CLASS TEST

Sl. : 02IGCE_DEF_13082024

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HYDROLOGY

CIVIL ENGINEERING

Date of Test : 13/08/2024

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (a)

2. (d)

A 12-hour unit hydrograph will be obtained by adding the ordinates of 6-hour UH and ordinates of 6-hour UH are lagged by 6 hours and then dividing the resulting ordinates by 2. So the base period for 12-hour UH will be

$$84 + 6 = 90 \text{ hours}$$

3. (b)

$$\text{Risk} = 1-(1-P)^{100}$$

$$= 1-\left(1-\frac{1}{100}\right)^{100} = 0.634 \simeq 64\%$$

4. (b)

For linear reservoir, $S = kQ$

The storage varies linearly with outflow discharge.

5. (a)

$$Q = \frac{1}{36} kp_c A$$

$$= \frac{1}{36}\times 1\times 3\times 7.2 \qquad [k = 1 \text{ impervious}]$$

$$= 0.6 \text{ m}^3/\text{s}$$

6. (d)

7. (c)

The equilibrium discharge is expressed as

$$Q_s = \frac{A}{D}\times 10^4 \text{ m}^3/\text{h}$$

where A is area of catchment in km^2 and D is duration in hours.

$$\therefore \quad Q_s = \frac{360}{5}\times 10^4 = 72\times 10^4 \text{ m}^3/\text{h}$$

$$= \frac{72\times 10^4}{3600} m^3/s = 200 \text{ m}^3/\text{s}$$

8. (c)

$$\phi\text{-index} = \frac{P-Q}{t} = \frac{6-3}{6} = 0.5 \text{ cm/h} \qquad (\text{Here } P = \text{Rainfall}, \quad R = \text{Runoff})$$

$$\therefore \quad 0.5 = \frac{12-R}{9} \qquad [\because \ \phi\text{-index remains the same}]$$

$$\Rightarrow \quad R = 7.5 \text{ cm}$$

9. **(c)**

Lysimeter is used to measure evapotranspiration.

10. **(c)**

$\because$ For same stage, $Q \propto \sqrt{S}$

$$\therefore \quad \frac{Q_2}{Q_1} = \sqrt{\frac{S_2}{S_1}} \qquad S_1 = \frac{1}{5000}$$

$$\Rightarrow \quad \frac{Q_2}{180} = \sqrt{\frac{5000}{2000}} \qquad S_2 = \frac{1}{2000}$$

$$\Rightarrow \quad Q_2 = 284.6 \text{ m}^3/\text{s} \qquad \frac{S_2}{S_1} = \frac{5000}{2000}$$

11. **(b)**

$$T = 200 \text{ years}$$

$$y_T = \text{Reduced variate} = -\ln\ln\left(\frac{T}{T-1}\right) = -\ln\ln\left(\frac{200}{200-1}\right)$$

$$\Rightarrow \quad y_T = 5.296 \simeq 5.3$$

12. **(a)**

$$P_{\text{avg}} = \frac{P_1A_0 + \left(\frac{P_1+P_2}{2}\right)A_1 + \left(\frac{P_2+P_3}{2}\right)A_2 + \left(\frac{P_3+P_4}{2}\right)A_3 + \left(\frac{P_4+P_3}{2}\right)A_4 + P_5A_5}{A_0 + A_1 + A_2 + A_3 + A_4 + A_5}$$

$$= \frac{70\times 60 + \left(\frac{70+90}{2}\right)275 + \left(\frac{90+100}{2}\right)260 + \left(\frac{100+125}{2}\right)380 + \left(\frac{125+140}{2}\right)215 + 140\times 40}{60+275+260+380+215+40}$$

$$= 103.85 \text{ mm}$$

13. **(d)**

$$P = (10+30+40+50+25+8)\times\frac{30}{60} = 81.5 \text{ mm}$$

$$R = 38 \text{ mm}$$

$$\therefore \quad W_{\text{index}} = \frac{P-R}{t} = \frac{81.5-38}{(180/60)} = 14.5 \text{ mm/hr}$$

$$\therefore \quad \phi_{\text{index}} = \frac{81.5-38-(10+8)0.5}{(180-30-30)/60} = 17.25 \text{ mm/hr}$$

Check:

$$\text{Runoff} = \left[(30-17.25)+(40-17.25)+(50-17.25)+(25-17.25)\right]\frac{30}{60}$$

= 38 mm which is same as given in question

14. (c)

$$h = 3 \text{ cm}$$

$$\therefore \quad A = \frac{0.36 \times \sum \text{Ordinates} \times \Delta t}{h}$$

$$= \frac{0.36 \times 105 \times 1}{3} = 12.60 \text{ km}^2$$

$$= 1260 \text{ ha}$$

Alternate solution,

$$V = Qt$$

$$\Rightarrow \quad Ah = Qt$$

$$\Rightarrow \quad A = \frac{(0 + 7 + 24 + 35 + 26 + 13 + 0) \times 3600}{0.03}$$

$$= 12.6 \times 10^6 \text{ m}^2 = 1260 \text{ ha}$$

15. (b)

±10% of normal annual rainfall at station III = 72 cm and 88 cm < Normal annual rainfall at station IV

∴ Using normal rational method

$$P_3 = \frac{N_3}{3}\left[\frac{P_1}{N_1} + \frac{P_2}{N_2} + \frac{P_4}{N_4}\right]$$

$$= \frac{80}{3}\left[\frac{90}{70} + \frac{65}{75} + \frac{75}{105}\right] = 76.44 \text{ cm}$$

16. (b)

$$f_0 = 25 \text{ mm/hr}, \quad k = 0.5/\text{hr}$$

$$f_c = 9 \text{ mm/hr}$$

$$\because \quad f_t = f_c + (f_0 - f_c)e^{-kt}$$

$$\Rightarrow \quad f_t = 9 + (25 - 9)\, e^{-0.5t}$$

$$\Rightarrow \quad f_t = 9 + 16\, e^{-0.5\,t}$$

$$\therefore \quad \text{Total infiltration} = \int_0^t f_t dt = \int_0^{10} (9 + 16e^{-0.5t})dt = 90 + 32\left(1 - e^{-5}\right)$$

$$= 90 + 31.78 = 121.78 \simeq 122 \text{ mm}$$

17. (a)

$$\frac{1}{2} \times 250 \times 42 \times 60 \times 60 = 10^{-2} \times \text{A}$$

$$\Rightarrow \quad A = 1890 \times 10^6 \text{ m}^2$$

$$\Rightarrow \quad A = 1890 \text{ km}^2$$

18. (d)

For confidence probability C, the confidence interval (if variate x_T is bounded by values x_1 and x_2) is given by

$$x_1 = x_T - f(c) \cdot S_e$$

$$x_2 = x_T + f(c) \cdot S_e$$

Given x_T = 19000 m^3/s

S_e = 2200 m^3/s

For 95% confidence probability $f(c)$ = 1.96

∴ x_1 = 19000 – 1.96 × 2200 = 14688 m^3/s

x_2 = 19000 + 1.96 × 2200 = 23312 m^3/s

19. (c)

$$N = \left(\frac{C_v}{\epsilon}\right)^2$$

where,
$$C_v = \frac{\sigma}{\mu} \times 100 = \frac{36}{120} \times 100 = 30\%$$

$$N = \left(\frac{30}{10}\right)^2 = 9$$

Additional raingauge = 9 – 6 = 3

20. (c)

e_s = 17.54 mm of Hg

Actual vapour pressure = Relative humidity × 17.54 = 0.5 × 17.54

e_a = 8.77 mm Hg

Let U_9 = Wind velocity at a height of 9 m above ground surface

∴ $U_9 = U_1 (9)^{1/7} = 16(9)^{1/7} = 21.9$ kmph

From Meyer's method,

$$\text{Evaporation loss, } E_L = k_m (e_s - e_a)\left(1 + \frac{U_9}{16}\right)$$

$$= 0.36(17.54 - 8.77)\left(1 + \frac{21.9}{16}\right) = 7.48 \text{ mm/day}$$

Daily evaporation as per pan evaporimeter

$$= \frac{70}{7} \times 0.8 = 8 \text{ mm/day}$$

So,
$$\%\ \text{error} = \frac{8 - 7.48}{8} \times 100 = 6.5\%$$

21. (d)

Peak of 2H-DRH = 135 – 10 = 125 m^3/s

Effective rainfall = 54 – 4 × 2

= 46 mm = 4.6 cm

$$\text{Peak of 2 hr UH} = \frac{125}{4.6} = 27.17 \text{ m}^3/\text{s}$$

22. (b)

$$P = \frac{1}{T} = \frac{1}{60}$$

$$P_{2 \text{ times in 15 years}} = {}^{15}C_2\left(\frac{1}{60}\right)^2\left(1-\frac{1}{60}\right)^{13}$$

$$= 0.02344 = 2.344\%$$

23. (d)

Horton's equation of I.C. curve,

$$f = f_c + (f_0 - f_c)e^{-kt}$$

$$\Rightarrow \quad (f - f_c) = (f_0 - f_c)e^{-kt}$$

$$\Rightarrow \quad \text{Log } (f - f_c) = \log(f_0 - f_c) - kt\log e$$

$$\Rightarrow \quad \log(f - f_c) - \log(f_0 - f_c) = -kt \log e$$

$$\Rightarrow \quad t = \frac{-1}{k\log e}\left[\log(f - f_c) - \log(f_0 - f_c)\right]$$

$$= \frac{-1}{k\log e}\log(f - f_c) + \frac{1}{k\log e}\log(f_0 - f_c)$$

$$\therefore \quad \text{Slope} = \frac{-1}{k\log e} = -0.4605$$

$$\Rightarrow \quad k = 5.0 \text{ time}^{-1}$$

24. (b)

$$\text{PET} = \frac{AH_n + E_a\gamma}{A + \gamma}$$

where,

$$A = 1 \text{ mm of Hg/°C}$$

$$H_n = 2 \text{ mm of evaporable water/day}$$

$$E_a = 2.5 \text{ mm/day}$$

$$\gamma = 0.5 \text{ mm of Hg/°C}$$

$$\therefore \quad \text{PET} = \frac{1 \times 2 + 2.5 \times 0.5}{1 + 0.5}$$

$$= \frac{2 + 1.25}{1.5} = \frac{3.25}{1.5} = 2.17 \text{ mm/day}$$

25. (b)

26. (a)

$$Q = \frac{Q_t(C_1 - C_2)}{C_2 - C_0}$$

$$Q_t = 10 \text{ cm}^3/\text{sec} = 10 \times 10^{-6} \text{ m}^3/\text{s}$$

$$C_1 = 20 \text{ mg}/l = 20 \text{ ppm} = 20 \times 10^3 \text{ ppb},$$
$$C_2 = 5 \text{ ppb},$$
$$C_0 = 0$$
$$\therefore \quad Q = 10 \times 10^{-6} \times \left(\frac{20 \times 10^3 - 5}{5 - 0}\right) \text{m}^3/\text{s} = 0.040 \text{ m}^3/\text{s}$$

27. (a)

$$\frac{U_c}{U_m} = \frac{1 \text{ cm}}{R \text{ cm}}$$
$$R = 1$$
$$R = 0.1 \text{ cm}$$
$$\frac{U_c}{U_m} = \frac{1}{0.1}$$
$$U_c = 10\, U_m$$
$$U_m = \frac{U_c}{10}$$

28. (c)

The risk involved is 0.20 and n = 2 years

$$\therefore \quad 0.20 = 1 - \left(1 - \frac{1}{T}\right)^2$$
$$\Rightarrow \quad T = 9.47 \text{ years}$$
$$\Rightarrow \quad T \simeq 9.5 \text{ years}$$

29. (b)

30. (c)

S.No.	Infiltration dam	Infiltration Capacity (mm/h)	Remarks
1.	Very Low	1.25	Highly Clayey soils
2.	Low	2.5 to 25	Clay soils
3.	Medium	12.5 to 25	Sandy loam
4.	High	> 25	Deep sands

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