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Irrigation Engineering

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Irrigation Engineering

Date of Test : 01/06/2019

Answer Key

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

DETAILED EXPLANATIONS

1. (c)

$$\text{Sodium adsorption ratio (SAR)} = \frac{[Na^+]}{\sqrt{\dfrac{[Ca^{2+}]+[Mg^{2+}]}{2}}} = \frac{20}{\sqrt{\dfrac{10+5}{2}}}$$

$$= 7.30$$

2. (a)

As per Kennedy's

Critical velocity, $V_0 = 0.55\, my^{0.64}$

m = critical velocity ratio = 0.90

y = depth of flow = 1.2 m

$\therefore$ $V_0 = 0.55 \times 0.9 \times (1.2)^{0.64} = 0.556$ m/sec

Also, discharge through channel, $Q = 4\ m^3/sec$

$\therefore$ Required cross-section area of channel

$$A = \frac{Q}{V_0} = \frac{4}{0.556} \simeq 7.20\ m^2$$

4. (c)

To prevent scouring

$\gamma_\omega RS < 0.056\, \gamma_\omega\, d(G_s - 1)$

where d = particle size (> 6 mm)

$$G_s = 2.65$$

$$\Rightarrow \quad RS \le \frac{d}{11}$$

$$R \le \frac{d}{11S}$$

$$R_{max} = \frac{d}{11S}$$

Given, d = 6 cm (> 6 mm) ok, S = 0.01

$$R_{max} = \frac{6 \times 10^{-2}}{0.01 \times 11} = 0.5454 \text{ m} = 54.54 \text{ cm}$$

5. (d)

$Q = 5\ m^3/s$

Area, A = 20 ha

Time = 5 hrs

Water stored in root zone = 0.4 m

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∴ Water application efficiency

$$\eta_a = \frac{\text{Water stored in root zone}}{\text{Water supplied to field}} \times 100$$

$$= \frac{0.4 \times 20 \times 10^4}{5 \times 5 \times 3600} \times 100 = 88.88\%$$

6. (a)

Given, Field capacity = 18.3%

Root zone depth, d = 1.2 m

Existing moisture content, $W = \frac{W_w}{W_s} = \frac{153 - 138}{138} \times 100 = 10.87\%$

∴ Depth of water required to be applied to bring the moisture upto its field capacity.

$$d_w = \frac{\gamma_d}{\gamma_w}.d.(FC - mc)$$

$$= 1.25 \times 1.2 \times \left(\frac{18.3 - 10.87}{100}\right) = 0.111 \text{ m} \simeq 111 \text{ mm}$$

10. (c)

Mean depth, $D = \frac{2 + 1.9 + 1.8 + 1.6 + 1.5}{5} = 1.76$ m

∴ Value of deviation from mean are (2 – 1.76), (1.9 – 1.76), (1.8 – 1.76), (1.6 – 1.76), (1.5 – 1.76)

= 0.24, 0.14, 0.04, –0.16, –0.26

Average of absolute deviations

$$d = \frac{0.24 + 0.14 + 0.04 + 0.16 + 0.26}{5} = 0.168 \text{ m}$$

Water distribution efficiency, $\eta_d = \left(1 - \frac{d}{D}\right) \times 100 = \left(1 - \frac{0.168}{1.76}\right) \times 100 = 90.45\%$

11. (b)

As per Lane's, he suggested a weighting factor of 1/3 to horizontal creep and 1 for vertical creep.

∴ Creep length, $L = 2d_1 + L/3 + 2d_2$

$= 2 \times 8 + 30/3 + 2 \times 10 = 46$ m

∴ Hydraulic gradient $i = \frac{H}{L} = \frac{6}{46} = 0.13$

12. (d)

Net vertical force, $\Sigma V = W - U = 1036 - 674 = 362$ kN

Net horizontal force, ΣH = Water force

$$= \frac{1}{2} \cdot \gamma_w H^2 = \frac{1}{2} \times 9.81 \times (10)^2 = 490.5 \text{ kN}$$

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$\therefore$ Shear friction factor, $$SFF = \frac{\mu.\Sigma V + B.q}{\Sigma H}$$

B = width of the base of foundation = 8.25 m; μ = 0.75; q = shear strength at the joint = 1400 kN/m^2

$$SFF = \frac{0.75 \times 362 + 8.25 \times 1400}{490.5} = 24.10$$

13. (b)

Intensity of irrigation for kharif = 100 – 65 = 35%

Intensity of irrigation for rabi = 100 – 50 = 50%

$\therefore$ Annual intensity of irrigation = sum of seasonal intensity of irrigation in a year

= 35% + 50% = 85%.

14. (c)

Given, Q = 50 m^3/sec

Silt factor, f = 1.1

As per Lacey's

$\therefore$ Velocity, $$V = \left(\frac{Qf^2}{140}\right)^{1/6} = \left(\frac{50 \times (1.1)^2}{140}\right)^{1/6} = 0.869 \text{ m/sec}$$

Bed slope, $$S = \frac{f^{5/3}}{3340\,Q^{1/6}} = \frac{(1.1)^{5/3}}{3340(50)^{1/6}} = 0.0001828$$

$$S = \frac{1}{5469}$$

15. (a)

Leaching requirement, $$LR = \frac{(EC)_i}{(EC)_d}$$

$(EC)_i$ = Electrical conductivity of irrigation water

= 1.2 milli mho/cm

$(EC)_d$ = Electrical conductivity of drained water

= $2 \times (EC)_e$

$(EC)_e$ = Electrical conductivity of saturated soil extract

= 10 milli mho/cm

$\therefore$ $$LR = \frac{(EC)_i}{2.(EC)_e} \times 100 = \frac{1.2}{2 \times 10} \times 100 = 6\%$$

Also, $$LR = \frac{D_d}{D_i}$$

$$D_i = C_u + D_d$$

C_u = consumptive use = 80 mm; D_d = depth of water drained out; D_i = depth of water applied for irrigation

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$$LR = \frac{D_i - D_u}{D_i}$$

$$\frac{6}{100} = \frac{D_i - 80}{D_i}$$

$$6\,D_i = 100\,D_i - 80 \times 100$$

$$94\,D_i = 8000$$

$$D_i = 85.1 \text{ mm}$$

16. (a)

Classification	E.C in μ Mho/cm	Exchangable sodium percentage, ESP(%)	pH
1. Saline or white alkali soil	> 4000	< 15	≤ 8.5
2. Alkaline or black alkali soil	< 4000	> 15	8.5 – 10
3. Soline-Alkali soil	> 4000	> 15	< 8.5

17. (d)

For non-scouring, $d \leq 11\,RS$

$$R_{max} = \frac{d}{11S}$$

$$V = \frac{1}{n}.R^{2/3}.S^{1/2}$$

$$n = \frac{1}{24}d^{1/6}$$

$$V = \frac{24}{d^{1/6}}R^{2/3}.S^{1/2}$$

$$V_{max} = \frac{24}{d^{1/6}}(R_{max})^{2/3}.S^{1/2}$$

$$= \frac{24}{d^{1/6}}\left(\frac{d}{11S}\right)^{2/3}.S^{1/2} = \frac{24}{(11)^{2/3}}.d^{2/3-1/2}.S^{1/2-2/3}$$

$$V_{max} = 4.85\,d^{1/2}\,.\,S^{-1/6} \quad \text{(where, } d \text{ is in m)}$$

If d is in cm, then,

$$V_{max} = 4.85\left(\frac{d}{100}\right)^{1/2}.S^{-1/6}$$

$$= 0.485\,d^{1/2}\,.\,S^{-1/6} \quad (d \text{ is in cm})$$

$$V_{max} \simeq 0.48\,d^{1/2}\,.\,S^{-1/6}$$

18. (d)

As per Blaney-Criddle formula

$$C_u \text{ or PET} = \Sigma\frac{kp}{40}[1.8t + 32]$$

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$$= \frac{0.65\times 9.3}{40}[1.8\times 28+32]+\frac{0.72\times 10.6}{40}[1.8\times 25+32]$$

$$= 27.14 \text{ cm}$$

In above equation, k = consumptive use coefficient/crop factor; p = monthly %age of annual day light hours; t = temperature (°C).

19. (d)

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

where, H = Total head = 1.5 m

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

d = Depth of d/s cutoff = 2 m

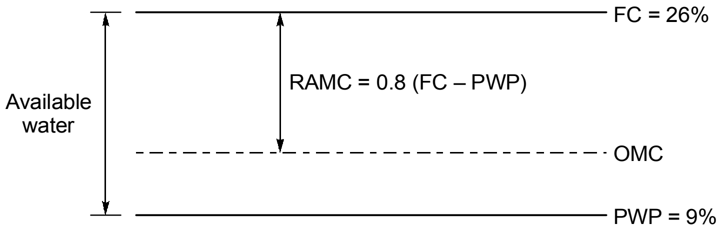
$$\alpha = \frac{b}{d} = \frac{13}{2} = 6.5$$

$$\lambda = \frac{1+\sqrt{1+6.5^2}}{2} = 3.79$$

$\therefore$ $$G_E = \frac{1.5}{2}\cdot\frac{1}{\pi\sqrt{3.79}}$$

$\Rightarrow$ $$G_E = 0.123 \simeq 0.12$$

20. (b)



d = depth of root zone = 75 cm

C_u per day = 1.58 cm/day

$\therefore$ RAMC = Readily available depth of water

$$= \frac{\gamma_d}{\gamma_w}.d.(FC-OMC) = \frac{1.4}{1}\times 0.75\times 0.8\times(0.26-0.09)$$

$$= 0.1428 \text{ m}$$

$\therefore$ Frequency of irrigation, $$FOI = \frac{RAMC}{C_u} = \frac{(0.1428\times 100)\text{cm}}{1.58 \text{ cm/day}} = 9.03 \simeq 9 \text{ days}$$

21. (b)

D = 0.19 m

B = 14 days

Outlet factor, $$D = \frac{8.64B}{\Delta} = \frac{8.64\times 14}{0.19} = 636.6 \text{ ha/m}^3\text{/sec} \simeq 637 \text{ ha/m}^3\text{/sec}$$

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25. (c)

Area, $A = 0.04 \text{ ha} = 0.04 \times 10^4 = 400 \text{ m}^2$

Depth of flow, $y = 10 \text{ cm} = 0.10 \text{ m}$

Infiltration rate, $f = 5 \text{ cm/hr}$

$Q = 0.02 \text{ m}^3/\text{sec}$

time taken to irrigate the crop

$$t = \frac{y}{f}.2.303.\log_{10}\left(\frac{Q}{Q - fA}\right)$$

$$= \frac{10}{5} \times 60 \times 2.303.\log_{10}\left(\frac{0.02}{0.02 - \frac{5 \times 10^{-2}}{3600} \times 400}\right) \text{ min}$$

$$= 39.05 \simeq 39 \text{ min}$$

27. (c)

90% of initial capacity = $0.9 \times 4 \times 10^6 = 36 \times 10^5 \text{ m}^3$

Volume of sediment deposited annually till 90% of initial capacity is filled

= (Annual sediment × trap efficiency in flow)

= $4 \times 10^6 \times 0.9 = 36 \times 10^3 \text{ m}^3$

∴ Number of years during which 90% of initial capacity shall be filled is given by

$$\text{Probable life of reservoir} = \frac{36 \times 10^5}{36 \times 10^3} = 100 \text{ years}$$

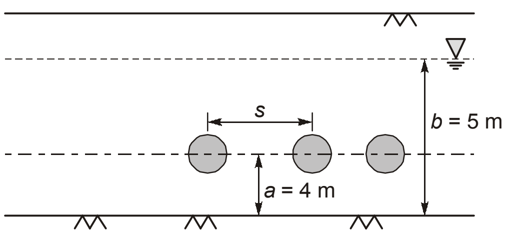
28. (c)

$$B = \frac{H}{\sqrt{S_c - C}} \quad (C = 0;\ \text{when uplift is ignored})$$

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

$$H = 35 \times \sqrt{2.65} = 56.97 \text{ m} \simeq 57 \text{ m}$$

29. (b)



Spacing of tile drain, $$s = \frac{4k}{q}\left(b^2 - a^2\right) = \frac{4 \times 10^{-6}}{1.8 \times 10^{-6}} \times \left(5^2 - 4^2\right) = 20 \text{ m}$$

30. (c)

$$\text{Sinuosity of meander} = \frac{\text{Curve length of meander}}{\text{Straight length of meander}}$$

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