ACE ENGINEERING PUBLICATIONS

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CIVIL ENGINEERING

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IRRIGATION ENGINEERING

Volume – I & II: Study Material with classrrom and
Self Practice Questions (Work Book)

Irrigation Engineering

Solutions for Volume : I Classroom Practice Questions

Chapter- 1
Basics of water resources Engineering

Class Room Practice Solutions

02. Ans: (a)

Sol: Q = 50 *l*it/sec ⇒ 5×10^{-3} m^3/s

$$f = 5\,cm/hr \Rightarrow \frac{5\times10^{-2}}{3600} m^2/s$$

$$A_{max} = \frac{Q}{f} = \frac{5\times10^{-3}}{5\times10^{-2}}\times 3600$$

$$= 3600\ m^2$$

1 ha = 10000 m

1 ha = 10^4 m

In hectares = 3600 × 10^{-4} hectares

= 0.36 ha

Chapter- 2
Soil, water and plant

Class Room Practice Solutions

01. Ans: (b)

Sol:

Evapo-transpiration (E.T) = $c_u \Leftrightarrow d_w$

$$f = \frac{d_w}{c_u}$$

$d_w = c_u$

$$d_w = Sd[FC - OMC]$$

= 1.3×70 [0.28–0.16]

= 10.92 cm

Note

In this problem time frequency is taken as 1 day ⇒ f = 1

02. Ans: (b)

Sol: Leaching is not separately mentioned in this case

⇒ CIR = NIR

$$GIR = \frac{NIR}{\eta_i} = \frac{NIR}{\eta_a.\eta_c} = \frac{14.9}{(0.8)(0.7)} = 26.6\,cm$$

03. Ans: (c)

Sol: Available Moisture (A.M) $\Rightarrow$ y in depth

$$S = \frac{12.75}{9.81} \Rightarrow \frac{\gamma_{soil}}{\gamma_w}(\text{Soil})$$

= 1.3

y = Sd[FC –pwp]

= 1.3×80 [35–0.2]

y = 15.6 cm

Chapter- 3
Water Requirement of Crops

Conceptual Solutions

08. Ans: (d)

Sol: Δ_{Kor} = 15.12 cm

D = ?

B_{Kor} = 4 weeks

$$\Delta = 846\frac{B}{D}$$

$$15.12 = \frac{846(28)}{D}$$

(B in weeks $\rightarrow$ days $\Rightarrow$ 4× 7 = 28 days)

= 1600 ha/cumec

19. Ans: (d)

Sol: The annual intensity of irrigation for this state

$$= \left(\frac{4.5}{5}\times 90\right) + \left(\frac{2.5}{5}\times 80\right) = 121\%$$

Class Room Practice Solutions

02. Ans: (c)

Sol: $$\frac{50}{100} = \frac{\text{Area to be irrigated}}{8000 - 8000\times\frac{30}{100}}$$

0.05 × 5600 = Area to be irrigated

Area to be irrigated = 2800 hect

03. Ans: (c)

Sol: Base period = 90 days

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

$$= 8.64\times\frac{90}{(105-15)}$$

= 8.64 × 1 ha/ cm^3

= 864 ha / m^3

04. Ans: (d)

Sol: η_a = 0.8, η_c = 0.7

Net irrigation requirement, NIR = 14.9

$$FIR = \frac{NIR}{\eta_a} = \frac{14.9}{0.8} = 18.625\,\text{cm}$$

$$\therefore\ GIR = \frac{FIR}{\eta_c} = \frac{18.625}{0.7} = 26.607\,\text{cm}$$

Chapter- 4
Quality of irrigation water

Conceptual Solutions

05. Ans: (c)

Sol: $Na^+ = 345ppm$

$Ca^{++} = 60$ ppm

$Mg^{++} = 16$ ppm

Converting them into milli equivalent / litre

Milli equivalent / wire =

$$\frac{\text{concentration in ppm}}{\text{equivalent weight of element}}$$

$$Na^+ = \frac{345}{23} = 15$$

$$Ca^{++} = \frac{60}{30} = 2$$

$$Mg^{++} = \frac{18}{12} = \frac{3}{2} = 1.5$$

Sodium absorption ratio (SAR) =

$$\frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

$$= \frac{15}{\sqrt{\frac{2+1.5}{2}}} = 11.33$$

10. Ans: (a)

Sol: If electro conductivity < 4000 $\Rightarrow$ black alkali soil

If electro conductivity > 4000 $\Rightarrow$ white alkali soil

Chapter- 5
Design of Lined Canals

Conceptual Solutions

03. Ans: (a)

Sol: Given channel is triangular lined channel

$$\Rightarrow \text{ Area} = y^2(\theta + \cot\theta)$$

Here $\tan\theta = \frac{1}{1.5} \Rightarrow \theta = \tan^{-1}\left(\frac{1}{1.5}\right) = 33.69$

$$\theta = 33.69 \times \frac{\pi}{180} = 0.588$$

$\cot\theta = 1.5$

Area = $(2.5)^2$ (0.58 + 1.5)

Area = 13

We know = Q = AV

26 = 13 × V

V = 2m/s

Considering F.O.S as 1.1

$\Rightarrow$ V = 2 × 1.1 = 2.2

Class Room Practice Solutions

01 Ans: (c)

Sol: y = 4 m

R = ?

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

$P = 2y(\theta + \cot\theta)$

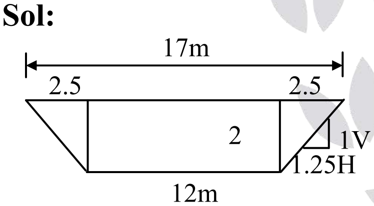
$$R = \frac{A}{P} = \frac{y^3(\theta + \cot\theta)}{2y(\theta + \cot\theta)}$$

y = 4 m

$$R = \frac{4}{2} = 2m$$

02. Ans: (c)

Sol:



FSD⇒ Full supply depth

$$A = \frac{(12+17)\times 2}{2} = 29\,m^2$$

$$P = 12 + 2\left(\sqrt{2.5^2 + 2^2}\right)$$

$= 18.40$

$$R = \frac{A}{P} = \frac{29}{18.40} = 1.576$$

Chapter- 6
Design of unlined canals in alluvial soils

Conceptual Solutions

02. Ans: (b)

Sol: $V = mV_0$

$= 0.55 \times 0.90 \times 1 = 0.495$

06. Ans: (c)

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

$P \propto \sqrt{Q}$

$P_1 = \sqrt{Q}$

$P_2 = \sqrt{1.96Q}$

% increase in wetted perimeter =

$$\frac{\sqrt{1.96Q} - \sqrt{Q}}{\sqrt{Q}} \times 100 = 40\%$$

07. Ans: (b)

Sol: Locey's require sour depth = R_L

$$= 1.35\left(\frac{q^2}{f}\right)^{1/3}$$

$$= 1.35\left(\frac{3^2}{1.2}\right)^{1/3}$$

$$= 1.35\left(\frac{90}{12}\right)^{1/3} = 2.64$$

09. Ans: (b)

Sol: Perimeter $= b + d\sqrt{5}$

$= 22 + 2.5\sqrt{5} = 27.59$

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

$27.59 = 4.75\sqrt{Q}$

$\sqrt{Q} = 5.80$

$Q = 33.64$

Class Room Practice Solutions

05. Ans: (a)

Sol: $Q = 4\ m^3/s$

$f = 2$

$$V = \left(\frac{Qf^2}{140}\right)^{1/6}$$

$$= \left(\frac{4\times 2^2}{140}\right)^{1/6}$$

$= 0.6966$ m/s

$$A = \frac{Q}{V} = \frac{4}{0.6966} = 5.742$$

$$R = 2.5\frac{V^2}{f} = 2.5\times\frac{0.6966^2}{2} = 0.60$$

$$P = \frac{A}{R} = 9.57$$

$$A = BD + \frac{D^2}{2}$$

$5.742 = BD + 0.5D^2$

$P = B + 2.236D$

$D\times 9.57 = BD + 2.236\ D^2$

$BD + 0.5D^2 = 5.74$

$BD + 2.236D^2 = 9.57D$

$1.736 = 9.570–D$

$D = 1.36$ m

06. Ans: (c)

Sol: $f = 1$

$Q = 30\ m^3/s$

$S = ?$

$$S = \frac{f^{5/3}}{3340Q^{1/6}} = \frac{1}{5887}$$

07. Ans: (a)

Sol:

$V_o = ?$

$D = 1.5$ m

$m = 1.1$

$N = 0.018$

$V_o = 0.55D^{0.64}$

$= 0.55(1.5)^{0.64}$

$V_o = 0.713$ m/s

08. Ans: (b)

Sol: Perimeter $= b + d\sqrt{5}$

$= 2 + 8\sqrt{5} = 19.88$

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

$19.88 = 4.75\sqrt{Q}$

$Q = 17.51$

Chapter- 7
Water Logging and Drainage

Conceptual Solutions

03. Ans: (a)

Sol: $P_H > 7 \Rightarrow$ alkaline

$P_H < 7 \Rightarrow$ acidic

Gives $P_H = 9.5 \Rightarrow$ the soil is alkaline.

Chapter- 8
Cross Regulatory Works, Canal outlets & Cross Drainage Works

Conceptual Solutions

12. Ans: (c)

Sol: $$S_e = \frac{m}{n} = \frac{\frac{1}{2}}{\frac{5}{3}} = \frac{1}{2}\times\frac{3}{5} = \frac{3}{10} = 0.3$$

22. Ans: (c)

Sol: $$S = \frac{\frac{dq}{q}\times 100}{\frac{dD}{D}\times 100}$$

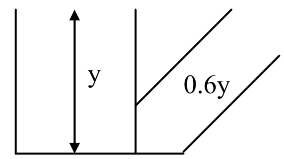
$$\frac{1}{2} = \frac{\frac{dq}{q}\times 100}{50}$$

$$\frac{dq}{q} = 25\%$$

Class Room Practice Solutions

02. Ans: (b)

Sol:



y –0.4y

= 0.6y

$$S_e = \frac{H}{D} = \frac{0.6y}{y}$$

$\Rightarrow S_e = 0.6$

06. Ans: (c)

Sol: (Canal) $Q_C > Q_d$ (drainage)

Type II Siphon (or) canal siphon

Chapter- 9
Diversion Head Works

Conceptual Solutions

06. Ans: (b)

Sol:

K = m

C = m

$$L = (6+6) + \frac{36}{3} + (10+10)$$

L = 44 m

H = 4 m

$$C_L = \frac{L}{H} = \frac{44}{4} = 11 \text{ m}$$

At mid point

$$\ell_{m.p} = 12 + \frac{18}{3}$$

= 18 m

$$h'_{M.P} = \frac{\ell_{MD}}{C_L} = \frac{18}{11} = 1.64 \text{ m}$$

$$h_{m.p} = H - h'_{M.P}$$

$$= 4 - 1.64 \text{ m}$$

$$= 2.36 \text{ m}$$

16. Ans: (b)

Sol: $P_e = \frac{P}{\gamma} + Z + h$

$$10 = 2 + 3 + h$$

$$10 = 5 + h$$

$$h = 5 \text{ m}$$

$$t_{\text{min bottom}} = \frac{h}{s_c}$$

$$= \frac{5}{2.5} = 2 \text{ m}$$

17. Ans: (2.67)

Sol: Floor thickness with suitable F.O.S (2.4) is

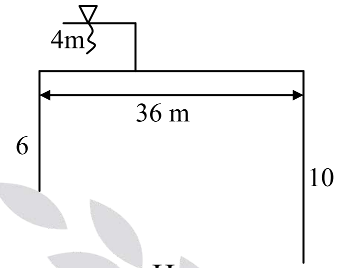
$$= \frac{4}{3} \times \frac{h}{s-1}$$

$$= \frac{4}{3} \times \frac{2.8}{2.4-1} = 2.66 \equiv 2.67$$

Class Room Practice Solutions

02. Ans: (a)

Sol:



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

$$\lambda = \frac{1+\sqrt{1+\alpha^2}}{2}; \quad \alpha = \frac{b}{d} = \frac{54}{6} = 9$$

$$\frac{1+\sqrt{1+81}}{2} = 5.02$$

$$G_E = \frac{6}{6\times\pi\times\sqrt{5.02}} = \frac{1}{\pi\times\sqrt{5.02}}$$

Chapter- 10
Gravity Dams

Conceptual Solutions

08. Ans: (a)

Sol: $\mu = 0.75$

$$\sum PV = 6000 \text{ t}$$

$$\sum P_H = 5000 \text{ t}$$

$$b = 70 \text{ m}$$

$$q = 140 \text{ t/m}^2$$

F.O.S against sliding $= \dfrac{\mu.\sum P_V}{\sum P_H}$

$$= \frac{0.75 \times 6000}{5000} = 0.9$$

(b)

Sol: $SFF = \dfrac{\mu \sum P_V + b.q}{\sum P_H}$

$$SFF = \frac{0.75 \times 6000 + 70 \times 140}{5000} = 2.86$$

11. Ans: (d)

Sol: For F > 32 km, the wave is given by equation given below

$$h_w = 0.032\sqrt{V.F}\ m$$

$$= 0.032 \times \sqrt{160 \times 4} = 2.56\ m$$

Force caused by waves P_w is given by equation

$P_w = 19.62\ h_w^2$ kN/m run of dam

$= 19.62 \times (2.56)^2$ kN = 128.6 kN

≈ 130 kN

13. Ans: (c)

Sol: Wave height

$(h_w) = 0.032\sqrt{V.F} + 0.763 - 0.271(F)^{1/4}$ for F < 32 km

$$h_w = 0.032\sqrt{100 \times 20} + 0.763 - 0.271(20)^{1/4}$$

= 1.62 m

Free board generally provided equal to

$1.5\ h_w = 1.5 \times 1.62 = 2.45$ m ≈ 2.5 m

16. Ans: (d)

Sol: $B = \dfrac{H}{\sqrt{S-C}} = \dfrac{60}{\sqrt{2.4-1}} = \dfrac{60}{\sqrt{1.4}}$

= 50.7 m

(with full uplift pressure C = 1) → (1)

$$B = \frac{H}{\mu(S-C)} = \frac{60}{0.7(1.4)} = 61.22m \approx 61m \rightarrow (2)$$

From (1) and (2) which is greater i.e. 61 m

Class Room Practice Solutions

04. Ans: (c)

Sol:

Limiting height (or) critical height of a dam

$$H_c = \frac{f}{\gamma_w (G+1)} = \frac{2500}{10(2.4+1)} = 73.52\,m$$

05. Ans: (d)

Sol: Limitting height at low dam with our considering uplift $H_V = \dfrac{f}{w(s-G+1)}$

$$= \frac{f}{w(2.5-0+1)} = \frac{f}{w(3.5)}$$

Limitting height at low dam with our considering uplift $H_S = \dfrac{f}{w(s-G+1)}$

$$= \frac{f}{w(2.5-1+1)} = \frac{f}{w(2.5)}$$

Ratio of $\frac{H_S}{H_v} = \frac{\frac{f}{w(2.5)}}{\frac{f}{w(3.5)}} = \frac{3.5}{2.5} = 1.4$

07. Ans: (A)

Sol: $SFF = \frac{M\sum V + bq}{\sum H}$

$\sum H = 70$

Factor of safety against sliding $= \frac{\mu.\sum V}{\sum H}$

$1.05 = \frac{\mu.\sum V}{70}$

$\mu.\sum V = 72.8$

q = 1.4 MPa

b = 70 m

$SFF = \frac{72.8 + 70 \times 1.4}{70}$

SFF = 2.44

Chapter- 11
Spillways

Conceptual Solutions

06. Ans: (b)

Sol: If initial head is H

Increased head by 125% ⇒ H + 1.25H

= 2.25 H

Q for ogee spill way $= C \times L_e \times H_e^{3/2}$

$Q \propto H_e^{3/2}$

$Q_1 = (H_1)^{3/2}$

$Q_2 = (2.25H_2)^{3/2} = 3.375H^{3/2}$

% increased in discharge $= \frac{Q_2 - Q_1}{Q_1} \times 100$

$= \frac{3.375H^{3/2} - H^{3/2}}{H^{3/2}} \times 100 = 237.5\%$

12. Ans: (9.96)

Sol: $L_e = L - 2H_d[K_A + (n-1)K_P]$

n = no. of spans

= 10 – 2(0.6) [0.1 + 2(0.1)]

n – 1 = no. of piers

= 10 – 0.36 = 99.64 cms

= 9.96 mts