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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 10/08/2019

ANSWER KEY > Irrigation Engineering

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

Detailed Explanations

3. (d)

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 hectare (10×10^4 m^2) field

$$= \frac{13.89}{100} \times 10^5 \text{m}^3 = 13,890 \text{ m}^3 \cong 13,890 \text{ k}l$$

4. (b)

$$\text{Scour depth} = 1.35\left(\frac{q^2}{f}\right)^{1/3} = 1.35\left(\frac{3^2}{1.2}\right)^{1/3} = 2.64 \text{ m}$$

5. (c)

Required discharge (mean) in the field = 0.4 cumecs

$$\text{Peak discharge required} = \frac{\text{mean discharge}}{\text{capacity factor}} = \frac{0.4}{0.8} = 0.5 \text{ cumecs}$$

$$\text{Design discharge for distributary} = \frac{\text{Required discharge for crops}}{\text{Time factor}} = \frac{0.5}{0.5} = 1 \text{ cumecs}$$

6. (d)

$$\text{Water depth applied to fields} = \frac{15 \times 5 \times 60 \times 60}{35 \times 10^4} = 0.7714 \text{ m}$$

Water depth actually stored in root zone = 0.4 m

$$\therefore \quad \text{Water application efficiency, } \eta_a = \frac{0.4}{0.7714} \times 100 = 51.85\%$$

7. (c)

$$d_{max} = 11RS_0$$

Where, $$R = \frac{By}{B+2y} \simeq y \qquad [\therefore B \gg y]$$

$$\therefore \quad d_{max} = 11(0.75) \times 0.0038 = 0.03135 \text{ m} = 31.35 \text{ mm}$$

8. (d)

The discharge (Q) in canal remains the same.

$$\text{Duty for rice, } D_1 = \frac{1350}{Q} \text{ ha/cumec}$$

$$\text{Duty for wheat, } D_2 = \frac{A_2}{Q} \text{ ha/cumec}$$

Now $$\frac{D_1\Delta_1}{B_1} = \frac{D_2\Delta_2}{B_2}$$

or $$\frac{A_1\Delta_1}{B_1} = \frac{A_2\Delta_2}{B_2}$$

$$\therefore \quad A_2 = \frac{123}{150} \times \frac{140}{60} \times 1350 = 2583 \text{ ha}$$

9. (a)

Gross commanded area (G.C.A) = 6000 ha

Culturable commanded area (C.C.A.) = G.C.A. – Area reserved for forests and roads

$$= 6000 - \frac{20}{100} \times 6000 = 4800 \text{ ha}$$

Pastures and fallow lands are included in culturable commanded area. So, it will be a part of culturable commanded area.

Area to be irrigated = Intensity of irrigation × CCA

$$= \frac{60}{100} \times 4800 = 2880 \text{ ha}$$

10. (a)

Given, B = 100 days; D = 1728 ha/cumec

$$\text{Delta, } \Delta = 8.64\frac{B}{D}$$

$$\Rightarrow \quad \Delta = \frac{8.64 \times 100}{1728} = 0.5 \text{ m} = 50 \text{ cm}$$

11. (b)

The limiting height of a low concrete gravity dam without considering uplift force is given by

$$H_{max} = \frac{f}{\gamma_w (G+1)}$$

$$= \frac{4.16 \times 10^3}{9.81(2.45+1)} = 122.915 \text{ m}$$

12. (c)

Depth of water required in the field during transplantation = 600 mm

Useful rainfall during this period = 150 mm

∴ Depth of water required to be supplied by the water course

= (600 – 150) = 450 mm

= 0.45 m

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

∴ Duty of water on the field is

$$D = \frac{8.64 \times 20}{0.45}$$

= 384 hectares/cumec

Since the losses of water in the water course are 25%, a discharge of 1 cumec at the head of the water course will be reduced to 0.75 cumec at the head of the field, and hence will irrigate

384 × 0.75 = 288 hectares

∴ Duty of water at the head of the water course

= 288 hectares/cumec

Total area under rice plantation

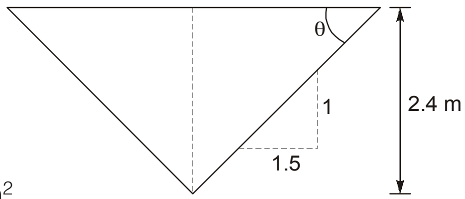
= 1200 × 0.75 = 900 hectares

∴ Discharge at the head of water course

$$= \frac{900}{288} = 3.125 \text{ cumec} = 3.13 \text{ cumec}$$

13. (b)

From the figure



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

$$\therefore \quad \theta = 0.588 \text{ radians} = 33.69°$$

$$A = y^2(\theta + \cot\theta)$$

$$= 2.4^2(0.588 + 1.5) = 12.03 \text{ m}^2$$

$$\therefore \quad V = \frac{28}{12.03} = 2.328 \text{ m/sec} \simeq 2.33 \text{ m/sec}$$

14. (c)

The deficiency created due to fall of moisture from 25% to 17% is

$$= \frac{16}{9.81} \times \frac{75}{100} \times (0.25 - 0.17) = 0.0979 \text{ m}$$

So, 0.0979 m is the net irrigation requirement.

∴ Quantity of water required to be supplied to the field irrigation requirement is

$$\text{FIR} = \frac{NIR}{\eta_a} = \frac{0.0979}{0.75} = 0.1305 \text{ m} = 13.05 \text{ cm}$$

15. (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

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

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

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

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

17. (a)

Total available moisture holding capacity of soil (in terms of depth, mm) = 12.5 × 0.8 = 10 cm = 100 mm

Moisture which must be added to the soil through irrigation $= \frac{50}{100} \times 100 = 50\text{mm}$

$$\text{Frequency of irrigation} = \frac{\text{Moisture added}}{\text{Consumptive use}} = \frac{50\text{mm}}{5\text{mm/day}} = 10\text{days}$$

18. (d)

For no scouring, $d \geq 11 RS$

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

$$\therefore \quad V = \frac{1}{N} R^{2/3} S^{1/2}$$

but, $$N = \frac{(d)^{1/6}}{24} \quad \text{(Strickler's formula)}$$

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

$$\therefore \quad V_{max} = \frac{24}{d^{1/6}} R_{max}{}^{2/3} S^{1/2}$$

$$V_{max} = \frac{24}{d^{1/6}} \left(\frac{d}{11S}\right)^{2/3} S^{1/2} = 4.85\, d^{1/2} S^{-1/6} \quad \text{(where } d \text{ is in m)}$$

when d is in 'cm' i.e. d_{cm}, then

$$d = \frac{d_{cm}}{100}$$

$$\therefore \quad V_{max} = 4.85 \left(\frac{d_{cm}}{100}\right)^{1/2} S^{-1/6}$$

$$\therefore \quad V_{max} = 0.485\, d^{1/2} S^{-1/6}$$

19. (a)

$$\text{Discharge required for crop } x = \frac{\text{Area under crop } x}{\text{Duty for crop } x} = \frac{0.30 \times 3000}{8.64 \times \frac{20}{\frac{17.5}{100}}} = 0.91 \text{ m}^3/\text{s}$$

$$\text{Discharge required for } y = \frac{\text{Area under crop } y}{\text{Duty for crop } y} = \frac{0.4 \times 3000}{8.64 \times \frac{15}{\frac{9}{100}}} = 0.83 \text{m}^3/\text{s}$$

$$\text{Total discharge} = (0.91 + 0.83) = 1.74 \text{ m}^3/\text{s}$$

21. (c)

$$\text{Culturable command area} = 10^5 \times \frac{75}{100} = 75000 \text{ hectares}$$

for Kharif crop, $$\text{Area under Kharif crop} = 75000 \times \frac{50}{100} = 37500 \text{ hectares}$$

$$\text{Duty for Kharif crop} = 1200 \text{ hectares/cumecs}$$

$$\text{Required discharge for Kharif crop} = \frac{37500}{1200} = 31.25 \text{ cumecs}$$

for Rabi crop, $$\text{Area under Rabi crop} = 75000 \times \frac{55}{100} = 41250 \text{ hectares}$$

$$\text{Duty for Rabi crop} = 1400 \text{ hectares/cumecs}$$

$$\text{Required discharge for Rabi crop} = \frac{41250}{1400} = 29.46 \text{ cumecs}$$

Discharge of the canal at the head of the field should be 31.25 cumecs (as it is maximum).
Now, considering 20% provision for losses,
Required discharge at the head of canal = 31.25 /0.8 = 39.06 cumecs

22. (b)

Given: $H = 100$ m

$S_c = 2.3$

$$C = 0.75$$

Case (i): No Tension

$$B_{\min} = \frac{H}{\sqrt{S_c - C}}$$

Case (ii): No sliding

$$B_{\min} = \frac{H}{\mu(S_c - C)}$$

Note: μ is not given so solve by case (i),

$$\therefore \quad B_{\min} = \frac{100}{\sqrt{2.3 - 0.75}} = 80.32\text{m}$$

23. (a)

Volume of total water applied = 750 m^3

Volume of water got wasted = 12% of 750 m^3 = 90 m^3

Water used in raising moisture content up to field capacity = 750 – 90 = 660 m^3

Depth of water used in raising moisture content up to field capacity from the existing 10%

$$= \frac{660}{1500} = 0.44 \text{ m}$$

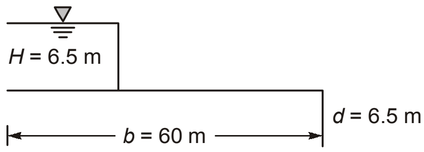
But water depth required in root zone to increase moisture content of soil to field capacity is given by,

$$0.44 = \frac{1.47}{1} \times 1.75 \times [\text{F.C} - 0.1]$$

$$\Rightarrow \quad \text{FC} = 0.2710$$

$$\text{Hence, field capacity} = 27.10\%$$

24. (a)



Exit gradient, $$G_E = \frac{H}{d} \times \frac{1}{\pi\sqrt{\lambda}}$$

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

and $$\alpha = \frac{b}{d} = \frac{60}{6.5} = 9.23$$

$$\therefore \quad \lambda = \frac{1 + \sqrt{1 + 9.23^2}}{2} = 5.142$$

$$G_E = \frac{6.5}{6.5} \times \frac{1}{\pi\sqrt{5.142}} = 0.14037 \simeq 0.14$$

25. (a)

$$\tau_0 = \gamma_w RS$$

$$= 1000 \times 2.5 \times \frac{1}{10000} = 0.25 \text{ kg/m}^2$$

$$\text{Now, on side slopes, shear stress} = 0.75\,\gamma_w RS$$

$$= 0.75 \times 0.25$$

$$= 0.1875 \text{ kg/m}^2 \simeq 0.19 \text{ kg/m}^2$$

26. (a)

Given,

$$\text{Initial bulk unit weight, } \gamma_1 = 20.4 \text{ kN/m}^3$$

$$\text{Water content, } w_1 = 20\% = 0.20$$

$$\text{Dry unit weight, } \gamma_{d_1} = \frac{\gamma_1}{1+w_1} = \frac{20.4}{1+0.20} = 17 \text{kN/m}^3$$

$$\text{Final bulk unit weight, } \gamma_2 = 18.7 \text{ kN/m}^3$$

$$\gamma_d = \frac{G\gamma_w}{1+e}$$

$\because$ G and γ_w are similar for a particular type of soil. So, if e remains unchanged, γ_d will also remain unchanged.

Hence, $$\gamma_{d_2} = \gamma_{d_1} = 17 \text{kN/m}^3$$

$$\gamma_{d_2} = \frac{\gamma_2}{1+w_2}$$

$$\Rightarrow \quad 17 = \frac{18.7}{1+w_2} \Rightarrow 1+w_2 = 1.1 \Rightarrow w_2 = 0.1 = 10\%$$

27. (c)

$$\text{Water depth required at canal} = \frac{\text{water depth requied in the field}}{\eta_a \cdot \eta_c} = \frac{8}{0.72 \times 0.87} = 12.77 \text{ cm}$$

$$\text{Volume of water required} = 8 \times 10^4 \times 12.77 \times 10^{-2} = 10216 \text{ k}l$$

28. (b)

According to Bligh's creep theory, the total creep length is given by

$$L = (2 \times 5) + (2 \times 3) + 25 + (2 \times 10) = 61 \text{ m}$$

Length of creep upto point A = $(2 \times 5) + (2 \times 3) + 10 = 26$ m

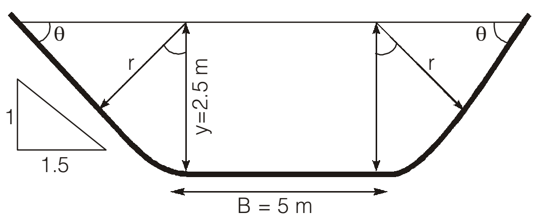
$\therefore$ Residual seepage head at point A is

$$h_A = 5\left(1 - \frac{26}{61}\right) = 2.87 \text{ m}$$

$\therefore$ Required thickness of floor at point A

or $$t = \frac{4}{3}\frac{h_A}{(G-1)} = \frac{4}{3} \times \frac{2.87}{(2.5-1)} = \frac{4}{3} \times \frac{2.87}{1.5} = 2.55 \text{ m}$$

29. (c)



For a lined trapezoidal channel, corners are rounded, due to which A and P are computed by the following equations

$$A = y(B + y\,\theta + y \cot \theta)$$

$$P = B + 2y\,\theta + 2y\cot\theta$$

Here for 1.5 (H) : 1 (V) side slope, we have

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

$$\cot\theta = 1.5,\ \theta = 0.588 \text{ radians}$$

$$y = 2.5 \text{ m},\ B = 5 \text{ m}$$

$$\therefore \quad A = 2.5\,(5 + 2.5\times 0.588 + 2.5\times 1.5) = 25.55 \text{ sq.m}$$

$$P = (5 + 2\times 2.5\times 0.588 + 2\times 2.5\times 1.5) = 15.44 \text{ m}$$

$$R = \frac{A}{P} = \frac{25.55}{15.44} = 1.655$$

$$Q = \frac{1}{n}\cdot A\cdot R^{2/3}\cdot\sqrt{S}$$

$$= \frac{1}{0.016}\times 25.55(1.655)^{2/3}\frac{1}{\sqrt{1000}} = 70.65 \text{ m}^3/\text{s}$$

During kor period of 10 days, volume of water which can be supplied by the channel

$$= 70.65\times(10\times 24\times 60\times 60)\ \text{m}^3 = 61.0416\times 10^6\ \text{m}^3$$

Area which can be irrigated (A) × Depth of water required = Volume of water available

$$\therefore \quad A\times 0.15 \text{ m} = 61.0416\times 10^6 \text{ m}^3$$

or
$$A = \frac{61.0416\times 10^6}{0.15}\text{m}^2 = 406.944\times 10^6\text{m}^2 = 406.94 \text{ sq. km}$$

30. (d)

Depth of water in root zone at field capacity per metre depth of soil,

$$d_{w_1} = 0.5 \text{ m}$$

Depth of water in root zone at permanent wilting point per metre depth of soil,

$$d_{w_2} = 0.2 \text{ m}$$

$$\text{Depth of soil, } d = 1 \text{ m},$$

$$\gamma_d = 12.5 \text{ kN/m}^3$$

$$\gamma_w = 10 \text{ kN/m}^3$$

$$\text{Field capacity} = \frac{\gamma_w\cdot d_{w_1}}{\gamma_d\cdot d} = \frac{10\times 0.5}{12.5\times 1} = 0.40 = 40\%$$

$$\text{Permanent wilting point} = \frac{\text{Field capacity}}{0.5}\times 0.2 = 0.16 = 16\%$$

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