CIVIL ENGINEERING

IRRIGATION ENGINEERING

Volume – I & II: Study Material with classroom and Self Practice Questions (Work Book)
02. Ans: (a)
Sol: \( Q = 50 \text{ lit/sec} \Rightarrow 5 \times 10^{-3} \text{ m}^3/\text{s} \)
\[ f = 5 \text{ cm/hr} \Rightarrow 5 \times 10^{-2} \text{ m}^2/\text{s} \]
\[ A_{\text{max}} = \frac{Q}{f} = \frac{5 \times 10^{-3}}{5 \times 10^{-2}} \times 3600 \]
\[ = 3600 \text{ m}^2 \]
1 ha = 10000 m
1 ha = \( 10^4 \) m
In hectares = \( 3600 \times 10^{-4} \) hectares
\[ = 0.36 \text{ ha} \]

01. Ans: (b)
Sol: Evapo-transpiration (E.T) = \( c_u \leftrightarrow d_w \)
\[ f = \frac{d_w}{c_u} \]
\[ d_w = c_u \times \Delta \]
\[ d_w = \text{Sd}[\text{FC} - \text{OMC}] \]
\[ = 1.3 \times 70 \times [0.28-0.16] \]
\[ = 10.92 \text{ cm} \]
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
\[ \Rightarrow \text{CIR} = \text{NIR} \]
\[ \frac{\text{GIR}}{\eta} = \frac{\text{NIR}}{\eta_a \eta_c} = \frac{14.9}{(0.8)(0.7)} = 26.6 \text{ cm} \]
Chapter- 3
Water Requirement of Crops

03. Ans: (c)
Sol: Available Moisture (A.M) ⇒ y in depth

\[ S = \frac{12.75}{9.81} \Rightarrow \gamma_{\text{soil}} \frac{\gamma_{\text{soil}}}{\gamma_{w}} \]

= 1.3

\[ y = Sd[FC - pwp] \]

= 1.3 \times 80 [35 – 0.2]

\[ y = 15.6 \text{ cm} \]

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 \times 5600 = Area to be irrigated

Area to be irrigated = 2800 hect

03. Ans: (c)
Sol:

Base period = 90 days

\[ D = \frac{B}{\Delta} \]

\[ = \frac{846}{4} \]

\[ = 216 \text{ days} \]

= 1600 ha/cumec

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: Na$^+$ = 345ppm
Ca$^{++}$ = 60 ppm
Mg$^{++}$ = 16 ppm
Converting them into milli equivalent / litre
Milli equivalent / wire =

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

\[
\begin{align*}
\text{Na}^+ & = \frac{345}{23} = 15 \\
\text{Ca}^{++} & = \frac{60}{30} = 2 \\
\text{Mg}^{++} & = \frac{18}{12} = \frac{3}{2} = 1.5
\end{align*}
\]

Sodium absorption ratio (SAR) =

\[
\frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}}
\]

\[
= \frac{15}{\sqrt{\frac{2+1.5}{2}}} = 11.33
\]

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 \(Q = AV\)

\(26 = 13 \times V\)

\(V = 2\text{m/s}\)

Considering F.O.S as 1.1

\(\Rightarrow V = 2 \times 1.1 = 2.2\)
**Chapter-6**

**Design of unlined canals in alluvial soils**

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### 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 =

\[
\left( \frac{\sqrt{1.96Q} - \sqrt{Q}}{\sqrt{Q}} \right) \times 100 = 40\%
\]

07. Ans: (b)

Sol: Locey’s require sour depth = \( R_L \)

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

\[
= 1.35 \left( \frac{3^2}{1.2} \right)^{1/3} = 2.64
\]
09. Ans: (b)
Sol: Perimeter  = b + d√5
      = 22 + 2.5√5 = 27.59
We know  \( P = 4.75\sqrt{Q} \)
\[ 27.59 = 4.75\sqrt{Q} \]
\[ \sqrt{Q} = 5.80 \]
\[ Q = 33.64 \]

05. Ans: (a)
Sol: \( Q = 4 \text{ m}^3/\text{s} \)
\( f = 2 \)
\[ V = \left( \frac{Qf^2}{140} \right)^{1/6} \]
\[ = \left( \frac{4 \times 2^2}{140} \right)^{1/6} \]
\[ = 0.6966 \text{ m/s} \]
\[ A = \frac{Q}{V} = \frac{4}{0.6966} = 5.742 \]
\[ R = 2.5 \frac{V^2}{f} = 2.5 \times \frac{0.6966^2}{2} \]
\[ = 0.60 \]
\[ P = \frac{A}{R} = 9.57 \]
\[ A = BD + \frac{D^2}{2} \]
\[ 5.742 = BD + 0.5D^2 \]
\[ P = B + 2.236D \]
\[ D \times 9.57 = BD + 2.236D^2 \]
\[ BD + 0.5D^2 = 5.74 \]
\[ BD + 2.236D^2 = 9.57D \]
\[ 1.736 = 9.570 – D \]
\[ D = 1.36 \text{ m} \]

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:
\( V_0 = ? \)
\( D = 1.5 \text{ m} \)
\( m = 1.1 \)
\( N = 0.018 \)
\( V_0 = 0.55D^{0.64} \)
\[ = 0.55(1.5)^{0.64} \]
\( V_0 = 0.713 \text{ m/s} \)

08. Ans: (b)
Sol: Perimeter  = b + d√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: \( S_c = \frac{m}{n} = \frac{1}{2} \times \frac{1}{5} = \frac{3}{10} = 0.3 \)

22. Ans: (c)
Sol: \( S = \frac{\frac{dq}{D} \times 100}{q} \)
\( \frac{1}{2} = \frac{q}{50} \)
\( dq = 25\% \)

Chapter- 9
Diversion Head Works

Conceptual Solutions

06. Ans: (b)
Sol: \( y - 0.4y = 0.6y \)
\( S_c = \frac{H}{D} = \frac{0.6y}{y} \)
\( \Rightarrow \) \( S_c = 0.6 \)

Class Room Practice Solutions

02. Ans: (b)
Sol: \( y - 0.4y = 0.6y \)
\( \Rightarrow \) \( S_c = 0.6 \)

06. Ans: (c)
Sol: (Canal) \( Q_c > Q_d \) (drainage)
Type II Siphon (or) canal siphon

06. Ans: (b)
Sol: \( K = m \)
\( C = m \)
\( L = (6 + 6) + \frac{36}{3} + (10 + 10) \)
\( L = 44 \) m
\( H = 4 \) m
\( C_L = \frac{L}{H} = \frac{44}{4} = 11 \) m

At mid point
\( \ell_{m.p} = \frac{12 + 18}{3} \)
\( = 18 \) m
16. Ans: (b)
Sol: \( P_e = \frac{P}{\gamma} \)
\[
10 = 2 + 3 + h
\]
\[
10 = 5 + h
\]
\[
h = 5 \text{ m}
\]
\[
t_{\text{min bottom}} = \frac{h}{s_c}
\]
\[
= \frac{5}{2.5} = 2 \text{ m}
\]

17. Ans: (2.67)
Sol: Floor thickness with suitable F.O.S (2.4)
is
\[
= \frac{4 \times h}{3} \times \frac{h}{s - 1}
\]
\[
= \frac{4 \times 2.8}{3} \times \frac{2.4 - 1}{2.4 - 1} = 2.66 \equiv 2.67.
\]
F.O.S against sliding = \( \frac{\mu \sum P_V}{\sum P_H} \)

= \( \frac{0.75 \times 6000}{5000} = 0.9 \)

(b)

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

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

11. Ans: (d)
Sol: For \( F > 32 \) km, the wave is given by equation given below

\( h_w = 0.032 \sqrt{V \cdot F} \) m

= \( 0.032 \times \sqrt{160 \times 4} = 2.56 \) m

Force caused by waves \( P_w \) is given by equation

\( P_w = 19.62 \times h_w^2 \) kN/m run of dam

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

\( \approx 130 \) kN

13. Ans: (c)
Sol: Wave height

\( (h_w) = 0.032 \sqrt{V \cdot F} + 0.763 - 0.271(F)^{1/4} \) 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 \( h_w = 1.5 \times 1.62 = 2.45 \approx 2.5 \) m

16. Ans: (d)
Sol: \( B = \frac{H}{\sqrt{S - C}} = \frac{60}{\sqrt{2.4 - 1}} = \frac{60}{\sqrt{1.4}} \)

= 50.7 m

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

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

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

05. Ans: (d)
Sol: Limiting height at low dam with our considering uplift

\( H_s = \frac{f}{w(s - G + 1)} \)

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

Limiting height at low dam with our considering uplift

\( H_s = \frac{f}{w(s - G + 1)} \)

\( = \frac{f}{w(2.5 - 1 + 1)} = \frac{f}{w(2.5)} \)
07. Ans: (A)  
Sol: \[ \text{SFF} = \frac{M \sum V + bq}{\sum H} \] 
\[ \sum H = 70 \] 
Factor of safety against sliding = \[ \frac{\mu \sum V}{\sum H} \] 
\[ 1.05 = \frac{\mu \sum V}{70} \] 
\[ \mu \sum V = 72.8 \] 
\[ q = 1.4 \text{ MPa} \] 
\[ b = 70 \text{ m} \] 
\[ \text{SFF} = \frac{72.8 + 70 \times 1.4}{70} \] 
\[ \text{SFF} = 2.44 \]

12. Ans: (9.96)  
Sol: \[ L_e = L - 2H_q \left[ K_A + (n - 1)K_p \right] \] 
\[ n = \text{no. of spans} \] 
\[ n - 1 = \text{no. of piers} \] 
\[ = 10 - 2(0.6) \left[ 0.1 + 2(0.1) \right] \] 
\[ = 10 - 0.36 = 9.64 \text{ cms} \] 
\[ = 9.96 \text{ mts} \]

% increased in discharge = \[ \frac{Q_2 - Q_1}{Q_1} \times 100 \] 
\[ = \frac{3.375H^{3/2} - H^{3/2}}{H^{3/2}} \times 100 = 237.5\% \]