CLASS TEST

Sl. : 01SKCE_ABCD_12082025

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IRRIGATION ENGINEERING

CIVIL ENGINEERING

Date of Test : 12/08/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (c)

Lysimeter is used to measure evapotranspiration.

2. (b)

$$\because \quad \Delta = \frac{8.64B}{D}$$

$$\Rightarrow \quad \frac{17.28}{100} = \frac{8.64 \times 20}{D}$$

$$\Rightarrow \quad D = \frac{8.64 \times 20 \times 100}{17.28}$$

$\Rightarrow \quad D$ = 1000 hectares per cum/s

3. (c)

4. (c)

The annual intensity of irrigation is the sum total of intensities of irrigation of all the seasons of the year.

Intensity of irrigation for Kharif = 100 – 76 = 24%

Intensity of irrigation of rabi season = 54%

∴ Annual intensity of irrigation = 24 + 54 = 78%

5. (c)

$$\text{NIR} = C_u - P_{\text{eff}}$$

$$C_u = 0.5(FC - PWP)\frac{\gamma_d d}{\gamma_w} = 0.5(0.25 - 0.15) \times \frac{16}{10} \times 1000 = 80 \text{ mm}$$

Effective rainfall = 40 mm

$$\therefore \quad \text{NIR} = 80 - 40 = 40 \text{ mm}$$

6. (b)

Normal scour depth $\quad R = 1.35\left(\frac{q^2}{f}\right)^{1/3}$

$$= 1.35 \times \left(\frac{9^2}{1}\right)^{1/3} = 1.35\left(3^{4/3}\right) = 5.84 \text{ m}$$

7. (c)

For elementary profile, $\quad B = \frac{H}{\sqrt{S_c - C}}$

When uplift is ignored $C = 0$

$$\therefore \quad B = \frac{H}{\sqrt{S_c}}$$

$\Rightarrow$ $$H = 36\sqrt{2.56} = 57.6 \text{ m}$$

$\therefore$ Maximum allowable height = 57.6 m.

8. (b)

The ratio of maximum shear stress on bed ($0.97 \times y_0S_0$) and that on sides ($0.75 \times y_0S_0$) will be

$$= \frac{0.97 \times y_0S_0}{0.75 \times y_0S_0} = 1.293 \simeq 1.3$$

9. (a)

- Bligh's assumed that the percolating water follows the outline of the base of the structure which is in contact with the sub-soil.
- The length of the path travelled by the percolating water is called the length of creep or creep length.
- Bligh's makes distinction between horizontal and vertical creep.

10. (a)

11. (d)

The theoretical concept of silt transportation is fundamentally the same in both Kennedy's and Lacey's theory. Both state that silt remains in suspension due to the vertical components of eddies created by the flow of water against the channel surface.

12. (c)

13. (b)

$$\text{Sensitivity, } S = \frac{(dq/q)}{(dy/y)}$$

where q is discharge through outlet

y is depth in distributary canal

Given $$S = 0.5$$

$$\frac{dq}{q} = ?$$

$\therefore$ $$\frac{dq}{q} = \frac{dy}{y} \times S = 50 \times 0.4 = 20\%$$

14. (c)

$$\text{Duty for gram} = \frac{8.64 \times 18}{0.12} = 1296 \text{ ha/cumec}$$

$$\text{Duty of wheat} = \frac{8.64 \times 15}{0.15} = 864 \text{ ha/cumec}$$

Area of gram irrigated = 2000 × 0.3 = 600 ha

Area of wheat irrigated = 2000 × 0.5 = 1000 ha

$$\text{Discharge for gram} = \frac{600}{1296} = 0.46 \text{ cumec}$$

$$\text{Discharge of wheat} = \frac{1000}{864} = 1.16 \text{ cumec}$$

Since, both gram and wheat are rabi crops.

So the discharge required in field channels is

$$Q_{design} = Q_{gram} + Q_{wheat}$$
$$= 0.46 + 1.16 = 1.62 \text{ cumecs}$$

15. (d)

Since the given size of bed particle is 1.00 mm which is less than 6 mm, we cannot use Shield's equation, since Re in this case will be less than 400. We will therefore use the general equation given by Mittal and Swamee, which is valid for all size of *d*.

$$\tau_c\ (\text{N/m}^2) = 0.155 + \frac{0.409\, d_{mm}^2}{\sqrt{1 + 0.177 d_{mm}^2}}$$

$$= 0.155 + \frac{0.409 \times 1^2}{\sqrt{1 + 0.177 \times 1}} = 0.53 \text{ N/m}^2$$

and $\tau_0 = \gamma_w RS$

$$= 9.81 \times 0.6 \times \frac{1}{2500}$$

$$= 2.35 \times 10^{-3} \text{ kN/m}^2$$

$= 2.35$ N/m^2 which is more than 0.53 N/m^2

Since $\tau_0 > \tau_c$, the soil will not be stationary and the scouring and sediment transport will occur.

16. (a)

$$t = 2.3 \frac{y}{f} \log_{10}\left(\frac{Q}{Q - fA}\right)$$

$$\frac{tf}{2.3y} = \log_{10}\left(\frac{Q}{Q - fA}\right) \qquad \left(\text{Assume } \frac{tf}{2.3} = x\right)$$

$$\Rightarrow \quad x = \log_{10}\left(\frac{Q}{Q - fA}\right)$$

$$\Rightarrow \quad 10x = \frac{Q}{Q - fA}$$

$$Q\,10x - fA\,10x = Q$$

$$Q(10x - 1) = fA\,10x$$

$$A = \frac{Q(10x-1)}{f(10x)}$$

Maximum value of $\left(\frac{10x-1}{10x}\right) = 1$

$$\therefore \qquad A_{max} = \frac{Q}{f}$$

It is maximum area that can be irrigated with a supply ditch of discharge 'Q' and soil having infiltration capacity 'f'. After irrigating this much of area, surface flow will stop, and deep percolation will start.

17. (a)

Depth of maximum available moisture,

$$d_w = \frac{\gamma_d \times d}{\gamma_w}(F - \phi)$$

Field Capacity, $$\text{FC} = \frac{\text{Weight of water contained in certain volume of soil}}{\text{Weight of same volume of dry soil}}$$

$$= \frac{\gamma_w \times V_v}{\gamma_d \times V}$$

Field Capacity $$\text{FC} = \frac{\gamma_w}{\gamma_d} \times n \qquad \left(\because n = \frac{V_v}{V}\right)$$

$$\frac{\gamma_d}{\gamma_w} = \frac{n}{\text{Field capacity}}$$

Maximum quantity of water stored between field capacity and permanent wilting point:

$$d_w = \left(\frac{\gamma_d}{\gamma_w}\right) \times d(\text{FC} - \text{PWP})$$

$$= \frac{n}{\text{FC}} \times d(\text{FC} - \text{PWP})$$

$$\therefore \qquad = \frac{0.5}{0.4} \times 1 \times (0.4 - 0.1) = 0.375\text{m}$$

But the moisture content should not fall below 50%.

$\because$ Depth of water required = 0.5 × 0.375 = 0.1875 m

$$\text{Actual depth stored} = 0.1875 \times \frac{60}{100} = 0.1125 \text{ m}$$

$$\therefore \quad \text{Frequency of irrigation} = \frac{\text{Actual depth stored}}{\text{Consumptive use}}$$

$$= \frac{0.1125}{0.02} = 5.625 \text{ days } \cong 5 \text{ days}$$

18. (a)

Outlet index, for orifice type outlet = $\frac{1}{2}$

$$\text{Channel index} = \frac{4}{3}$$

$$\text{Setting} = \frac{\text{Outlet index}}{\text{Channel index}} = \frac{1/2}{4/3} = 0.375$$

19. (a)

$$\text{Mean depth, } D = \frac{2.0 + 1.9 + 1.8 + 1.6 + 1.5}{5}$$

$$= \frac{8.8}{5} = 1.76 \text{ m}$$

The average of absolute values of deviations,

$$d = \frac{|2 - 1.76| + |1.9 - 1.76| + |1.8 - 1.76| + |1.6 - 1.76| + |1.5 - 1.76|}{5}$$

$$d = 0.168 \text{ m}$$

$$\text{Water distribution efficiency} = \left(1 - \frac{d}{D}\right)$$

$$= \left(1 - \frac{0.168}{1.76}\right) = 0.905 = 90.5\%$$

20. (d)

Type of water	Electrical conductivity (at 25°C) in μmho/cm
(i) Low salinity water	≤ 250
(ii) Medium salinity water	250-750
(iii) High salinity water	750-2250
(iv) Very high salinity water	>2250

Type of water	Sodium absorption ratio (SAR)
Low sodium water	0 to 10
Medium sodium water	10 to 18
High sodium water	18 to 26
Very high sodium water	>26

The salt concentration is generally measured by determining the electrical conductivity of water. They are directly proportional to each other.

21. **(a)**

Maximum seepage head available,

$$H = 100 - 80 = 20 \text{ m}$$

Depth of downstream cutoff

$$d = 9 \text{ m}$$

Total length of flow, $b = 15 + 5 + 25 = 45$ m

$$\therefore \quad \alpha = \frac{b}{d} = \frac{45}{9} = 5$$

$$\therefore \quad \lambda = \frac{1+\sqrt{1+\alpha^2}}{2} = \frac{1+\sqrt{1+25}}{2} = 3.045 \text{ or } 3.05$$

$$\text{Hence exit gradient} = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}} = \frac{20}{9}\times\frac{1}{\pi\times\sqrt{3.0495}} = 0.4051 \simeq 0.4$$

22. **(a)**

Given: Bed width (B) = 5 m, Bed slope, $(S_o) = \frac{1}{1000}$

Depth, $y = 2.5$ m, $n = 0.016$

Side slope 1.5 H : 1 V

For trapezoidal lined channel:

$$A = By + (\theta + \cot\theta)y^2 \; ; \; p = 2y(\theta + \cot\theta) + B$$

$$\cot\theta = 1.5$$

$$\theta = 34.1° = 0.59 \text{ radian}$$

$$A = 5 \times 2.5 + (0.59 + 1.5)\,(2.5)^2 = 25.56 \text{ m}^2$$

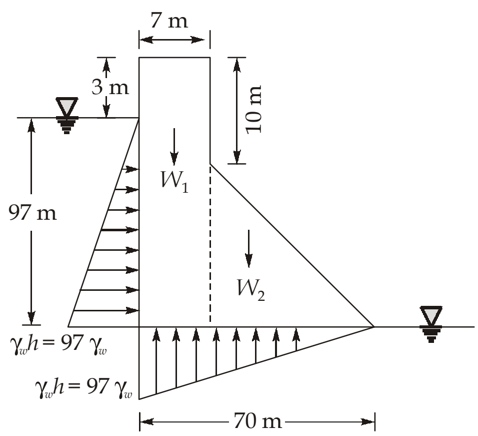
$$P = 2 \times 2.5 \times (0.59 + 1.5) + 5 = 15.45 \text{ m}$$

$$\therefore \text{Hydraulic mean depth, } R = \frac{A}{P} = \frac{25.56}{15.45} = 1.65 \text{ m}$$

$$Q = \frac{A}{n}R^{2/3}S^{1/2} = \frac{25.56}{0.016}\times(1.65)^{2/3}\times\left(\frac{1}{1000}\right)^{1/2}$$

$$= 70.54 \text{ m}^3/\text{s}$$

23. **(c)**



Considering unit width of dam,

$$W_1 = (7 \times 100 \times 1) \times 24 \text{ kN/m}^3 = 16800 \text{ kN}$$

$$W_2 = \frac{1}{2} \times (70-7) \times 90 \times 1 \times 24 = 68040 \text{ kN}$$

Uplift pressure, $U = \left[\frac{1}{2} \times (97\gamma_w) \times 70 \times 1\right] = 33304.95 \text{ kN}$

Hence, $\Sigma F_v = W_1 + W_2 - U = 16800 + 68040 - 33304.95 = 51535.05 \text{ kN}$

Now, $\mu \Sigma F_v = 0.75 \times 51535.05 = 38651.3 \text{ kN}$

Horizontal force due to water pressure

$$\Sigma F_H = \frac{1}{2}\gamma_w H^2 = \frac{1}{2} \times 9.81 \times 97^2 = 46151.145 \text{ kN}$$

$\therefore$ FOS against sliding $= \frac{\mu \Sigma F_v}{\Sigma F_H} = \frac{38651.3}{46151.145} = 0.837$

24. (b)

Here, $EC_e = 7 \text{ dS/m}$

$EC_0 = 22 \text{ dS/m}$

$EC_{100} = 4 \text{dS/m}$

We get, relative yield, $y_t = 100 \times \frac{EC_0 - EC_e}{EC_0 - EC_{100}}$

$$= \frac{22-7}{22-4} \times 100 = 83.33\%$$

Yield reduction $= 100 - 83.33\% = 16.67\%$

25. (b)

Given that $Q_A = Q_B$ and $f_A > f_B$

$$V = \left(\frac{Qf^2}{140}\right)^{1/6}$$

Hence $V_A > V_B$

Since, Q is same, $\therefore$ $A_A < A_B$ $\quad (\because V_A > V_B)$

$$P = 4.75\sqrt{Q}$$

Hence $P_A = P_B$

$\therefore$ Channel B has more hydraulic radius for the same wetted perimeter and this happens only when the channel has more depth.

Hence, $y_B > y_A$

26. (a)

$M_O = 3 \times 10^5$ ton-m

$M_R = 4 \times 10^5$ ton-m

$\therefore$ $\Sigma M = M_R - M_o$

$= 1 \times 10^5$ ton-m

$\Sigma V = 6000 - 1000 = 5000$ tons

$$x = \frac{\Sigma M}{\Sigma V} = \frac{1\times 10^5}{5000} = 20 \text{ m}$$

$$e = \frac{b}{2} - x = 25 - 20 = 5 \text{ m}$$

$$\text{Pressure acting at the toe} = \frac{\Sigma V}{b}\left(1+\frac{6e}{b}\right)$$

$$= \frac{\Sigma V}{b}\left(1+\frac{6\times 5}{50}\right)$$

$$= 160 \text{ t/m}^2$$

27. (a)

$b = 20$ m, $d = 5$ m, $H = 3$ m

$$\alpha = \frac{b}{d} = \frac{20}{5} = 4$$

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2} = \frac{1+\sqrt{1+4^2}}{2} = 2.562$$

Exit gradient as per Khosla's theory,

$$G_e = \frac{H}{d}\times\frac{1}{\pi\sqrt{\lambda}}$$

$$\Rightarrow \quad G_e = \frac{3}{5\pi\sqrt{2.562}} = 0.119$$

Critical gradient, $$i_c = \frac{G_s - 1}{1+e} = \frac{2.68-1}{1+0.7} = 0.988$$

$$\text{FOS} = \frac{i_c}{G_e} = \frac{0.988}{0.119} = 8.30$$

28. (b)

$$\text{Milli equivalents of Na}^+ = \frac{345}{23} = 15 \text{ meq}/l$$

$$\text{Milli equivalents of Ca}^{+2} = \frac{60}{20} = 3 \text{ meq}/l$$

$$\text{Milli equivalents of Mg}^{+2} = \frac{18}{12} = 1.5 \text{ mgq}/l$$

Now, $$\text{SAR} = \frac{[\text{Na}^+]}{\sqrt{\frac{[\text{Ca}^{+2}]+[\text{Mg}^{+2}]}{2}}}$$

$$= \frac{15}{\sqrt{\frac{3+1.5}{2}}}$$

$$= 10$$

29. (d)

Cutoffs are provided on the downstream side.

30. (d)

A drainage gallery reduces the uplift pressure at all levels below the gallery i.e., upstream as well as downstream.

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