CLASS TEST

Sl. : 03SKCE_OMNPQ_30092025


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# IRRIGATION ENGINEERING

## CIVIL ENGINEERING

**Date of Test : 30/09/2025**

## ANSWER KEY

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

## DETAILED EXPLANATIONS

**1. (b)**

Height of the wave is found out by Stevensons' formulae

**Case-1:** $F \leq 32$ km

$$h_w(\text{m}) = 0.032\sqrt{VF} + 0.763 - 0.271F^{1/4}$$

**Case-2:** $F > 32$ km

$$h_w(\text{m}) = 0.032\sqrt{VF}$$

where, $V$ = Wind velocity (kmph)

$F$ = Fetch (km)

Given, $F$ = 50 km > 32 km

$$\therefore \quad h_w = 0.032\sqrt{50 \times 8} = 0.64 \text{ m}$$

**2. (c)**

Some methods used to determine consumptive use are:

1. Blaney Criddle Method
2. Modified Penman Method
3. Thornthwaite Method
4. Jensen Haise Method
5. Hargreaves Class A Pan Evaporation Method

**3. (d)**

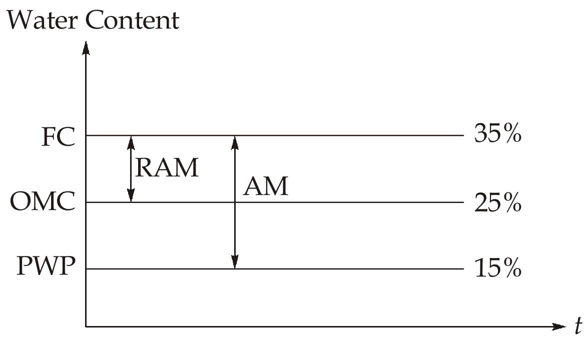
**4. (d)**

Lacey's scour depth, $$R_s = 1.35\left(\frac{q^2}{f}\right)^{1/3}$$

$$f = 1.76\sqrt{d_{mm}} = 1.76\sqrt{4} = 3.52$$

$$\therefore \quad R_s = 1.35\left(\frac{100}{3.52}\right)^{1/3} = 4.119 \text{ m} \simeq 4.12 \text{ m}$$

**5. (c)**




RAM: Reading Available Moisture

AM: Available Moisture

$$d_{\text{RAM}} = \frac{\gamma_d}{\gamma_w} \times d \times (FC - OMC)$$

$$= \frac{1.3}{1} \times 1.5 \text{ m} \times (0.35 - 0.25)$$

$$= 0.195 \text{ m} = 195 \text{ mm}$$

**6. (c)**

Lane's (weighted) creep length

$$= \Sigma V + \frac{\Sigma H}{3}$$

$$= 4 + 4 + \frac{6}{3} + 6 + 6 + \frac{6}{3} + 3 + 3$$

$$= 30 \text{ m}$$

**7. (b)**

$$\text{SAR} = \frac{\text{Na}^{+}}{\sqrt{\frac{\text{Ca}^{2+} + \text{Mg}^{2+}}{2}}}$$

$$\Rightarrow \quad \text{SAR} = \frac{30}{\sqrt{\frac{5+2}{2}}} = 16.0357 \simeq 16.04$$

**8. (a)**

$$y = 1.5 \text{ m}$$

$$\tau_0 = \gamma R S_0$$

For wide rectangular channel,

$$R \simeq y$$

$$\tau_0 = 9810 \times 1.5 \times \left(\frac{1}{1000}\right) \text{kN/m}^2 = 14.715 \text{ kN/m}^2$$

$$\Rightarrow \quad \tau_0 = \frac{14.715}{9.81} = 1.5 \text{ kgf/m}^2$$

**9. (d)**

As per Bligh's creep theory:

$$t = \frac{h}{G-1}$$

By providing FOS of $\frac{4}{3}$ for design

$$\therefore \quad t_{design} = \frac{4}{3} \times \left(\frac{3}{2.4-1}\right)$$

$$\Rightarrow \quad t_{design} = 2.86 \text{ m}$$

**10. (a)**

Kennedy did not give any slope equation.

**11. (c)**

To prevent sliding failure,

$$B \geq \frac{H}{\mu(G_C - C)} = \frac{80}{0.75(2.4-0.8)} = 66.67 \text{ m}$$

$$\therefore \quad B \geq 66.67 \text{ m} \quad \ldots(i)$$

To prevent tension failure,

$$B \geq \frac{H}{\sqrt{G_C - C}} = \frac{80}{\sqrt{2.4-0.8}} = 63.25 \text{ m}$$

$$\therefore \quad B \geq 63.25 \text{ m} \quad \ldots(ii)$$

To prevent overturning failure,

$$B \geq \frac{H}{\sqrt{2(G_C - C)}} = \frac{80}{\sqrt{2} \times \sqrt{2.4-0.8}} = 44.72 \text{ m}$$

$$\therefore \quad B \geq 44.72 \text{ m} \quad \ldots(iii)$$

∴ From (i), (ii) and (iii), minimum width of elementary dam = 66.67 m

**12. (c)**

Depth of water required through irrigation

$$= (15 - 7.5) + (18 - 6) + (21 - 3.3) + (24 - 0)$$

$$= (7.5 + 12 + 17.7 + 24)$$

$$= 61.2 \text{ cm}$$

Volume of water required through irrigation in field

$$= \frac{61.2}{100} \times 100 \times 10^4 \text{ m}^3 = 0.612 \text{ Mm}^3$$

Volume of water required through canal

$$= \frac{0.612}{0.5 \times 0.4} = 3.06 \text{ Mm}^3$$

**13. (a)**

Time required to irrigate a strip of area A with a continuous discharge $Q$ is

$$t = \frac{y}{f} \ln\left(\frac{Q}{Q - Af}\right)$$

$$\Rightarrow \quad 120 \text{ min.} = \frac{15 \text{ cm}}{8 \text{ cm/hr}} \ln\left(\frac{Q}{Q - \frac{2000 \text{ m}^2 \times 0.08 \text{ m}}{3600 \text{ s}}}\right)$$

$$\Rightarrow \quad \frac{2h \times 8/h}{15} = \ln\left(\frac{Q}{Q - \frac{2}{45} \text{ m}^3/\text{s}}\right)$$

$$\Rightarrow \quad \frac{16}{15} = \ln\left(\frac{Q}{Q - \frac{2}{45}}\right)$$

$$\Rightarrow \quad 2.9057 = \frac{Q}{Q - \frac{2}{45}}$$

$$\Rightarrow \quad 2.9057Q - 0.1291 = Q$$
$$\Rightarrow \quad 1.9057Q = 0.1291$$
$$\Rightarrow \quad Q = 0.0677 \text{ m}^3/\text{s}$$
$$\simeq 0.068 \text{ m}^3/\text{s}$$

**14. (a)**

Discharge in Kharif season,

$$\Sigma Q = 6 + 4 + 2 = 12 \text{ m}^3/\text{s}$$

Discharge in Rabi season,

$$\Sigma Q = 6 + 4.1 = 10.1 \text{ m}^3/\text{s}$$

$\therefore$ Average discharge,

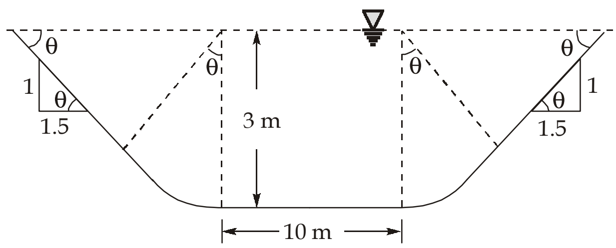
$$Q_{avg} = \frac{1}{2}(12 + 10.1) = 11.05 \text{ m}^3/\text{s}$$

$$Q_{max} = 12 \text{ m}^3/\text{s}$$

$\therefore$ Capacity factor,
$$CF = \frac{Q_{avg}}{Q_{max}} = \frac{11.05}{12} = 0.921$$

**Note:** Sugarcane is perennial crop and therefore it is added in discharge of both Kharif and Rabi season.

**15. (c)**




$$\cot\theta = 1.5 \Rightarrow \theta = 0.588 \text{ radian}$$
$$A = BD + D^2(\theta + \cot\theta)$$
$$\Rightarrow \quad A = 10 \times 3 + 3^2(0.588 + 1.5)$$
$$\Rightarrow \quad A = 48.792 \text{ m}^2$$
$$P = B + 2D(\theta + \cot\theta)$$
$$\Rightarrow \quad P = 10 + 2 \times 3[0.588 + 1.5]$$
$$\Rightarrow \quad P = 22.528 \text{ m}$$
$$\therefore \quad R = \frac{A}{P} = \frac{48.792}{22.528} = 2.166 \text{ m}$$
$$Q = \frac{1}{n}A\left(R^{2/3}\right)(S)^{1/2}$$
$$\Rightarrow \quad Q = \frac{1}{0.012} \times 48.792 \times \left(2.166^{2/3}\right)\left(\frac{1}{4500}\right)^{1/2}$$
$$\Rightarrow \quad Q = 101.469 \text{ m}^3/\text{s} \simeq 101.47 \text{ m}^3/\text{s}$$

**16. (d)**

$$Q_D = \frac{4k\left(b^2 - a^2\right)}{L}$$

$$\frac{(Q_D)_A}{(Q_D)_B} = \frac{4k_A(b^2 - a^2)L_B}{4k_B(b^2 - a^2)L_A}$$

$$= \frac{2}{1} \times \frac{5}{6} \times 1.5 = 2.5$$

**17. (b)**

The difference in bed level of the canal and drainage is 4 m while the flow depth in drainage is 10 m. Thus HFL of drain at 125 m (115 m + 10 m) is higher than the canal bed at 120 m. Therefore syphon aqueduct is most suitable.

**18. (a)**

$$\text{Distribution efficiency, } \eta_d\% = \left(1 - \frac{d}{D}\right) \times 100$$

$$D = \frac{1.5 + 1.1}{2} = 1.3 \text{ m}$$

$$d = \frac{|1.5 - 1.3| + |1.1 - 1.3|}{2} = 0.2$$

$$\eta_d = \left(1 - \frac{0.2}{1.3}\right) \times 100$$

$$= 84.6\%$$

**19. (d)**

$$Q_2 = C_0 I_2 + C_1 I_1 + C_2 Q_1$$

$$= 0.048 \times 20.0 + 0.429 \times 10.0 + 0.523 \times 10.0 \text{ m}^3/\text{s}$$

$$= 10.48 \text{ m}^3/\text{s}$$

**20. (b)**

The consumptive use is computed from the Blaney-Criddle equation as,

$$C_u = k \sum f$$

where, $$f = \frac{P}{40}[1.8t + 32]$$

Computations are done in the tabular form as shown below.

| Month | $t$ (°C) | $P$ (%) | $f$ |
|---|---|---|---|
| Nov | 19.0 | 7.19 | 11.9 |
| Dec | 16.0 | 7.15 | 10.9 |
| Jan | 15.0 | 7.30 | 10.8 |
| | | | $\sum f = 33.6$ |

$$C_u = k \sum f = 0.75 \times 33.6 = 25.2 \text{ cm}$$

$$Re = 1.2 + 0.8 = 2 \text{ cm}$$

$$\therefore \quad \text{CIR} = C_u - Re = 25.2 - 2.0 \text{ cm}$$

$$= 23.2 \text{ cm}$$

**21. (b)**

The volume of water stored between the normal pool level and the minimum pool level is known as the useful storage.

**22. (a)**

The leaching requirement ($L$) is given by

$$L = \frac{D_d}{D_i} = \frac{EC_{(i)}}{EC_{(d)}}$$

$$(EC)_d = 2\ (\text{EC})_e$$
$$= 2 \times 8.2 = 16.4\ \mu\text{mho/m}$$
$$(EC)_i = 2.8\ \mu\text{mho/m}$$

$\therefore$ $$L = \frac{2.8}{16.4} \times 100 = 17.07\% \simeq 17.1\%$$

**23. (b)**

Field capacity is given by,

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

$\Rightarrow$ $$\text{FC} = \frac{\gamma_w}{\gamma_d} \times n$$

$\Rightarrow$ $$\frac{\gamma_d}{\gamma_w} = \frac{n}{FC} = \frac{0.36}{0.35} = 1.03$$

Maximum quantity of water stored between field capacity (FC) and permanent wilting point,

$$d = \frac{\gamma_d}{\gamma_w} \times d \times (FC - \phi)$$
$$= 1.03 \times 0.56 \times (0.35 - 0.15)$$
$$= 0.1154\ \text{m} = 11.54\ \text{cm} \simeq 11.5\ \text{cm}$$

**24. (a)**

For a trapezoidal section, we have

$$A = bd + d^2\ (\theta + \cot\theta)$$
$$P = b + 2d\ (\theta + \cot\theta)$$
$$\text{Side slope} = 1.5\ \text{H} : 1\ \text{V}$$

$$\cot\theta = \frac{1.5}{1}$$

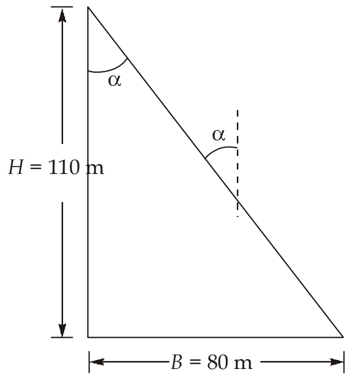
$\therefore$ $$\theta = 0.59\ \text{rad} = 33.69°$$

$\therefore$ $$R = \frac{A}{P} = \frac{bd + d^2(\theta + \cot\theta)}{b + 2d(\theta + \cot\theta)}$$

$\Rightarrow$ $$R = \frac{(45 \times 2.5) + 2.5^2\ (0.59 + 1.5)}{45 + 2 \times 2.5(0.59 + 1.5)}$$

$\Rightarrow \quad R = 2.26$ m

**25. (b)**




Here $\tan\alpha = \dfrac{80}{110} = 0.7273$

Now, vertical stress at toe, is given by,

$$(P_{max})_{toe} = 3.5 \text{ MPa}$$

$$\therefore \quad \sigma_{max} = (P_{max})_{toe} \times \sec^2\alpha$$
$$= 3.5 \times (1 + \tan^2\alpha)$$
$$= 3.5 \times (1 + 0.53)$$
$$= 5.355 \text{ MPa} \simeq 5.36 \text{ MPa}$$

**26. (d)**

Shear friction factor is given by

$$\text{SFF} = \frac{\mu\Sigma F_v + (B \times 1)q}{\Sigma F_H}$$

$$q = 14 \text{ kg/cm}^2 = \frac{14 \times 10000 \times 9.81}{1000} = 1373.4 \text{ kN/m}^2$$

$$\text{SFF} = \frac{0.75 \times 1065 + (8.25 \times 1) \times 1373.4}{490}$$

$$\Rightarrow \quad \text{SFF} = 24.75$$

**27. (c)**

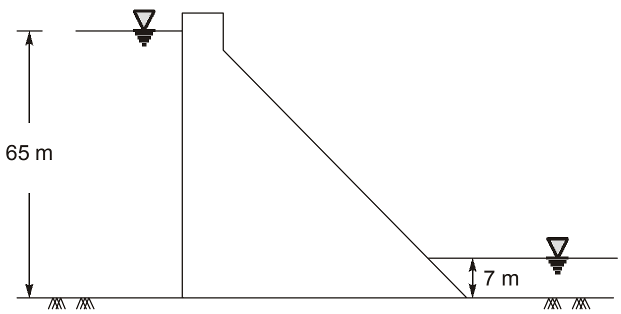
$$\text{Water depth required at canal} = \frac{\text{Water depth required in the field}}{\eta_a \cdot \eta_c}$$

$$= \frac{10}{0.8 \times 0.9} = 13.89 \text{ cm}$$

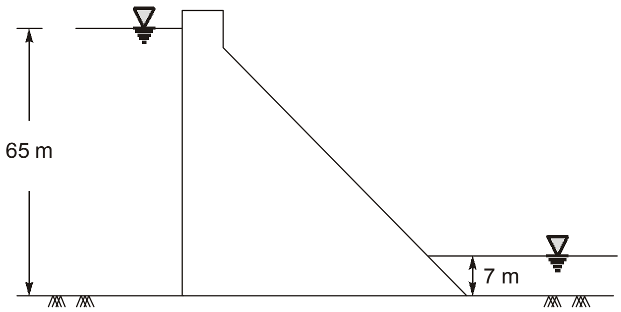
$\therefore$ Volume of water required for 10 ha field

$$= \left(\frac{13.89}{100}\text{m}\right) \times 10 \times 10^4 \text{ m}^2$$

$$= 13890 \text{ m}^3$$



**28. (b)**




Hydrostatic force on upstream side,

$$F_1 = \frac{1}{2}\gamma_w H^2 = \frac{1}{2}\times 10\times 65^2$$
$$= 21125 \text{ kN/m}$$

Hydrostatic force on downstream side,

$$F_2 = \frac{1}{2}\gamma_w h^2 = \frac{1}{2}\times 10\times 7^2$$
$$= 245 \text{ kN/m}$$

Net force, $F = F_1 - F_2$
$= 21125 - 245$
$= 20880$ kN per meter length of dam

**29. (a)**

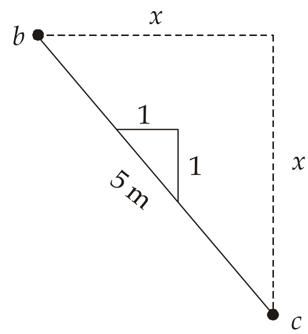
Khosla's exit gradient,

$$G_E = \frac{H}{d\pi\sqrt{\lambda}}$$

where, $H = 4$ m
$d = 8$ m

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

where, $\alpha = \frac{b}{d}$




But $5^2 = x^2 + x^2$

$\Rightarrow$ $x = \frac{5}{\sqrt{2}}\text{ m} = 3.536\text{ m}$

where, $b$ = Horizontal length of the floor

$\therefore$ $b = (10 + 3.536 + 20)\text{ m} = 33.536\text{ m}$

$$\therefore \quad \lambda = \frac{1+\sqrt{1+\left(\frac{33.536}{8}\right)^2}}{2} = 2.655$$

$$\therefore \quad G_E = \frac{4}{8\pi\sqrt{2.655}} = 0.09768 = \frac{1}{10.238}$$
$$\simeq 1 \text{ in } 10$$

**30. (b)**

Blaney Criddle equation

$$f = \frac{p}{40} \times (18.t + 32)$$

| Months | t (°C) | $p$ | $f$ (cm) |
|---|---|---|---|
| Nov. | 19 | 7.19 | 11.9 |
| Dec. | 16 | 7.15 | 10.87 |
| Jan. | 12.5 | 7.30 | 9.95 |
| Feb. | 13 | 7.03 | 9.74 |

$$\Sigma f = 42.46 \text{ cm}$$

$$C_u = k\Sigma f = 0.75 \times 42.46 = 31.845 \text{ cm}$$

$$\Sigma R_e = 12 + 8 = 20 \text{ mm} = 2 \text{ cm}$$

$$\text{CIR} = C_u - R_e = 31.845 - 2 = 29.845 \text{ cm}$$

$$\text{NIR} \simeq \text{CIR} = \text{CIR (As no water is used for deep percolation)}$$

$$\therefore \quad \text{FIR} = \frac{NIR}{\eta_a} = \frac{29.845}{0.70} = 42.64 \text{ cm}$$

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