)	7.	(c)	13.	(c)	19.	(d)	25.	(d)
2.	(c)	8.	(c)	14.	(a)	20.	(b)	26.	(c)
3.	(a)	9.	(d)	15.	(c)	21.	(a)	27.	(d)
4.	(a)	10.	(b)	16.	(d)	22.	(a)	28.	(a)
5.	(a)	11.	(c)	17.	(b)	23.	(c)	29.	(c)
6.	(a)	12.	(a)	18.	(c)	24.	(c)	30.	(b)

DETAILED EXPLANATIONS

1. (a)

The rising limb of a hydrograph is also known as concentration curve and it represents the increase in discharge due to the gradual building up of storage in channels and over the catchment surface.

4. (a)

Since variation is more than 10%,

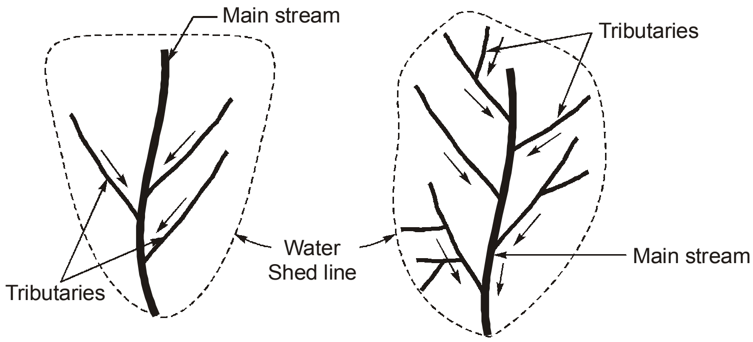
$$P_x = \frac{105}{3}\left[\frac{156}{155}+\frac{140}{150}+\frac{104}{120}\right] = 98.2 \text{ cm}$$

5. (a)

$$Q_{\text{equilibrium}} = 2.78\frac{A}{T}$$

$$= 2.78\times 360\times\frac{1}{4} \simeq 250\,\text{cumecs}$$

6. (a)



(Fan Shaped Catchment) (Fern Leaf Catchment)

7. (c)

The limiting case of a UH of zero duration is known as IUH (Instantaneous Unit Hydrograph). The ordinate of one IUH at any time '*t*' is the slope of *S*-curve of intensity 1 cm/hr.

8. (c)

(ii) Soluble salts when dissolved in water leads to decrement in rate of evaporation.

(iii) A deep water body/lake may store radiation energy received in summer and release it in winter causing less evaporation in summer and more evaporation in winter compared to a shallow lake exposed to a similar situation.

10. (b)

Drizzle is a fine sprinkle of numerous water droplets of size less than 0.5 mm and intensity less then 1 mm/hr.

11. (c)

$$\text{Peak of DRH} = 135 - 10 = 125 \text{ m}^3/\text{s}$$

$$P = 54 \text{ mm}, \quad \phi = 4 \text{ mm/hr}$$

$$\therefore \quad n = P - \phi \times t = 54 - 4 \times 1 = 50 \text{ mm} = 5 \text{ cm}$$

$$\therefore \quad \text{Peak of 1 hr. UH} = \frac{125}{5} = 25 \text{ m}^3/\text{s}$$

12. (a)

$$n = 2 + 3 = 5 \text{ cm}$$

For DRH, $(\Sigma O) = (1 + 7 + 26 + 37 + 27 + 13 + 1) - 7 = 105$

$$n = \frac{0.36 \sum Ot}{A}$$

$$\Rightarrow \quad A = \frac{0.36 \times 105 \times 1}{5} = 7.56 \text{ km}^2$$

13. (c)

$$P = 5 \times 2 = 10 \text{ cm}$$

$$= 10 \times 10^{-2} \times 100 \times 10^4 = 10^5 \text{ m}^3$$

$$R = 1 \text{ m}^3/\text{s} \times 10 \times 60 \times 60 = 36000 \text{ m}^3$$

$$\therefore \quad \text{Runoff coefficient} = \frac{R}{P} = \frac{36000}{10^5} = 0.36$$

14. (a)

Time (hr)	4-*h* UH (m^3/s)	*S*-curve addition	*S*-curve	Offset *S*-curve	Δy	6-*h* UH = ($\Delta y \times 4/6$)
0	0	–	0	–	0	0
2	9	–	9	–	9	6
4	20	0	20	–	20	13.33
6	35	9	44	0	44	29.33
8	43	20	63	9	54	36
10	22	44	66	20	46	30.67
		63		44		
		66		69		
				66		

15. (c)

(i) Mean rainfall, $(\bar{P}) = \frac{\sum P}{n} = \frac{800 + 620 + 400 + 560}{4} = 595 \text{ mm}$

(ii) Standard deviation, $\sigma = \sqrt{\frac{(P - \bar{P})^2}{n - 1}} = 165.23$

(iii) Coefficient of variation, $c_v = \frac{100\sigma}{\bar{P}} = \frac{100 \times 166.93}{595} = 27.77$

(iv) Optimum number of rain gauges, $(N) = \left(\frac{c_v}{\epsilon}\right)^2 = \left(\frac{28.29}{10}\right)^2 \Rightarrow 7.7113 \approx 8 \text{ Nos}$

(v) Additional gauges required to be installed

$= 8$ – Existing 4 gauges $= 8 - 4 = 4$

16. (d)

Peak flow $= 270 \text{ m}^3/\text{s}$

Base flow $= 30 \text{ m}^3/\text{s}$

Peak flow of resulting DRN $= 270 - 30 = 240 \text{ m}^3/\text{s}$

Given that, $P = 4$, $\phi = 0.5$ cm/hr, $t = 4$hr

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

$$0.5 = \frac{4 - R}{4}$$

$$R = 2 \text{ cm}$$

We know that, $$\frac{UH}{DRN} = \frac{1}{R}$$

$$\frac{UH}{240} = \frac{1}{2}$$

$$UH = 120 \text{ m}^3/\text{s}$$

17. (b)

$$\text{Loss} = \text{Rainfall} - \text{Runoff} = \frac{0.8}{100}\times 6 - \frac{256000}{8.6\times 10^6} = 0.01823 \text{ m} = 1.823\,\text{cm}$$

$$\text{Rate of loss} = \frac{1.823}{6} = 0.304\,\text{cm/hr}$$

19. (d)

Given return period, $T = 50$ years

$$P = \frac{1}{T} = \frac{1}{50}$$

And $$q = 1 - \frac{1}{50}$$

Here binominal distribution is followed.

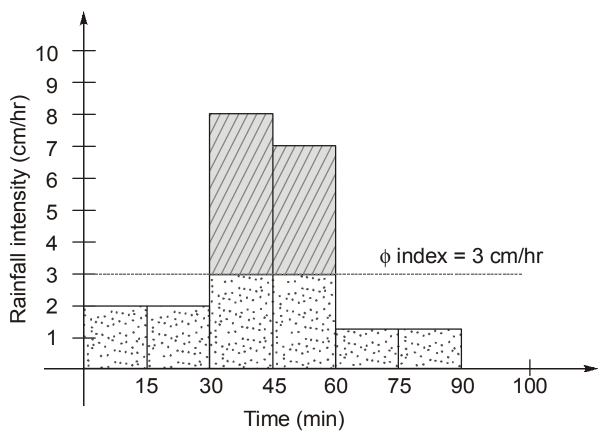
The binomial distribution can be used to find the probability of occurrence of the event occurring r times in n successive years. Thus

$$P_{r,\,n} = n_{C_r} P_r q^{n-r}$$

Here, $n = 16$, $r = 2$

$$P = {}^{16}C_2\left(\frac{1}{50}\right)^2\left(\frac{49}{50}\right)^{14}$$

20. (b)



Hatched portion shows the total runoff and dotted portion shows the total infiltration.

$$\therefore \quad \text{Total runoff} = (8-3)\times\frac{15}{60} + (7-3)\times\frac{15}{60} = \left[(8-3)+(7-3)\right]\times\frac{15}{60} = 2.25\,\text{cm}$$

$$\text{Total precipitation} = 2\times\frac{15}{60} + 2\times\frac{15}{60} + 8\times\frac{15}{60} + 7\times\frac{15}{60} + 1.25\times\frac{15}{60} + 1.25\times\frac{15}{60}$$

$$= (2+2+8+7+1.25+1.25)\times\frac{15}{60} = 5.375 \text{ cm}$$

$$W\text{-index} = \frac{\text{Total precipitation} - \text{Runoff}}{\text{Duration of rainfall in hr}} = \frac{5.375 - 2.25}{90/60}$$

$$= 2.083 \text{ cm/hr} \simeq 2.08 \text{ cm/hr}$$

22. (a)

Given: $N = 8, \sigma = 8$ cm, $E = 10\%$

We know that $N = \left(\frac{C_v}{E}\right)^2$

$$8 = \left(\frac{C_v}{E}\right)^2$$

$$C_v = 10 \times \sqrt{8} = 10 \times 2\sqrt{2}$$

$$C_v = \frac{\sigma}{\mu} \times 100$$

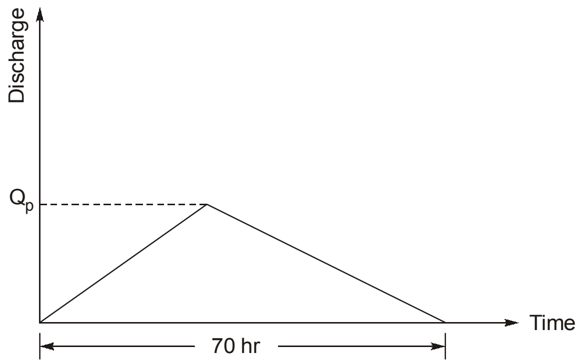
$$\mu = \frac{\sigma}{C_v} \times 100$$

$$\mu = \frac{8}{10 \times 2\sqrt{2}} \times 100 = \frac{40}{\sqrt{2}} = 20\sqrt{2}$$

24. (c)

Let the peak of the UH be Q_P.

The UH can be shown as



Area of DRH gives the volume of rainfall,

$$\frac{1}{2} \times 70 \times 60 \times 60 \times Q_P = \frac{1}{100} \times 756 \times 10^6$$

$\Rightarrow$ $Q_p = 60 \text{ m}^3/\text{s}$

$\therefore$ Peak of DRH $= n \times$ peak of UH $= 5 \times 60 = 300 \text{ m}^3/\text{s}$

25. (d)

Total rainfall = 0.5 + 1.8 + 2.9 = 5.2 cm

Infiltration = 5.2 – 2 = 3.2 cm

Excess rainfall duration, t_e = 2 × 3 = 6 hrs.

$$\phi\text{-index} = \frac{3.2}{6} = 0.533 \text{ cm/hr}$$

This value being more than 0.5 cm/hr,

The excess rainfall duration will reduce by 2 hrs.

$$\therefore \quad t_e = 4 \text{ hrs.}$$

$$\text{Infiltration} = (1.8 + 2.9) - 2 = 2.7 \text{ cm}$$

$$\phi\text{-index} = \frac{2.7}{4} = 0.675 \text{ cm/hr}$$

26. (c)

$$\bar{x} = \frac{1}{n}\Sigma n_i = \frac{80+90+100+60+70}{5} = 80 \text{ cm}$$

The standard deviation of the rainfall is given by

$$\sigma = \sqrt{\frac{(x-\bar{x})^2}{n-1}}$$

$$\sigma = 15.81$$

$$\Rightarrow \quad C_V = \frac{\sigma}{\bar{x}} \times 100 = 19.76$$

$$N = \left(\frac{C_V}{\epsilon}\right)^2 = \left(\frac{19.76}{6}\right)^2 = 10.85 \simeq 11$$

Thus, additional number of rainguages = 11 – 5 = 6

27. (d)

Time base of both the unit hydrographs is same. Let it be t.

$$\therefore \quad \frac{1}{2}\times 30 \times t \times \frac{1}{235} = \frac{1}{2}\times 90 \times t \times \frac{1}{A_2}$$

$$\Rightarrow \quad A_2 = 235 \times 3$$

$$\Rightarrow \quad A_2 = 705 \text{ km}^2$$

28. (a)

The calculations are tabulated below:

Time (hr)	FH (m^3/s)	Base Flow (m^3/s)	DRH (m^3/s)
Col. (1)	*Col.* (2)	*Col.* (3)	*Col.* (4)
0	5	5	0
12	15	5	10
24	40	5	35
36	80	5	75
48	60	5	55
60	50	5	45
72	25	5	20
84	15	5	10
96	5	5	0
			$\Sigma O = 250$

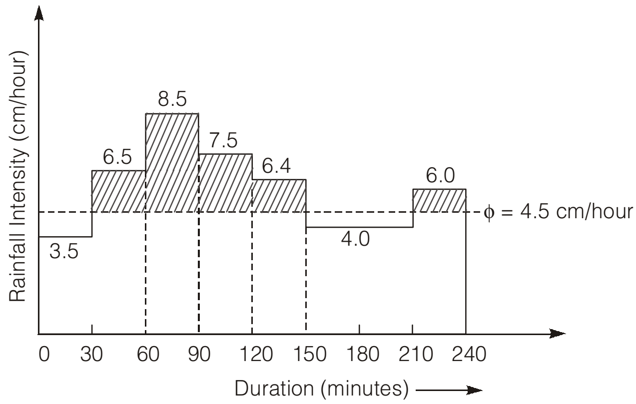
$$\text{Base flow} = 5 \text{ m}^3/\text{sec}$$

$$\text{Now, direct runoff depth, } DRD = \frac{0.36 \times \Sigma O \times t}{A}$$

where $\Sigma O = 250 \text{ m}^3/\text{s}$; $t = 12$ hr; $A = 450 \text{ km}^2$

$$\therefore \qquad DRD = \frac{0.36 \times 250 \times 12}{450} = 2.4 \text{ cm}$$

29. (c)



Rainfall excess is shown by hatched area.

Total rainfall

$$P = (3.5+6.5+8.5+7.5+6.4+4.0+4.0+6.0)\times\frac{30}{60} = 23.2 \text{ cm}$$

Total rainfall excess

$$R = [(6.5-4.5)+(8.5-4.5)+(7.5-4.5)+(6.4-4.5)+(6.0-4.5)]\times\frac{30}{60}$$

$$= (2+4+3+1.9+1.5)\times\frac{1}{2} = 6.2\,cm$$

$$W\text{-index} = \frac{P-R}{t} = \frac{23.2-6.2}{4} = 4.25 \text{ cm/hour}$$

30. (b)

Given that rainfall intensity = 1 cm/hr

For S-curve rainfall intensity, $\frac{1}{D} = 1$

$\Rightarrow \qquad D = 1$ hr

We, $\qquad Q_e = \frac{2.778A}{D}$ = Equilibrium discharge

At $\qquad t = \infty, \theta = Q_e$

$Q = 2 - (1 + t)e^{-3t}$

$t = \infty$

$Q = 2 - (3 + e)e^{-3 \times \infty}$

$Q_e = 2 \text{ m}^3/\text{s}$

$$2 = 2.778\frac{A}{1}$$

$A = 0.7199 \text{ km}^2 = 71.99 \text{ ha} \approx 72 \text{ ha}$

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