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IRRIGATION ENGINEERING

CIVIL ENGINEERING

Date of Test : 19/06/2026

ANSWER KEY >

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

DETAILED EXPLANATIONS

1. (a)

2. (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 thoroughly flooded with water, so as to cause through saturation of the land.

3. (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.

4. (b)

The max. height is given by

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

Here uplift is neglected,

So $C = 0$

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

5. (d)

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

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

6. (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.

7. (b)

8. (a)

The leaching requirement (L) is given by

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

$$\begin{aligned} (EC)_d &= 2 (EC)_e \\ &= 2 \times 8.2 = 16.4 \text{ } \mu\text{mho/m} \end{aligned}$$

$$(EC)_i = 2.8 \text{ } \mu\text{mho/m}$$

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

9. (c)

$$\text{Area under crop} = 0.20 \times 5000 = 1000 \text{ hectare}$$

$$\text{Discharge required} = \frac{1500}{1000} = 1.5 \text{ cumec} = \frac{1000}{1500} = \frac{2}{3} \text{ m}^3/\text{s}$$

Quantity of water required = $Q \times$ Base period

$$\begin{aligned} &= \frac{2}{3} \times 180 \times 86400 \\ &= 10.368 \times 10^6 \text{ m}^3/\text{s} \end{aligned}$$

$$\begin{aligned} \text{Net volume required} &= \frac{10.368 \times 10^6}{0.80} = 12.96 \times 10^6 \text{ m}^3 \\ &= 1296 \text{ ha-m} \end{aligned}$$

10. (b)

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

[] in terms of milliequivalents

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

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

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

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

11. (a)

Maximum seepage head available,

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

Depth of downstream cutoff

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

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

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

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

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

12. (c)

For rice

Area = 1500 ha, $B = 144$ days, $\Delta = 125 \text{ cm} = 1.25 \text{ m}$

For wheat

$B = 121$ days, $\Delta = 52 \text{ cm} = 0.52 \text{ m}$

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

$$Q_R = Q_W$$

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

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

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

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

13. (a)

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

Depth, $y = 2.5 \text{ m}$, $n = 0.016$

Side slope 1.5 H : 1 V

For trapezoidal lined channel:

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

$$\cot\theta = 1.5$$

$$\theta = 34.1^\circ = 0.59 \text{ radian}$$

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

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

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

$$\begin{aligned} Q &= \frac{A}{n} R^{2/3} S^{1/2} = \frac{25.56}{0.016} \times (1.65)^{2/3} \times \left(\frac{1}{1000}\right)^{1/2} \\ &= 70.54 \text{ m}^3/\text{s} \end{aligned}$$

14. (a)

Given:

$$\text{Area of strip, } A = 0.05 \text{ hectares} = 0.05 \times 10^4 \text{ m}^2 = 500 \text{ m}^2$$

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

Infiltration capacity of soil,

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

Average depth of flow on the field,

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

∴ Time required to irrigate a strip of land is,

$$\begin{aligned} t &= 2.303 \frac{y}{f} \log \left(\frac{Q}{Q - fA} \right) \\ &= 2.303 \times \frac{0.08}{0.05} \log \left(\frac{108}{108 - 0.05 \times 500} \right) \\ &= 0.4213 \text{ hr} = 25.278 \text{ min} \approx 25.28 \text{ min} \end{aligned}$$

15. (b)

Field capacity is given by,

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

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

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

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

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

16. (b)

Bed level of drainage is higher than canal

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

∴ Full supply of canal is higher than bed level of drain.

∴ Syphon type of cross-drainage work is required.

17. (d)

Shear friction factor is given by

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

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

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

$$\Rightarrow SFF = 24.75$$

18. (c)

Discharge in Kharif season,

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

Discharge in Rabi season,

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

∴ Average discharge,

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

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

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

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

19. (b)

Spacing of tile drain is given by

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

$$\Rightarrow k = \frac{Sq}{4(b^2 - a^2)}$$

$$= \frac{150 \times 4 \times 10^{-6}}{4(8.5^2 - 8^2)}$$

$$= 1.818 \times 10^{-5} \text{ m/s} \simeq 1.8 \times 10^{-5} \text{ m/s}$$

20. (a)

Height of dam = 90 m

$$S_c = 2.4$$

$$C = 0.72$$

$$\mu = 0.6$$

Case-1: Consider no tension criterion.

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

Case-2: Consider no sliding criterion

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

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

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

21. (d)

22. (d)

As the reservoir is empty.

∴ Resultant of force will be near to the heel.

$$\begin{aligned} \therefore (P)_{\text{heel}} &= \frac{\Sigma w}{b} \left(1 + \frac{6e}{b} \right) \\ &= \frac{420}{3.6} \left(1 + \frac{6 \times 0.6}{3.6} \right) \\ &= 233.33 \text{ kN/m}^2 \text{ (Compressive)} \end{aligned}$$

23. (b)

As we know, water distribution efficiency is,

$$\eta_d = \left[1 - \frac{d}{D} \right] \times 100$$

where,

 D = mean depth

$$= \frac{2.0 + 1.9 + 1.8 + 1.6 + 1.5}{5} = \frac{8.8}{5} = 1.76 \text{ m}$$

 d = Average of absolute values of their deviations from the mean

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

$$= \frac{0.84}{5} = 0.168 \text{ m}$$

$$\eta_d = \left[1 - \frac{d}{D} \right] \times 100$$

$$= \left[1 - \frac{0.168}{1.76} \right] \times 100$$

$$= (1 - 0.095) \times 100 = 90.5\%$$

24. (b)

25. (c)

For Kharif crops:

Duty (in ha/cumec) \times Delta (m) = 8.64 \times Base period (in days)

$$\begin{aligned} \therefore \text{Duty} &= \frac{8.64 \times 135}{1.55} \\ &= 752.516 \text{ ha/cumec} \end{aligned}$$

But
$$\text{Duty} = \frac{\text{Area}}{\text{Discharge}}$$

$$\Rightarrow 752.516 = \frac{2200}{Q}$$

$$\Rightarrow Q = 2.92 \text{ m}^3/\text{sec}$$

Now, for Rabi crop,

$$\text{Duty} = \frac{8.64 \times \text{Base period}}{\text{Delta}}$$

$$\Rightarrow \frac{\text{Area}}{Q} = \frac{8.64 \times 90}{0.45}$$

$$\Rightarrow \text{Area} = 1728 \times 2.92 = 5045.76 \text{ ha}$$

26. (c)

Using Blaney - Criddle formula,

$$\text{Consumptive use, } C_u = \frac{k p}{40} [1.8t + 32]$$

where, k is consumptive use coefficient = 0.59.

p is percentage of monthly = 7.30.

t is mean monthly temperature = 289° K or 16°C

$$R_{289} - 273 = 16^\circ\text{C}$$

$$\therefore C_u = \frac{0.59 \times 7.3}{40} [1.8 \times 16 + 32] = 6.55 \text{ cm}$$

$$\begin{aligned} \therefore \text{Consumptive irrigation requirement} &= C_u - R_e \\ &= 6.55 - 2.22 = 4.35 \text{ cm} \simeq 5 \text{ cm} \end{aligned}$$

27. (a)

$$\text{Maximum storage capacity} = \frac{\gamma_d d}{\gamma_w} [\text{Field capacity} - \text{Permanent Wilting point}]$$

$$= \frac{20}{10} \times 0.8 [0.3 - 0.15] = 0.24 = 24 \text{ cm}$$

28. (a)

The crop period is defined as the total period from the time of sowing of a crop to the time of harvesting it.

29. (b)

$$\begin{aligned}\text{Available moisture} &= \text{Field capacity} - \text{Permanent wilting point} \\ &= 35 - 22 = 13\%\end{aligned}$$

$$\begin{aligned}\text{From,} \quad D_w &= \frac{\gamma_d \times d}{\gamma_w} \times [FC - PWP] \\ &= \frac{1.5 \times 0.70}{1} \times [0.35 - 0.22]\end{aligned}$$

$$\Rightarrow D_w = 13.65 \text{ cm}$$

$$\therefore \text{Frequency of irrigation, } f_w = \frac{13.65}{1.7} = 8.03 \text{ days} \simeq 8 \text{ days}$$

30. (a)

When a dam is constructed across a river valley, to form storage reservoir then it is known as storage head works.

When a barrage is constructed across a river to raise the water level then it is known as diversion head works.

