



ACE
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CIVIL ENGINEERING

IRRIGATION ENGINEERING

**Volume-I & II: Study Material with Classroom and
Self Practice Questions (Workbook)**



Irrigation Engineering

Solutions for Volume : I Classroom Practice Questions

Chapter- 1 Basics of water resources Engineering

Class Room Practice Solutions

02. Ans: (a)

Sol: $Q = 50 \text{ lit/sec} \Rightarrow 5 \times 10^{-3} \text{ m}^3/\text{s}$

$$f = 5 \text{ cm/hr} \Rightarrow \frac{5 \times 10^{-2}}{3600} \text{ m}^2/\text{s}$$

$$A_{\max} = \frac{Q}{f} = \frac{5 \times 10^{-3}}{5 \times 10^{-2}} \times 3600 \\ = 3600 \text{ m}^2$$

$$1 \text{ ha} = 10000 \text{ m}^2$$

$$1 \text{ ha} = 10^4 \text{ m}^2$$

$$\text{In hectares} = 3600 \times 10^{-4} \text{ hectares} \\ = 0.36 \text{ ha}$$

Chapter- 2 Soil, water and plant

Class Room Practice Solutions

01. Ans: (b)

Sol:

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

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

$$d_w = c_u$$

$$d_w = Sd[\text{FC} - \text{OMC}]$$

$$= 1.3 \times 70 [0.28 - 0.16]$$

$$= 10.92 \text{ cm}$$

Note

In this problem time frequency is taken as 1 day $\Rightarrow f = 1$

02. Ans: (b)

Sol: Leaching is not separately mentioned in this case

$$\Rightarrow \text{CIR} = \text{NIR}$$

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



03. Ans: (c)

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

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

$$= 1.3$$

$$y = Sd[\text{FC} - \text{pwp}]$$

$$= 1.3 \times 80 [35 - 0.2]$$

$$y = 15.6 \text{ cm}$$

Chapter-3 Water Requirement of Crops

Conceptual Solutions

08. Ans: (d)

Sol: $\Delta_{\text{Kor}} = 15.12 \text{ cm}$

$$D = ?$$

$$B_{\text{Kor}} = 4 \text{ weeks}$$

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

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

$$(B \text{ in weeks} \rightarrow \text{days} \Rightarrow 4 \times 7 = 28 \text{ days})$$

$$= 1600 \text{ ha/cumec}$$

17. Ans: (*)

Sol:

$$\text{Volume}_{\text{canal}} = \text{Area} \times y_{\text{canal}}$$

$$= 10 \times 10^4 \times \frac{y_{\text{field}}}{\eta}$$

$$= 10 \times 10^4 \times \frac{10 \times 10^{-2}}{0.9}$$

$$= 11,111.11 \text{ m}^3$$

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)

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

$$0.05 \times 5600 = \text{Area to be irrigated}$$

$$\text{Area to be irrigated} = 2800 \text{ hect}$$

03. Ans: (c)

Sol: Base period = 90 days

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

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

$$= 8.64 \times 1 \text{ ha/ cm}^3$$

$$= 864 \text{ ha / m}^3$$

04. Ans: (d)

Sol: $\eta_a = 0.8, \eta_c = 0.7$

Net irrigation requirement, NIR = 14.9



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

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

Chapter- 4 Quality of irrigation water

Conceptual Solutions

05. Ans: (c)

Sol: $\text{Na}^+ = 345 \text{ ppm}$

$$\text{Ca}^{++} = 60 \text{ ppm}$$

$$\text{Mg}^{++} = 16 \text{ ppm}$$

Converting them into milli equivalent / litre

Milli equivalent / wire

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

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

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

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

Sodium absorption ratio (SAR)

$$= \frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}} = \frac{15}{\sqrt{\frac{2+1.5}{2}}} = 11.33$$

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

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

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

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

$$\cot \theta = 1.5$$

$$\text{Area} = (2.5)^2 (0.58 + 1.5)$$

$$\text{Area} = 13$$

$$\text{We know } Q = AV$$

$$26 = 13 \times V$$

$$V = 2 \text{ m/s}$$

Considering F.O.S as 1.1

$$\Rightarrow V = 2 \times 1.1 = 2.2$$



Class Room Practice Solutions

01 Ans: (c)

Sol: $y = 4$ m

$$R = ?$$

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

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

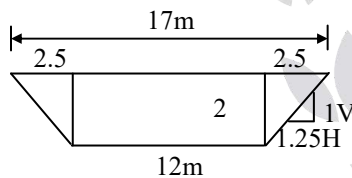
$$R = \frac{A}{P} = \frac{y^3(\theta + \cot\theta)}{2y(\theta + \cot\theta)}$$

$$y = 4$$
 m

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

02. Ans: (c)

Sol:



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

$$P = 12 + 2(\sqrt{2.5^2 + 2^2}) = 18.40$$

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

Chapter- 6
Design of unlined canals in alluvial soils

Conceptual Solutions

02. Ans: (b)

Sol: $V = mV_0$
 $= 0.55 \times 0.90 \times 1 = 0.495$

05. Ans: (c)

Sol: $\tau_c' = \tau_c \sqrt{\frac{1 - \sin^2 \theta}{\sin^2 \phi}}$

$$\cot \theta = 1.5 = \frac{3}{2}$$

$$\sin \theta = \frac{2}{\sqrt{13}}$$

$$\phi = 37^\circ$$

$$\sin \phi = \frac{3}{5}$$

$$\tau_c' = 0.059 w d$$

$$0.059 w_d = WRS_o \sqrt{\frac{1 - \frac{4}{13}}{1 - \frac{9}{25}}}$$

$$\Rightarrow R = \frac{d}{20.87S_o}$$

$$\Rightarrow R = \frac{d}{21S_o}$$



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: $Q = 4 \text{ m}^3/\text{s}$

$$f = 2$$

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

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

$$= 0.6966 \text{ m/s}$$

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

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

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

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

$$5.742 = BD + 0.5D^2$$

$$P = B + 2.236D$$

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

$$BD + 0.5D^2 = 5.74$$

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

$$1.736 = 9.57D - D$$

$$D = 1.36 \text{ m}$$

06. Ans: (c)

Sol: $f = 1$

$$Q = 30 \text{ m}^3/\text{s}$$

$$S = ?$$

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



07. Ans: (a)

Sol:

$$V_o = ?$$

$$D = 1.5 \text{ m}$$

$$m = 1.1$$

$$N = 0.018$$

$$V_o = 0.55D^{0.64}$$

$$= 0.55(1.5)^{0.64}$$

$$V_o = 0.713 \text{ m/s}$$

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

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

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



Class Room Practice Solutions

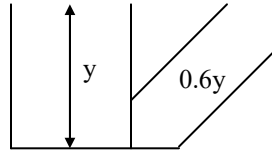
02. Ans: (b)

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:

$$K = m$$

$$C = m$$

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

$$L = 44 \text{ m}$$

$$H = 4 \text{ m}$$

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

At mid point

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

$$= 18 \text{ m}$$

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

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

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

$$= 2.36 \text{ m}$$

16. Ans: (b)

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

$$10 = 2 + 3 + h$$

$$10 = 5 + h$$

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

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

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

17. Ans: (2.67)

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

is

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

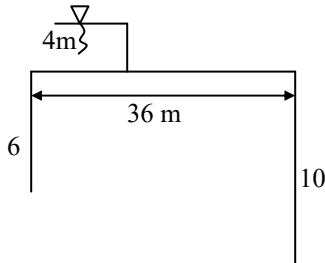
$$= \frac{4}{3} \times \frac{2.8}{2.4-1} = 2.66 \approx 2.67$$



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
River Training Works

Conceptual Solutions

02. Ans: (b)

Sol:

$$Q = 1600 \text{ m}^3/\text{s}$$

$$\begin{aligned} \text{Meander belt} &= 153.75\sqrt{Q} \\ &= 153.75\sqrt{1600} \\ &= 6150 \text{ m} \end{aligned}$$

i.e., the order of 6 km

03. Ans: (b)

Sol:

$$Q = 6000 \text{ m}^3/\text{s}$$

$$M_w = 153.75 \sqrt{Q}$$

$$M_L = 53.75 \sqrt{Q}$$

$$M_R = \frac{M_w}{m_L} = 2.97$$

≈ 3

04. Ans: (d)

Sol:

$$\text{Meander belt} = 153.75\sqrt{Q} = 3000 \text{ m}$$

$$\sqrt{Q} = \frac{3000}{153.75}$$

$$\Rightarrow Q = 380.72 \text{ cumec}$$

$$Q_{\text{peak}} = 2\bar{Q} = 760 \text{ cumec}$$

i.e., the order of 700cumec



06. Ans: (a)
Sol: $Q = 1600 \text{ cumec}$
 $P = 4.75\sqrt{Q}$
 $= 4.75\sqrt{1600}$
 $= 190 \text{ m}$

Chapter- 11 Dams General Principles

Conceptual Solutions

06. Ans: (a)
Sol: Rate of silt deposition per year
 $= 0.1 \text{ Mm}^3/\text{year}$
Capacity of reservoir $= 30 \text{ Mm}^3$
Silt storage capacity $= 20\% \text{ capacity}$
 $= \frac{20}{100} \times 30 = 6 \text{ Mm}^3$
Life of reservoir $= \frac{6}{0.1} = 60 \text{ years}$

Chapter- 12 Gravity Dams

Conceptual Solutions

08. Ans: (a)
Sol: $\mu = 0.75$
 $\sum PV = 6000 \text{ t}$
 $\sum P_H = 5000 \text{ t}$
 $b = 70 \text{ m}$
 $q = 140 \text{ t/m}^2$

$$\text{F.O.S against sliding} = \frac{\mu \cdot \sum P_V}{\sum P_H}$$

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

(b)

Sol: $\text{SFF} = \frac{\mu \sum P_V + b \cdot q}{\sum P_H}$

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

11. Ans: (d)

Sol: For $F > 32 \text{ km}$, the wave is given by equation given below

$$h_w = 0.032\sqrt{V \cdot F} \text{ m}$$

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

Force caused by waves P_w is given by equation

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

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

$$\approx 130 \text{ kN}$$

13. Ans: (c)

Sol: Wave height

$$(h_w) = 0.032\sqrt{V \cdot F} + 0.763 - 0.271(F)^{1/4} \text{ for}$$

$F < 32 \text{ km}$

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

$$= 1.62 \text{ m}$$

Free board generally provided equal to

$$1.5 h_w = 1.5 \times 1.62 = 2.45 \text{ m} \approx 2.5 \text{ m}$$



16. Ans: (d)

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

$$= 50.7 \text{ m}$$

(with full uplift pressure $C = 1$) \rightarrow (1)

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

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

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

05. Ans: (d)

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

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

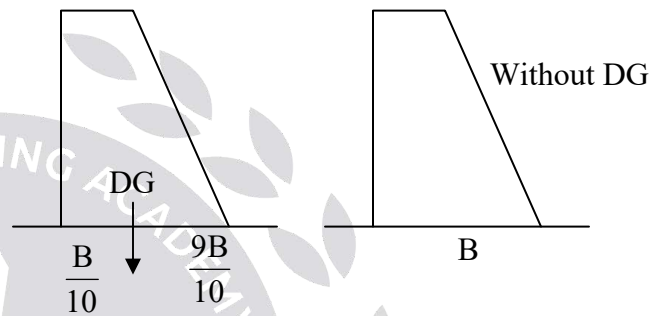
Limiting height at low dam with our considering uplift $H_s = \frac{f}{w(s-G+1)}$

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

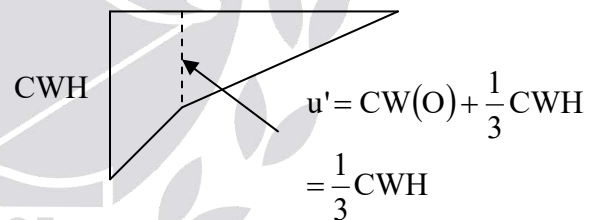
$$\text{Ratio of } \frac{H_s}{H_v} = \frac{\frac{f}{w(2.5)}}{\frac{f}{w(3.5)}} = \frac{3.5}{2.5} = 1.4$$

06. Ans: (d)

Sol:



1 With drainage gallery



$$U_1 = \frac{B}{10(2)} \left[CWH + \frac{1}{3} CWH \right] + \frac{9B}{10(2)} \frac{CWH}{3}$$

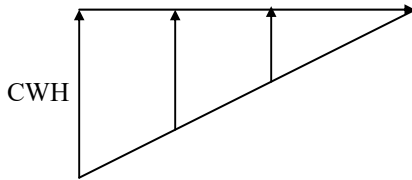
$$= \frac{B}{20} \left(\frac{4}{3} CWH \right) + \frac{9B}{20} \frac{CWH}{3}$$

$$= 13 \frac{CWHB}{60}$$



2. Without drainage gallery

$$U_2 = \frac{1}{2} BCWH$$



Reduction in uplift force in case of DG

$$= CWHB \left[\frac{1}{2} - \frac{13}{60} \right] = CWHB \left[\frac{17}{60} \right]$$

% Reduction

$$= \frac{\frac{17}{60} CWHB \times 100}{\frac{1}{2} CWHB} = 56.67\%$$

07. Ans: (A)

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

$$\sum H = 70$$

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

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

$$\mu \cdot \sum V = 72.8$$

$$q = 1.4 \text{ MPa}$$

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

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

$$SFF = 2.44$$

Chapter- 13 Spillways

Conceptual Solutions

06. Ans: (b)

Sol: If initial head is H

Increased head by 125% $\Rightarrow H + 1.25H$

$$= 2.25 H$$

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

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

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

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

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

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

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

$$= 10 - 0.36 = 9.64 \text{ cms}$$

$$= 9.96 \text{ mts}$$