CLASS TEST

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 18/09/2019

ANSWER KEY ➤ **Engineering Hydrology**

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

Detailed Explanations

1. **(b)**
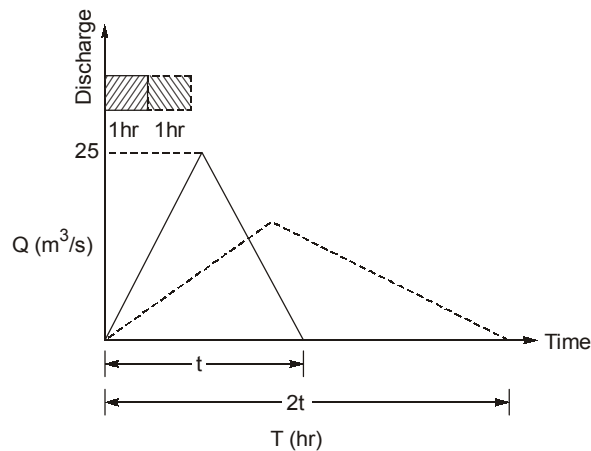
For 2-hr UH, the base time will increase, hence peak will go down.

2. **(d)**

Certain chemicals such as cetyl alcohol (hexadecanol) and stearyl alcohol (octadecanol) forms monomolecular layers on a water surface. These layers act as evaporation inhibitors by preventing the water molecules to escape past them.

4. **(a)**

Since variation is more than 10%,

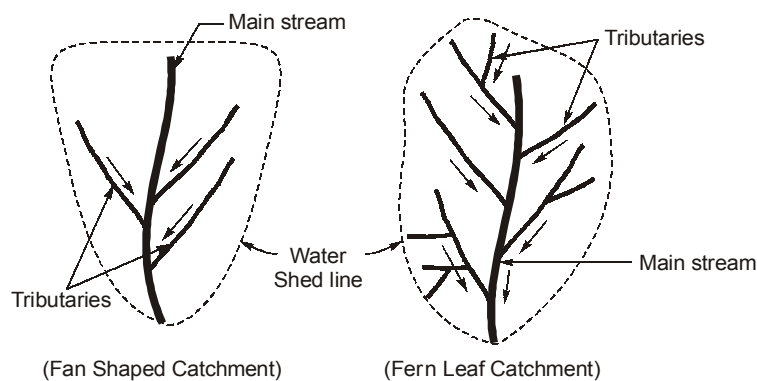$$P_x = \frac{105}{3}\left[\frac{156}{155}+\frac{140}{150}+\frac{104}{120}\right]$$
$$= 98.2 \text{ cm}$$

5. **(a)**

$$Q_{equilibrium} = 2.78\frac{A}{T}$$
$$= 2.78 \times 360 \times \frac{1}{4} \simeq 250 \text{ cumecs}$$

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.   (a)
Isopleth is a line on a map connecting points having same numerical values of a certain quantity such as population figure or geographical measurement. Isobars are contour lines that connects different points with same constant pressure. Isochrones are lines on a map connecting points relating to equal time of travel of surface runoff or equal time of concentration.

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,
$$(\Sigma O) = (1 + 7 + 26 + 37 + 27 + 13 + 1) - 7 = 105$$
$$n = \frac{0.36 \Sigma Ot}{A}$$
$$\Rightarrow \quad A = \frac{0.36 \times 105 \times 1}{5} = 7.56 \text{ km}^2$$

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 (m³/s)	S-curve addition	S-curve	Offset S-curve	Δy	6-h UH = (Δy × 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) $$\text{Mean rainfall, } (\bar{P}) = \frac{\Sigma P}{n} = \frac{800 + 620 + 400 + 560}{4} = 595 \text{ mm}$$

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

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

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

(v) Additional gauges required to be installed

$$= 8 - \text{Existing 4 gauges}$$
$$= 8 - 4 = 4$$

16. (d)

Time (1)	Total Stream flow in cumecs (2)	Base flow in cumecs (3)	Direct run off = column (2) – 4.8 (4)
0	4.8	4.8	0
2	5.1	4.8	0.3
4	6.5	4.8	1.7
6	7.4	4.8	2.6
8	10.2	4.8	5.4
10	8.8	4.8	4.0
12	7.4	4.8	2.6

Using Simpson's rule, the area enclosed by this discharge hydrograph

$$= \frac{H}{3}\left[\frac{1^{st} + \text{last ordinate}}{2} + 4 \times \text{Even ordinates} + 2 \times \text{odd ordinates}\right]$$

$$= \frac{2 \times 60 \times 60}{3}\left[\frac{0 + 2.6}{2} + 4(0.3 + 2.6 + 4.0) + 2(1.7 + 5.4)\right]$$

$$= 103440 \text{ m}^3$$

$\therefore$ Depth of water in the hydrograph $= \dfrac{103440}{400 \times 10^4} = 2.586 \times 10^{-2}\text{m}$ or 2.586 cm

$$\text{Rainfall} = 4 \text{ cm}$$
$$\text{Runoff} = 2.586 \text{ cm}$$

$\therefore$ Infiltration including basin recharge $= 4 - 2.586 = 1.414$ cm

$$t_r = 4 \text{ hr (given)}$$

$\therefore \qquad\qquad\qquad \phi_{index} = \dfrac{1.414}{4} = 0.35 \text{ cm/hr}$

17. (b)

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

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

18. (b)

The probability of occurrence of an event $(x \geq x_T)$ at least once over a period of n successive years is called the risk, $\bar{R}$.

Hence, risk is given by

$$\bar{R} = 1 - \left(\text{Probability of occurence of the event } x \geq x_T \text{ in } n \text{ years}\right)$$

$$= 1 - \left(1 - \frac{1}{T}\right)^n = 1 - \left(1 - \frac{1}{50}\right)^{25} = 0.397 \simeq 0.40$$

where, $\qquad\qquad T = $ Return period = 50 years

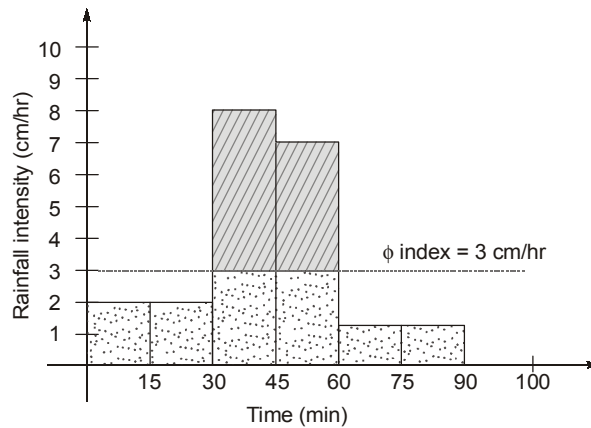$\qquad\qquad\qquad n = $ Expected life = 25 years

19. (b)

Thiessen Polygon Method: In this method, the rainfall recorded at each station is given a weightage on the basis of an area closest to the station.

$$P_{avg} = \frac{P_1A_1 + P_2A_2 + ... + P_nA_n}{A_1 + A_2 + ... + A_n}$$

where, $P_1, P_2, ... P_n$ are the rainfall data of areas $A_1, A_2 ... A_n$.

20. (b)

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

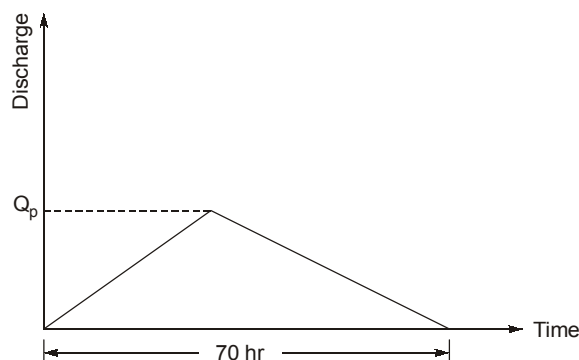$\therefore$ Total runoff $= (8-3) \times \dfrac{15}{60} + (7-3) \times \dfrac{15}{60} = \left[(8-3) + (7-3) \right] \times \dfrac{15}{60} = 2.25\,cm$

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

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

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

$= 2.083$ cm/hr $\simeq 2.08$ cm/hr

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,

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

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

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

25. **(d)**

$$\text{Total rainfall} = 0.5 + 1.8 + 2.9 = 5.2 \text{ cm}$$

$$\text{Infiltration} = 5.2 - 2 = 3.2 \text{ cm}$$

$$\text{Excess rainfall duration, } t_e = 2 \times 3 = 6 \text{ hrs.}$$

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

This value being more than 0.5 cm/hr,

The excess rainfall duration will reduce by 2 hrs.

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

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

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

26. **(c)**

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

The standard deviation of the rainfall is given by

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

$$\sigma = 15.81$$

$$\Rightarrow \qquad C_V = \frac{\sigma}{\overline{x}} \times 100 = 19.76$$

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

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

27. **(d)**

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

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

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

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

28. (a)

The calculations are tabulated below:

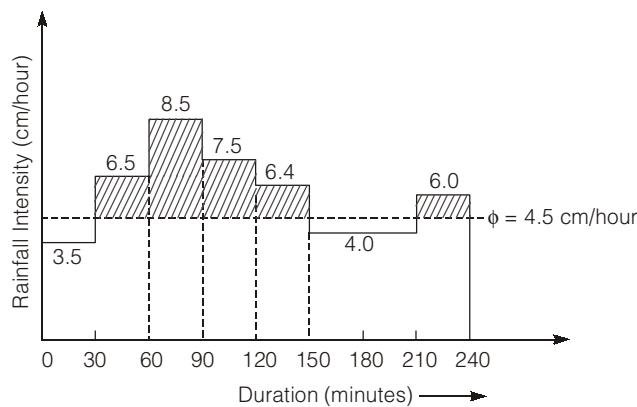| Time (hr)	FH (m³/s)	Base Flow (m³/s)	DRH (m³/s)
Col. (1)	Col. (2)	Col. (3)	Col. (4)
0	5	5	0
12	15	5	10
24	40	5	35
36	80	5	75
48	60	5	55
60	50	5	45
72	25	5	20
84	15	5	10
96	5	5	0
			$\Sigma O = 250$

Base flow = 5 m³/sec

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

where ΣO = 250 m³/s; t = 12 hr; A = 450 km²

∴ $DRD = \dfrac{0.36 \times 250 \times 12}{450} = 2.4$ cm

29. (c)

Rainfall excess is shown by hatched area.
Total rainfall

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

Total rainfall excess

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

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

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

30. **(c)**

Time(hr)	0	12	24	36	48
Inflow(m³/s)	100	750	780	470	270

$$Q_{initial} = 100 \text{ m}^3/\text{s}$$
$$k = 18 \text{ hours}$$
$$x = 0.3$$
$$2kx < \Delta t < k$$
$$2 \times 18 \times 0.3 < \Delta t < 18$$
$$\Delta t = 12 \text{ hrs}$$

Using Muskingham equation

$$C_0 = \frac{-kx + 0.5\,\Delta t}{k(1-x) + 0.5\,\Delta t} = \frac{-18 \times 0.3 + 0.5 \times 12}{18(1-0.3) + 0.5 \times 12} = 0.0323$$

$$C_1 = \frac{kx + 0.5\,\Delta t}{k(1-x) + 0.5\,\Delta t} = \frac{18 \times 0.3 + 0.5 \times 12}{18(1-0.3) + 0.5 \times 12} = 0.613$$

$$C_2 = \frac{k(1-x) - 0.5\,\Delta t}{k(1-x) + 0.5\,\Delta t} = \frac{18(1-0.3) - 0.5 \times 12}{18(1-0.3) + 0.5 \times 12} = 0.355$$

■■■■