CLASS TEST

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IRRIGATION ENGINEERING

CIVIL ENGINEERING

Date of Test : 30/08/2023

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (d)

Given: Discharge = 8 m^3/sec, Area = 30 hectare, Time = 4 hour

Water stored in root zone = 0.28 m

Water application efficiency η_{app} is given by,

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

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

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

2. (b)

As per Lacey's theory, an artificially constructed channel having a certain fixed slope and a certain fixed section can behave in regime only if the following conditions are satisfied:

(i) Discharge is constant

(ii) Flow is uniform

(iii) Silt charge and silt grade is constant

(iv) Channel is flowing through a material which can be scoured as easily as it can be deposed, and is of the same grade as it transported.

Regime theory or Lacey's theory is applicable to such a channel in which all variables are equally free to vary, has a tendency to assume a semi-elliptical section.

3. (b)

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

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

5. (d)

In siphon aqueducts, the uplift due to water table acts where the bottom floor is depressed below the drainage bed. The maximum uplift under the worst condition is when there is no water flowing in the drain and the water table has risen up to drain bed.

6. (c)

The ratio of maximum tractive shear stress on the sides and that on the channel bed is

$$= \frac{0.75\,\gamma RS}{0.97\,\gamma RS} = 0.7732 \simeq 0.77$$

7. (c)

$$\text{Depth of water applied} = \frac{\gamma_d}{\gamma_w} \cdot d\left(\text{Field capacity} - \text{Moisture content before irrigation}\right)$$

$$\Rightarrow \quad 60 = \frac{15.3}{9.81} \times d \times (0.15 - 0.08)$$

$$\Rightarrow \quad d = 549.58\ \text{mm}$$
$$= 54.958 \approx 55\ \text{cm}$$

8. **(c)**

Discharge required for wheat = $\frac{\text{Area}}{\text{Duty}} = \frac{1200}{1800} = 0.667 \text{cumecs}$

Actual design discharge = $\frac{\text{Discharge}}{\text{Time factor}} = \frac{0.667}{0.9} = 0.74$ cumecs

10. **(d)**

Using Lacey's theory

Discharge, $Q = 50 \text{ m}^3/\text{s}$

Silt factor, $f = 1.10$

Velocity, $V = \left[\frac{Qf^2}{140}\right]^{1/6} = \left[\frac{50 \times 1.1^2}{140}\right]^{1/6} = 0.87 \text{ m/s}$

Now, Hydraulic radius, $R = \frac{5}{2}\frac{V^2}{f} = \frac{5}{2} \times \frac{0.87^2}{1.1} = 1.72 \text{ m}$

11. **(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.

12. **(a)**

Height of dam = 90 m

$S_c = 2.4$

$C = 0.72$

$\mu = 0.6$

Case-1: Considering no tension criterion.

Minimum 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

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

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

$\therefore \quad B_{\min} = 89.286 \text{ m} \simeq 89.3 \text{ m}$

14. **(b)**

Field capacity is given by,

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

$\Rightarrow \quad \text{FC} = \frac{\gamma_w}{\gamma_d} \times n$ where γ is porosity of soil

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

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

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

15. (b)

Shear friction factor is given by

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

$$q = 14\ \text{kg/cm}^2 = \frac{14\times 9.81}{10^{-4}}\times 10^{-3} = 1373.4\ \text{kN/m}^2$$

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

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

16. (a)

Given:

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

Discharge, $Q = 0.03$ 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,

$$t = 2.303\frac{y}{f}\log\left(\frac{Q}{Q-fA}\right) = 2.303\times\frac{0.08}{0.05}\log\left(\frac{108}{108-0.05\times 500}\right)$$

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

17. (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.

19. (b)

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

Relative yield,
$$y_t = 100 \times \frac{EC_0 - EC_e}{EC_0 - EC_{100}} = \frac{22-7}{22-4} \times 100 = 83.33\%$$

$$\text{Yield reduction} = 100 - 83.33\% = 16.67\%$$

20. (d)

(i) Kharif crops are known as monsoon crops.

(ii) Rabi crops are known as winter crops.

(iii) Using the relation,

$$\Delta = \frac{8.64 \times B}{D}$$

Delta for kharif crops,
$$\Delta = 60 \text{ cm} = 0.6 \text{ m}$$
$$B = 3 \text{ weeks} = 21 \text{ days}$$
$$\text{Duty} = \frac{8.64 \times 21}{0.6} = 302.4 \text{ ha/cumec}$$
$$\text{Area to be irrigated} = 5000 \text{ ha}$$
$$\text{Required discharge of channel} = \frac{5000}{302.4} = 16.53 \text{ m}^3\text{/s}$$

Discharge for rabi crops,
$$\Delta = 25 \text{ cm} = 0.25 \text{ m}$$
$$B = 4 \text{ weeks} = 28 \text{ days}$$
$$\text{Duty} = \frac{8.64 \times 28}{0.25} = 967.48 \text{ ha/cumec}$$
$$\text{Area to be irrigated} = 4000 \text{ ha}$$
$$\text{Required discharge of channel} = \frac{4000}{967.68} = 4.13 \text{ m}^3\text{/s}$$

So, the channel is to be designed for the maximum discharge of 16.53 m^3/s.

21. (a)

Non-modular outlet are those through which discharge depends upon difference of head between distributary and water course.

22. (d)

Following are the precautions is field preparation and sowing are taken for improving duty of water.

(i) Land to be used for cultivation should, as or as possible, be levelled.

(ii) The fields should be properly ploughed to the required depth.

(iii) Improved modern cultivation methods may preferably be adopted.

(iv) Porous soils should be treated before sowing crops to reduce seepage of water.

(v) Alkaline soils should be properly leached before sowing.

(vi) Manure fertilizer should be added to increase water holding capacity of the soil.

(vii) Rotation of crops should be preferred as this will ensure increased crop yields with minimum use of water.

23. (d)

Option (d) is correct.

Inferior crops one those which have low requirements of nutrients for their growth.

24. (a)

$$\% \text{ sunshine hour, } P = \frac{330}{2500} \times 100 = 13.2\%$$

$$C_u = \frac{kP}{40}(1.8t + 32) = \frac{0.6 \times 13.2}{40}(1.8 \times 35 + 32) = 18.81 \text{ cm}$$

25. (d)

Average boundary shear stress

$$\tau_{av} = \gamma_w RS$$
$$= 9.81 \times 0.88 \times 0.004 \times 10^3 = 34.53 \text{ N/mm}^2$$

26. (c)

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

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

$$\text{Quantity of water required} = Q \times \text{Base period}$$

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

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

27. (b)

For the case of horizontal impervious floor with cut-off at the downstream end, the exit gradient is given by,

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

$$\lambda = \frac{1 + \sqrt{1 + \alpha^2}}{2} \quad \left(\alpha = \frac{b}{d}\right)$$

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

Given data: $b = 16 + 4 + 25 = 45$ m, $d = 10$ m, $H = 120 - 102 = 18$ m

$$\alpha = \frac{45}{10} = 4.5$$

$$\lambda = \frac{1 + \sqrt{1 + 4.5^2}}{2} = 2.805$$

$$G_E = \frac{H}{d}\frac{1}{\pi\sqrt{\lambda}} = \frac{120 - 102}{10} \times \frac{1}{\pi\sqrt{2.805}} = 0.342$$

28. **(b)**

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

where [·] represents concentration in meq./L

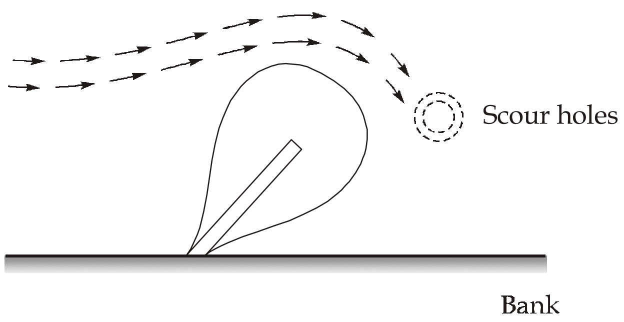
$$[Na^+] = \frac{\text{Weight}}{\text{Equivalent weight}} = \frac{250}{\frac{23}{1}} = 10.869 \text{ meq.}$$

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

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

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

29. **(a)**



30. **(d)**

Water application efficiency is high in drip irrigation.

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