CLASS TEST

Sl. : 01SKCE_J+K_15072025

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IRRIGATION ENGINEERING

CIVIL ENGINEERING

Date of Test : 15/07/2025

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

Using Lacey's theory

$$Q = 50\text{ m}^3/\text{s}$$
$$f = 1.10$$
$$V = \left[\frac{Qf^2}{140}\right]^{1/6} = \left[\frac{50\times1.1^2}{140}\right]^{1/6}$$
$$= 0.865\text{ m/s} \simeq 0.87\text{ m/s}$$
$$R = \frac{5}{2}\frac{V^2}{f} = \frac{5}{2}\times\frac{0.87^2}{1.1}$$
$$= 1.72\text{ m}$$

2. (c)

According to Lacey's theory the dimensions of bed width, depth and slope of canal attain a state of equilibrium with time which is called true regime. Lacey defined a regime channel as stable channel transporting a minimum bed load constant with fully active bed.

3. (c)

For Rice

$$\text{Duty} \times \text{Delta} = 8.64 \times \text{Base period}$$
$$\Rightarrow \quad \text{Duty} = \frac{8.64\times140}{1.50} = 806.4\text{ ha/cumec}$$
$$\therefore \quad \text{Discharge of canal} = \frac{1200}{806.4} = 1.488\text{ cumec}$$

For vegetable

$$\text{Duty} \times \Delta = 8.64B$$
$$\Rightarrow \quad \text{Duty} = \frac{8.64\times90}{0.4} = 1944\text{ ha/cumec}$$

$\therefore$ Area of vegetable which can be irrigated = 1944 × 1.488 = 2892.67 ha $\simeq$ 2892.7 ha

4. (a)

The leaching requirement (L) is given by

$$L = \frac{D_d}{D_i} = \frac{EC_{(i)}}{EC_{(d)}}$$
$$(EC)_d = 2\ (\text{EC})_e$$
$$= 2 \times 8.2 = 16.4\ \mu\text{mho/m}$$
$$(EC)_i = 2.8\ \mu\text{mho/m}$$
$$\therefore \quad L = \frac{2.8}{16.4}\times100 = 17.07\% \simeq 17.1\%$$

5. (a)

Maximum area that can be irrigated is,

$$A = \frac{Q}{f} = \frac{0.02 \times 3600}{5 \times 10^{-2}}$$

$$A = 1440 \text{ m}^2 = 0.144 \text{ hectares}$$

6. (c)

Furrow irrigation: In this method of irrigation, water is applied to the land to be irrigated by a series of furrows, furrows are small, parallel channels, made to carry water for irrigating the crops.

Check irrigation: Check flooding method of irrigation is similar to ordinary flooding except that the water is controlled by surrounding the check area with low or flat levees.

Flood irrigation: This type of irrigation is also called inundation irrigation. In this method of irrigation, soil is kept submerged and throughly flooded with water, so as to cause through saturation of the land.

7. (d)

Given: Discharge = 8 m^3/sec, Area = 30 hectare, Time = 4 hour
Water stored in root zone = 0.28 m
Water application efficiency is given by,

$$\eta_{app} = \frac{\text{Water stored in root zone}}{\text{Water supplied in field}}$$

$$\text{Water supplied to field} = \frac{8 \times 4 \times 3600}{30 \times 10^4} \text{ m} = 0.384 \text{ m}$$

$$\therefore \quad \eta_{app} = \frac{0.28}{0.384} = 0.7292 \text{ or } 72.92\%$$

8. (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.

9. (b)

The max. height is given by

$$H = \frac{f_w}{\gamma_w (G - C + 1)}$$

Here uplift is neglected,

So $C = 0$

$$\therefore \quad H = \frac{3.78 \times 10^3}{9.81(2.4 + 1)} = 113.33 \text{ m}$$

10. (c)

As per Kennedy's method, critical velocity is given by,

$$V_0 = 0.55\ m\ y^{0.64}$$
$$= 0.55 \times 1.15 \times 1.6^{0.64} = 0.854\ \text{m/s}$$

11. (c)

For rice

Area = 1500 ha, B = 144 days, Δ = 125 cm = 1.25 m

For wheat

B = 121 days, Δ = 52 cm = 0.52 m

Since the same canal is used, the discharge will be same for both crops,

$$Q_R = Q_W$$

$$\text{Duty for rice, } D = \frac{8.64 \times B}{\Delta} = \frac{8.64 \times 144}{1.25} = 995.328 \text{ ha/cumec}$$

$$\text{Hence discharge} = \frac{\text{Area}}{D} = \frac{1500}{995.328} = 1.507 \text{ cumec}$$

$$\text{Now, Duty for wheat} = \frac{8.64 \times B}{\Delta} = \frac{8.64 \times 121}{0.52} = 2010.46 \text{ ha/cumec}$$

$$\text{Area that can be irrigated} = \text{Duty} \times \text{Discharge}$$
$$= 2010.46 \times 1.507 = 3029.76 \text{ ha}$$

12. (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.

13. (a)

Maximum seepage head available,

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

Depth of downstream cutoff

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

$$\text{Total length of flow, } b = 15 + 5 + 25 = 45 \text{ m}$$

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

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

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

14. (a)

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

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

Side slope 1.5 H : 1 V

For trapezoidal lined channel:

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

$$\cot\theta = 1.5$$

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

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

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

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

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

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

15. (d)

Given:

Area of strip, A = 0.05 hectares = 0.05×10^4 m^2 = 500 m^2

Discharge, Q = 0.03 cumecs = $0.03 \times 60 \times 60$ = 108 m^3/hr

Infiltration capacity of soil,

$$f = 5 \text{ cm/hr} = 0.05 \text{ m/hr}$$

Average depth of flow on the field,

$$y = 8 \text{ cm} = 0.08 \text{ m}$$

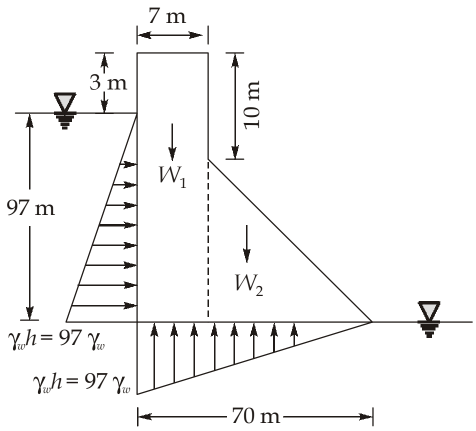
$\therefore$ Time required to irrigate a strip of land is,

$$t = 2.303\frac{y}{f}\log\left(\frac{Q}{Q - fA}\right)$$

$$= 2.303 \times \frac{0.08}{0.05}\log\left(\frac{108}{108 - 0.05 \times 500}\right)$$

$$= 0.4213 \text{ hr} = 25.278 \text{ min} \simeq 25.28 \text{ min}$$

16. (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
$$= \frac{\mu \Sigma F_v}{\Sigma F_H} = \frac{38651.3}{46151.145} = 0.837$$

17. (b)

Field capacity is given by,

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

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

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

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

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

$$= 1.03 \times 0.56 \times (0.35 - 0.15)$$

$$= 0.1154\ \text{m} = 11.54\ \text{cm} \simeq 11.5\ \text{cm}$$

18. **(b)**

Bed level of drainage is higher than canal

$\therefore$ Full supply level of canal = 124 + 4.2 = 128.2 m

$\therefore$ Full supply of canal is higher than bed level of drain.

$\therefore$ Syphon type of cross-drainage work is required.

19. **(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

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

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

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

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

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

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

20. **(a)**

Shear friction factor is given by

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

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

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

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

21. **(c)**

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,

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

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

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

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

22. (b)

Spacing of tile drain is given by

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

$$\Rightarrow \quad k = \frac{Sq}{4\left(b^2 - a^2\right)} = \frac{150 \times 4 \times 10^{-6}}{4\left(8.5^2 - 8^2\right)} = 1.818 \times 10^{-5} \text{ m/s} \simeq 1.8 \times 10^{-5} \text{ m/s}$$

23. (b)

$$\text{Height of dam} = 90 \text{ m}$$
$$S_c = 2.4$$
$$C = 0.72$$
$$\mu = 0.6$$

Case-1: Consider no tension criterion.

Width of dam, $$B_{\min} = \frac{H}{\sqrt{S_c - C}} = \frac{90}{\sqrt{2.4 - 0.72}} = 69.437 \text{ m}$$

Case-2: Consider no sliding criterion

$$B_{\min} = \frac{H}{\mu\left(S_c - C\right)} = \frac{90}{0.6(2.4 - 0.72)} = 89.286 \text{ m}$$

Feasible or minimum width that shall be provided is max (69.437 m, 89.286 m)

$$\therefore \quad B_{\min} = 89.286 \text{ m} \simeq 89.29 \text{ m}$$

24. (b)

$$\text{SAR} = \frac{\left[\text{Na}^+\right]}{\sqrt{\dfrac{\left[\text{Ca}^{2+}\right] + \left[\text{Mg}^{2+}\right]}{2}}}$$

[ ] in terms of milliequivalents

$$[\text{Na}^+] = \frac{\text{Weight}}{\text{Equivalent weight}} = \frac{250}{\frac{23}{1}} = 10.869 \text{ meq.}$$

$$[\text{Ca}^{+2}] = \frac{100}{\frac{40}{2}} = 5 \text{ meq.}$$

$$[\text{Mg}^{2+}] = \frac{35}{\frac{24}{2}} = 2.917 \text{ meq.}$$

$$\text{SAR} = \frac{10.869}{\sqrt{\dfrac{5 + 2.917}{2}}} = 5.463 \simeq 5.46$$

25. (d)

As the reservoir is empty.

$\therefore$ Resultant of force will be near to the heel.

$$\therefore \quad (P)_{\text{heel}} = \frac{\Sigma w}{b}\left(1 + \frac{6e}{b}\right)$$

$$= \frac{420}{3.6}\left(1 + \frac{6 \times 0.6}{3.6}\right) = 233.33 \text{ kN/m}^2 \text{ (Compressive)} = 0.233 \text{ MPa}$$

26. (c)

$$\text{Sensitivity} = \frac{dq/q}{dy/y} = \frac{(dq/q)\times 100}{(dy/y)\times 100} = \frac{30\%}{50\%} = 0.6$$

27. (b)

Here,
$$EC_e = 7\ \text{dS/m}$$
$$EC_0 = 22\ \text{dS/m}$$
$$EC_{100} = 4\text{dS/m}$$

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

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

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

28. (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, $\therefore$ $A_A < A_B$ $(\because V_A > V_B)$

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

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, $y_B > y_A$

29. (b)

Drainable porosity = Total porosity – Water content after gravity drainage
= 47 – 39
= 8%

Drainable water volume = Drainable porosity × Drainable soil volume
= 0.08 × 20 × 15 × 1
= 24 m^3

30. (b)

By principle of irreversibility, $h_A + h_F = 4$

$\Rightarrow$ $3 + h_F = 4$

$\Rightarrow$ $h_F = 1$ m

Similarly, $h_E = 1.5$ m

$h_D = 2.5$ m

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