## Solutions

## General Aptitude

1. Ans. C.

In if clause (type2) 'were' is in the past tense so the so main clause should be in the conditional clause (past tense). Therefore ' $C$ ' is the best answer
2. Ans. A.
'turned a deaf ear' means ignored
3. Ans. C.

Where there is a will there is a way. It is a quotation
4. Ans. A.
$x \%$ of $y=\frac{x}{100} y=\frac{x y}{100}$
$y \%$ of $x=\frac{y}{100} y=\frac{x y}{100}$
$(x \%$ of $y)+(y \%$ of $x)=\frac{2}{100} x y=2 \%$ of $x y$
5. Ans. A.

Let the original number be xy
$y$---unit digit of
$x+y=12$ $\qquad$
$10 y+x=10 x+y+54$
$9 x-9 y=-54$
Solving (1) \& (2) we get, $\mathbf{x = 3}$ and $\mathbf{y = 9}$
So the number is 39
6. Ans. D.
let the deposited money in the company $P$ is $8 x$
And the deposited money in the company Q is 9 x
Interest after one year from the company
$P=8 \times\left(\frac{6}{100}\right)$
Interest after one year from the company
$Q=9 \times\left(\frac{4}{100}\right)$
Ratio of Interest
$=\frac{\frac{8 x \times 6}{100}}{\frac{9 x \times 4}{100}}=\frac{4}{3}$
7. Ans. D.
'Today, historians correlate greatness of a king at his time with the availability of evidence.' This statement leads to the best inference i.e. option 'D'
8. Ans. B.

From given facts, the following venn diagram is possible.

$\mathrm{H}=$ Humans
$M=$ Mammals
E = Engineers
BH = Build houses :
From above diagram, statement III is true.
9. Ans. D.

Lateral surface area of the square pyramid

$$
\begin{aligned}
& A=a \sqrt{a^{2}+4 h^{2}} \quad \begin{array}{l}
4 a \rightarrow \text { perimeter } \\
\\
h \rightarrow \text { height } \\
\quad l \rightarrow \text { slanting height }
\end{array} \\
& P=\left(\frac{a}{2}\right)^{2}+h^{2} \Rightarrow h^{2}=\left(1-\frac{a^{2}}{2}\right) \\
& A=a \sqrt{a^{2}+4\left(l^{1}-\frac{a^{2}}{2}\right)}=a 2 l
\end{aligned}
$$

10. Ans. C.

Ananth covers $1 / 6$ of the book in 1 hour.
Bharath covers $1 / 4$ of the book in 1 hour
$\frac{\left(\frac{1}{6}\right) x}{\left(\frac{1}{4}\right)}=2$
$\Rightarrow \frac{x}{6}=\frac{4}{2}=\frac{1}{2}$
$\Rightarrow x=\frac{6}{2}=3$ hours

## Civil Engineering

1. Ans. A.

Median speed is the speed at the middle value in series of spot speeds that are arranged in ascending order. $50 \%$ of speed values will be greater than the median $50 \%$ will be less than the median.
Ascending order of spot speed studies are
32,39,45,51,53,56,60,62,66,79
Median speed
$=\frac{53+56}{2}=54.5 \mathrm{~km} / \mathrm{hr}$
2. Ans. D.
$f^{\prime}(x)=0 \Rightarrow 2 x-4=0$
$\Rightarrow \mathrm{x}=2$
(stationary point)
$\mathbf{f}^{\prime \prime}(x)=\mathbf{2}>\mathbf{0} \Rightarrow(x)$ is minimum at
and the minimum value is $f(2)$
i.e.,
$(2)^{2}-4(2)+2=2$
$\therefore$ The optimum value of $f(x)$ is -2 (minimum)
3. Ans. C.

The function is $\mathbf{f}(\mathbf{x})=\mathbf{0},-\pi<x \leq 0$
$=\pi-\pi, 0<x<\pi$
and Fourier series is
$\left.f(x)=\frac{\pi}{4}+\frac{2}{\pi}\left[\frac{\cos x}{1^{2}}+\frac{\cos 3 x}{3^{2}}+\ldots\right]\right]+$
$\left[\frac{\sin x}{1}+\frac{\sin 2 x}{2}+\frac{\sin 3 x}{3}+\ldots\right]$
At $x=0$ (a point of discontinuity), the fourier series converges
to $\frac{\mathbf{1}}{\mathbf{2}}\left[\mathbf{f}\left(\boldsymbol{0}^{-}\right)+\mathbf{f}\left(\mathbf{0}^{+}\right)\right]$, where $\mathbf{f}\left(\boldsymbol{\sigma}^{-}\right)=\lim _{\mathrm{x} \rightarrow \mathrm{B}}(\mathbf{0})=0$ and $f\left(0^{+}\right)=\lim _{x \rightarrow B}(\pi-x)=\pi$

Hence, (1) becomes
$\frac{\pi}{2}=\frac{\pi}{4}+\frac{2}{\pi}\left[\frac{1}{1^{2}}+\frac{1}{3^{2}}+\ldots\right]$
$\Rightarrow \frac{1}{1}+\frac{1}{3^{\pi}}+\frac{1}{5^{3}}+\ldots \frac{\pi^{4}}{8}$
4. Ans. A.
$P\left(X \cup Y^{c}\right)=0.7 \Rightarrow P(x)+P\left(y^{c}\right)-P(x) \cdot P\left(y^{c}\right)$
$=0.7$
(Since, $x, y$ are independent events)
$\Rightarrow P(x)+1-P(y)-P(x)\{1-P(y)\}=0.7$
$\Rightarrow P(y)-P(x \cap y)=0.3---(1)$
$P(x \cup y)=P(x)+P(y)-P(x \cap y)=0.4+0.3$
$=0.73$
Second Method:
We know that
$\Rightarrow P\left(x \cup y^{\prime}\right)=P(x)+P\left[(x \cup y)^{\prime}\right]$
$\Rightarrow 0.7+0.4+1-P(x \cup y)$
$\Rightarrow P(x \cup y)=0.7$
5. Ans. D.
(i) $\lim _{x \rightarrow \infty} \frac{x y}{x^{2}+y^{2}}=\lim _{y \rightarrow B}\left(\frac{0}{0^{2}+y^{2}}\right)=0$
(i.e., put $\mathbf{x}=\mathbf{0}$ and then $\mathbf{y = 0}$ )
(ii) $\lim _{\substack{x \rightarrow B \\ y \rightarrow B}} \frac{x y}{x^{2}+y^{2}}=\lim _{x \rightarrow B}\left(\frac{0}{x^{3}+0}\right)=0$
(i.e., put $\mathbf{y}=\mathbf{0}$ and then $\mathbf{x = 0}$ )
(iii) $\lim _{\substack{y \\ y \rightarrow 0}} \frac{x y}{x^{2}+y^{2}}=\lim _{x \rightarrow b} \frac{x(m x)}{x^{2}+m^{2} x^{2}}$
(i.e., put $\mathbf{y}=\mathbf{m x}$ )
$=\lim _{x \rightarrow \infty}\left(\frac{m}{1+m^{2}}\right)=\frac{m}{1+m^{2}}$,
which depends on 'm'.
Hence, the limit does not exists.
6. Ans. A.

Number of joints (J) = 7
For rigid joint plan truss kinematic
Indeterminacy $=\mathbf{2 J} \mathbf{- R}$
$=2 \times 7-(2+1)=14-3=11$

7. Ans. B.

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$$
\tau_{c_{\max }}=0.62 \sqrt{f_{\mathrm{ck}}}
$$

$\boldsymbol{\tau}_{\boldsymbol{a}_{\text {max }}}$ depends on grade of concrete only.
8. Ans. B.

$\sum M_{A}=0$
$\mathrm{P} \times \mathrm{L}-\mathrm{T}_{\mathrm{z}} \times \mathrm{L}-\mathrm{T}_{\mathrm{Y}} \times \mathrm{L}=0$
$2 \times T \times L / \sqrt{2}=P$
$\mathrm{T}=(\mathrm{P} * \sqrt{2}) / 2=\mathrm{P} / \sqrt{2}$
9. Ans. D.

Minimum compressive strength of burnt clay brick $=3.5$ MPa
10. Ans. C.


## (5) $-(7)=$ Total float $=t_{E}-t_{L}=0$

$(11)-(12)=$ Total float $=t_{E}-t_{L}=0$
11. Ans. D.

For pure clays, the bearing capacity is independent of the footing width.
12. Ans. C.

For quick sand conditions
$i=\frac{G-1}{1+e} \Rightarrow G=i(1+e)+1$
Given porosity $\boldsymbol{\eta}=\mathbf{3 0 \%}=\mathbf{0 . 3}$
$e=\frac{n}{1-n}=\frac{0.3}{1-0.3}=\frac{0.3}{0.7}=0.43$
$G=i(1+0.43)+1$
$=i(1.43)+1$
$=1.43+1$
13. Ans. B.

$\bar{\sigma}=10 \times(16-10)$
$=10 \times 6$
$=60 \mathrm{kN} / \mathrm{m}^{1}$
$0 . C R=\frac{90}{60}=\frac{9}{6}=1.5$
14. Ans. B.
h $=\frac{2.75}{4} \times 100=68.75 \%$
$\phi_{h}=100-\phi_{\mathrm{R}}=31.25 \%$
Now, $\phi_{p}=\frac{\text { Pr essure head at point }}{\text { Total head }} \times 100$
$\Rightarrow 31.25=\frac{\mathrm{h}}{4} \times 100 \Rightarrow \mathrm{~h}=1.25 \mathrm{~m}$
15. Ans. A.
$\Delta h=100 \mathrm{~cm}, \mathrm{~A}=1000 \mathrm{~km}^{2}$
$\mathrm{n}=\mathbf{0 . 2 5}, \mathrm{r}=0.05$
$\because$ P orovity $(\eta)=$ Spiyfald $(y)+$ Sp Ratention $(r)$
$\Rightarrow \mathrm{y}=\mathbf{0 . 2 5 - 0 . 0 5}=\mathbf{0 . 2 0}$
Amount of water drained out
$=\mathrm{y} \times \mathrm{A} \times \Delta \mathrm{h}=0.2 \times 1000 \times 100 \times 10^{-\pi}$
$=0.2 \mathrm{~km}^{\mathrm{y}}$.
16. Ans. C.

Newtonian fluid - Curve 2
Pseudo plastic fluid - Curve 4
Plastic fluid - Curve 5
Dilatant fluid - Curve 3
17. Ans. D.

The atmospheric layer closest to the earth surface is troposphere .
18. Ans. C.

Total area of settling tank required,

$$
A=\frac{Q}{V}=\frac{1500}{20}=75 \mathrm{~m}^{2}
$$

Since no. of tanks $=2$
So, area of each tank

$$
\begin{aligned}
& =\frac{75}{2}=37.5 \mathrm{~m}^{2} \\
& \frac{\pi d^{4}}{4}=37.5 \Rightarrow d=6.91 \mathrm{~m}
\end{aligned}
$$

19. Ans. C.

Since each household gets water $=540 \mathrm{~L} /$ day
So, total treated water $=540 \times 4=2160$ L/day
Let bypass flow rate is QL/day
So,
$75=\frac{Q \times 42.0+(2160-Q) \times 0}{2160}$
$\Rightarrow 2160 \times 75=Q \times 420$
$\Rightarrow Q=385.71 \mathrm{~L} /$ day
20. Ans. C.

Faintest sound that a normal healthy individual can
hear $20 \mu \mathrm{pa}$
21. Ans. C.

Radius of Radius of relative stiffiness, $L=\left[\frac{E h^{3}}{12 k\left(1-\mu^{2}\right)}\right]^{\frac{1}{4}}$
Statement -1 : False
Directly proportional to modulus of elasticity and also $\mu$
( $\therefore$ As $\mu$ increases $L$ decreases)
Statement -2: False
22. Ans. A.

If Veh/day ranges from 3000 to 6000 , min. $15 \%$ of traffic to be surveyed
23. Ans. D.

For optimal flight planning for a photogrammetric survey both side lap and end lap should be considered.
24. Ans. D.


Departure $=1 . \sin 30=10 \times \sin 30=10 \times \frac{1}{2}$
25. Ans. A.


Tangent length
$=R \cdot \tan \left(\frac{\Delta}{2}\right)=R \cdot \tan \left(\frac{60}{2}\right)$
$=R \tan 30^{\circ}=0.557 R$
26. Ans. B.

27. Ans. B.

Mean of $f(x)$ is
$E(x)=\int_{-\pi}^{s} x_{0}\left(\frac{x}{a}+1\right) d x+\int_{B}^{\pi} x_{0}\left(\frac{-x}{a}+1\right) d x$
$=\left(\frac{x^{y}}{3 a}+\frac{x^{a}}{2}\right)_{-a}^{b}+\left(\frac{-x^{3}}{3 a}+\frac{x^{a}}{2}\right)_{0}^{\pi}=0$
Variance of $f(x)$ is $E\left(x^{a}\right)-\{E(x)\}^{z}$ where
$E\left(x^{a}\right)=\int_{-a}^{s} x^{a} \cdot\left(\frac{x}{a}+1\right) d x+\int_{b}^{a} x^{a} \cdot\left(\frac{-x}{a}+1\right) d x$
$=\left(\frac{x^{4}}{4 a}+\frac{x^{2}}{3}\right)_{-a}^{b}+\left(\frac{-x^{4}}{4 a}+\frac{x^{4}}{3}\right)_{0}^{\pi}=\frac{a^{4}}{6}$
$\Rightarrow$ Variance is $\frac{a^{\prime}}{6}$
Next, mean of $g(x)$ is
$E(x)=\int_{a}^{0} x \cdot\left(\frac{-x}{a}\right) d x+\int_{0}^{a} x \cdot\left(\frac{x}{a}\right) d x=0$
Variance of $\boldsymbol{g}(\mathbf{x})$ is $E\left(x^{2}\right)-\{E(x)\}^{2}$, where
$E\left(x^{a}\right)=\int_{-\infty}^{B} x^{a^{2}} \cdot\left(\frac{-x}{a}\right) d x+\int_{B}^{\pi} x^{x^{2}} \cdot\left(\frac{x}{a}\right) d x=\frac{a^{y}}{2}$
$\Rightarrow$ Variance is $\frac{a^{n}}{2}$
$\therefore$ Mean of $f(x)$ and $g(x)$ are same but variance of $f(x)$ and $g(x)$ are different.
28. Ans. D.

Given curves $\mathbf{x}^{\mathbf{z}}=\mathbf{4 y} \quad \ldots(1)$ and $\mathbf{y}^{\mathbf{z}}=\mathbf{4 x}$
Diff (1), (2) w.r.to ' $x$ ', we get
$2 x=4 \frac{d y}{d x} \Rightarrow\left(\frac{d y}{d x}\right)_{(b, b)}=0=m_{1}$ and (say)
$2 y \frac{d y}{d x}=4 \Rightarrow\left(\frac{d y}{d x}\right)_{m} \rightarrow \infty=m_{2}$ (8ay)
Let $\mathbf{m}_{\mathbf{2}}=\mathbf{1}_{\mathbf{m}^{\boldsymbol{r}}}$ wherer $\mathbf{m}^{\prime}=\mathbf{0}$
$\tan \theta=\left|\frac{m_{1}-m_{2}}{1+m_{1} m_{2}}\right|=\left|\frac{m_{1} m^{\prime}-1}{m^{2}+m_{1}}\right|=\left|\frac{0-1}{0+0}\right|=\infty$
$\Rightarrow \theta=\frac{\pi}{2}=90^{\circ}$,
29. Ans. A.

Parabola is $x^{7}=8 y \Rightarrow y=\frac{x^{2}}{8}$ and straight line is $y=8$
At the point of intersection, we have
$\frac{x^{2}}{8}=8 \Rightarrow x=-8,8$ and $y=8 \geq y=\frac{x^{2}}{8}$
$\therefore$ Required area is $\int_{x-8}^{8}\left(8-\frac{x^{2}}{8}\right) d x$
$=2 \int_{0}^{8}\left(8-\frac{x^{2}}{8}\right) d x\left(\because 8-\frac{x^{2}}{8}\right.$ is even function $)$
$=2\left[8 x-\frac{x^{3}}{24}\right]_{0}^{8}=\frac{256}{3}=85.33 \mathrm{Sq}$ units
30. Ans. B.

The quadratic approximation of $f(x)$ at the point $x=0$ is

$$
\begin{aligned}
f(x) & =f(0)+\frac{x}{11} f^{\prime}(0)+\frac{x^{2}}{2 l} f^{\prime \prime}(0) \\
& =(-5)+x \cdot\{0\}+\frac{x^{2}}{2}\{-6\}=-3 x^{2}-5
\end{aligned}
$$

31. Ans. C.


For no change in the volume
Volumetric strain $\left(s_{v}\right)=0$
$\left(\frac{\delta_{\mu}+\delta_{y}+\delta_{z}}{3}\right)(1-2 \mu)=0$
$1-2 \mu=0$
$1-2 \mu$
Possions ratio $\mu=\frac{1}{2}=0.5$
32. Ans. B.

$\sigma_{u}=45 \mathrm{MPa}$
$\sigma_{v}=45 \mathrm{MPa}$
$r_{w}=4 r$
We know that
$\sigma_{\operatorname{mav} \min }=\left(\frac{\sigma_{u}+\sigma_{\psi}}{2}\right) \pm \sqrt{\left(\frac{\sigma_{u}+\sigma_{\psi}}{2}\right)^{2}+r_{u \psi}^{z}}$
$\sigma_{\max }=\left(\frac{5+5}{2}\right)+\sqrt{\left(\frac{5+5}{2}\right)^{2}+i^{2}}$
$10=5+\sqrt{5^{2}} \Rightarrow 10-5=$ r
$F=5 \mathrm{MPa}$
33. Ans. A.

Since there is no external horizontal load.
So, $H_{B}=0$
$\Rightarrow M_{z}=0$
34. Ans. C.



$$
\begin{aligned}
& \Sigma F x=0 \\
& \Rightarrow F_{G \beta} \times \cos 45^{\circ}+F_{G z} \cos 45^{5}+F_{G R}=0 \\
& \Rightarrow F_{Q \beta}=W=100 \mathrm{kN}(\text { Compressive }) \\
& \Delta_{Q R}=\frac{F_{G R} \times L}{2 A_{1}}=\frac{100 \times \sqrt{2 L}}{4 \times 0.05 \times 0.3 \times 106} \\
& \quad=0.471 \text { (Shortening) }
\end{aligned}
$$

35. Ans. C.


100kN
100kN
$r_{v}=\frac{V_{u} \pm \frac{M}{d} \cdot \tan \beta}{b d}$
$\Rightarrow V_{d}=r_{v} b d=V_{u} \pm \frac{M_{u}}{d x} \tan \beta$
$V_{u}=100-10 \times 5=50 \mathrm{kN} ; \mathrm{dx}=500 \mathrm{~mm}$
$M_{u}=100 \times 5-10 \times \frac{5 \times 5}{2}=375 \mathrm{kN}-\mathrm{m}$
$V_{d}=50+\frac{375}{0.5} \times \tan \beta$
$\tan \beta=\frac{600-400}{10 \times 1000}=\frac{200}{10,000}$
$V_{d}=50+\frac{375}{0.5} \times \frac{200}{10,000}=50+15=65 \mathrm{kN}$
36. Ans. D.

$M_{u}=11.25 \times 0.15=1.687 \mathrm{kN}-m$
Section Modulus,

$$
z=\frac{b d^{z}}{6}=\frac{0.15 \times(0.15)^{z}}{6}=0.00056 \mathrm{~m}^{1}
$$

Modulus of rupture,
$f=\frac{M}{z}=\frac{1.6875}{0.000563} \times 10^{-1} \mathrm{MPa}=2.99 \mathrm{MPa}$
37. Ans. C.
$p^{2}>4 g d$
This question can be solved by trick, Option (B) and (D) are not dimensionally correct.
38. Ans. A.


Mechanism -I

$-2 M_{B} \theta-M_{B} \theta-M_{B} \theta-M_{\nabla} \theta+P\left(\frac{2 L \theta}{3}\right)=0$
$-5 M_{2} \theta+\frac{2 \mathrm{PL}}{3} \theta=0$
$\frac{2 P L}{3}=5 \mathrm{M}$
$P=\frac{15 M_{B}}{2 L}=7.5 M_{B} / \mathrm{L}$
Mechanism-II

$\frac{21}{3} \theta=\frac{41}{3} \phi$
$\theta=2 \phi$
$-2 M_{\theta} \theta-2 M_{\theta} \theta-2 M_{\theta} \theta-M_{\theta} \theta+P\left(\frac{2 L}{3}\right) \theta=0$
$-4 M_{\theta} \theta-3 M_{\theta} \phi+\frac{2 \mathrm{PL}}{3} \theta=0$
$-4 M_{\theta} \theta-3 M_{B}\left(\frac{\theta}{2}\right)+\frac{2 P L}{3} \theta=0$
$\frac{11}{2} M_{B} \theta=\frac{2 P L}{3} \theta$
$P=\frac{33}{4} M_{B}=8.25 M_{B}$
So the minimum value of load $=7.5 \mathrm{M}_{\boldsymbol{F}} / \mathrm{L}$
39. Ans. C.

40. Ans. A.

Given No. of flow channels

$$
\left(N_{f}\right)=20
$$

No. of equipotential drops
$\left(\mathrm{N}_{\mathrm{t}}\right)=10$
Head loss (h) $=5 \mathrm{~m}$
Coefficient of
permeable $=3 \mathrm{~mm} / \mathrm{min}=\frac{3 \times 10^{-1} \mathrm{~m}}{60 \mathrm{sec}}=5.0 \times 10^{-4} \mathrm{~m} / \mathrm{sec}$
Seepageq $=\mathrm{kh} \frac{\mathrm{N}_{\mathrm{f}}}{\mathrm{N}_{\mathrm{t}}}=0.5 \times 10^{-4} \times 5 \times \frac{20}{10}\left(\frac{\mathrm{~m}^{1}}{\mathrm{sec}}\right)$
$=5 \times 10^{-4} \mathrm{~m}^{1} / \mathrm{sec}=5 \times 10^{-4} \times 10^{6} \mathrm{~cm}^{2} / \mathrm{sec}$
$\mathrm{q}=500 \mathrm{~cm}^{1 /} / \mathrm{sec}$
41. Ans. C.


In $\mathrm{C}-\mathrm{p}$ ail
$\mathrm{k}_{\mathrm{A}}=\frac{1-\sin \phi^{\prime}}{1+\sin \phi^{\prime}}=\frac{1-\sin 24}{1+\sin 24}=0.422$
Active earth pressure in $\mathbf{C - b}$ soil at $A$ is
$\sigma_{\mathrm{B}}=\mathrm{k}_{\mathrm{A}}, \sigma_{\mathrm{A}}-2 \mathrm{c}_{\sqrt{ }} \sqrt{\mathrm{k}_{\mathrm{A}}}$
$\sigma_{\mathrm{B}}=0.422(1 \times 16.5+4 \times(19-9.81)+3 \times)$
$(18.5-9.81)+7 \times 9.8-2 \times 25 \times \sqrt{0.422}$
$=(0.422 \times 79.33)+68.67-50 \times 0.65$
$=33.48+68.67-32.5=69.65 \mathrm{kN} / \mathrm{m}^{2}$
42. Ans. B.


So, OMC-SP>OMC-MP; MDD-SP<MDD-MP
43. Ans. C.

As per Darcy's law,

$Q=K_{\text {mig }} \times i \times A$
$K_{\text {ova }}=\frac{\Sigma_{1}}{\Sigma_{z_{1}}}=\frac{150+150}{\frac{150}{0.02}+\frac{150}{k}}$
$K_{\text {iva }}=\frac{Q L}{A h t}=\frac{Q}{A i t}$
$\Rightarrow \frac{150+150}{\frac{150}{0.02}+\frac{150}{k}}=\frac{200 \times 10^{11}}{15 \times 60} \times \frac{1}{80 \times 10^{2}} \times \frac{1}{1}$
$\Rightarrow \frac{300}{150 \times\left[50+\frac{1}{k}\right]}=\frac{5}{180}$
$\Rightarrow \mathrm{k}=0.045 \mathrm{~mm} / \mathrm{sec}$
44. Ans. B.


As per Teraghis for local shear failure
$C_{m}=\frac{2}{3} C^{\prime}=\frac{2}{3} \times 35$
$\phi_{\mathrm{m}}=\tan ^{-1}\left(\frac{2}{3} \tan \phi\right)$
$\mathrm{a}_{\mathrm{m}}=\mathrm{C}_{\mathrm{m}} \mathrm{N}_{\mathrm{E}}+\mathrm{G}\left(\mathrm{N}_{\mathrm{q}}^{\prime}-1\right)+\frac{1}{2} B_{1} y \cdot N_{p}$
$a_{m}=\left(\frac{2}{3} c\right) N_{c}+G\left(N_{4}-1\right)+\frac{1}{2} B_{i} y N_{c}$
$\phi_{m}=\tan ^{-1}\left(\frac{2}{3} \tan \phi\right)=\tan ^{-1}\left(\frac{2}{3} \tan 28.63\right)$
$=\tan ^{-1}(0.3639)$
$\phi_{\mathrm{m}}=19.998 \cong 20^{6}$
From Table
for $\phi_{\mathrm{m}}=20^{\circ} \Rightarrow \mathrm{N}_{\mathrm{c}}=17.7, \mathrm{~N}_{\mathrm{q}}=7.4, \mathrm{~N}_{\mathrm{r}}=5$
$\mathrm{a}_{\mathrm{m}}=\frac{2}{3} \mathrm{CN}_{\mathrm{c}}+\left(\gamma_{\mathrm{t}} \mathrm{Df}\right)\left(\mathrm{N}_{\mathrm{a}}-1\right)+\frac{1}{2}\left(\mathrm{~B} \gamma_{\mathrm{t}}\right) \mathrm{N}_{\mathrm{r}}$
$=\frac{2}{3} \times 35 \times 17.7+17 \times 1.5 \times(7.4-1)+\frac{1}{2} \times$
$4 \times 17 \times 5$
$=413++163.2+170=746.2$
Net Safe bearing capacity
$=\frac{\mathrm{G}_{\mathrm{n}}}{\mathrm{F} .0 \mathrm{~S}}=\frac{746.2}{2.5}=298.48 \mathrm{kN} / \mathrm{m}^{2}$
45. Ans. A.

For exerted by jet in X-direction

$$
\begin{aligned}
F_{u} & =p a(V-v)^{x} \times \sin \theta \\
& =10^{4} \times \frac{\pi}{4} \times(0.02)^{z} \times(10)^{z} \times \sin 30^{s} \\
& =15.71 \mathrm{~N}
\end{aligned}
$$

Taking moment about hinge,
$F_{u} \times 0.1=F \times 0.2$
$\Rightarrow F=\frac{F_{u}}{2}=\frac{15.71}{2}=7.85 \mathrm{~N}$

46. Ans. B.

| Time | Ordinate of <br> 1 hr UH | Lag | Ordinate of <br> 2h DRH | Ordinate of <br> 2h UH |
| :--- | :--- | :--- | :--- | :--- |
| $10: 00$ | 0 |  | 0 | 0 |
| $11: 00$ | 3 | 0 | 3 | 1.5 |
| $12: 00$ | 12 | 3 | 15 | 7.5 |
| $01: 00$ | 8 | 12 | 20 | 10 |
| $02: 00$ | 6 | 8 | 14 | 7 |
| $03: 00$ | 3 | 6 | 9 | 4.5 |
| $03: 00$ | 3 | 6 | 9 | 4.5 |
| $04: 00$ | 0 | 3 | 3 | 1.5 |
|  |  | 0 | 0 | 0 |

Flow of river $=$ rainfall excess $\times$ ordinate of $2-\mathrm{h} \mathrm{UH}+$ Base flow
$=4 \times 10+20=60 \mathrm{~m}^{2} / \mathrm{s}$
47. Ans. A.

The maximum height of hump $\Delta \mathbf{z}$ is given by
$E=E_{\min }+\Delta z_{\operatorname{mas}}$
$\Rightarrow \mathrm{y}+\frac{q^{2}}{2 g y^{2}}=\frac{3}{2} y_{c}+\Delta z_{\max }$
$\mathrm{q}=\frac{\mathrm{Q}}{\mathrm{B}}=\frac{6}{3}=2 \mathrm{~m}^{2} / \mathrm{s}, \mathrm{y}=0.5 \mathrm{~m}$
$y_{c}=\left(\frac{\mathrm{q}^{2}}{\mathrm{~g}}\right)^{1 / 3}=\left(\frac{2^{2}}{9.81}\right)^{1 / 3}=0.74 \mathrm{~m}$
So, $0.5+\frac{(2)^{2}}{2 \times 9.81 \times(0.5)^{2}}=\frac{3}{2} \times 0.74+\Delta Z_{\text {max }}$
$\Rightarrow \Delta z_{\text {max }}=0.205 \mathrm{~m}$
48. Ans. C.

Energy equation,
$H=\frac{P}{A}+\frac{V^{z}}{2 g}+h$
$\Rightarrow 500=\frac{\mathrm{V}^{\mathrm{z}}}{2 g}+0.05 \times \frac{\mathrm{V}^{\mathrm{z}}}{2 g}$
$\Rightarrow \mathrm{V}=\sqrt{\frac{2 \times 10 \times 500}{1.05}}$
Water power
$=\frac{1}{2} \mathrm{mv}_{1}^{2}$
$=\frac{1}{2} \times 10^{4} \times \frac{\pi}{4} \times(0.15)^{2} \times(97.59)$
$=8212.5 \mathrm{kw}$
Power generated $=\boldsymbol{\eta}_{0} \times$ WD
$0.8 \times 8212.5$
$\approx 6570 \mathrm{~kW}$
49. Ans. D.

Seepage velocity $=\frac{\mathbf{1 0 0}}{\mathbf{1 0 0}}=\mathbf{1 m} /$ day
Discharge Velocity $=\mathrm{n} \times$ seepage velocity
$=0.15 \times 1=0.15 \mathrm{~m} /$ day
$i=\frac{h}{L}=\frac{3}{100}$
$V=k . i \Rightarrow 15=k \times \frac{3}{100} \Rightarrow k=5 \mathrm{~m} /$ day
50. Ans. A.

Total hardness
$=\mathrm{Mg} / \mathrm{L}^{\text {of } \mathrm{Ca}^{2+}}$ and $\mathrm{mg}^{2+}=4.1 \times 50=20 \mathrm{mg} / \mathrm{L}^{2 s} \mathrm{CaCO}_{3}$
Alkalinity $=\mathbf{3 . 3} \times \mathbf{5 0}=\mathbf{1 6 5} \mathbf{m g} / \mathrm{L}$ as $\mathrm{CaCo}_{3}$
$\mathrm{NCH}=\mathrm{TH}$-Alkalinity $=205-165=40 \mathrm{mg} / \mathrm{L}$
51. Ans. C.
$L_{w b}=L_{4 b}-20 \log _{50}\left(\frac{60}{30}\right)$
$=74-$ 20 $^{-10} g_{85} 2$

- 67.9 dB

52. Ans. A.

Given
$(B O D)_{\mathrm{g}}=200 \mathrm{mg} / \mathrm{L}$
$k_{0}=0.22 /$ day
$(B O D)_{2}=$ ?
$(B O D)_{4}=L_{8}\left(1-e^{-L_{2} 2 k}\right)$
$200=L_{8}\left(1-e^{-0.3 n+1}\right)$
$L_{0}=\frac{200}{1-e^{-5.50}}=\frac{200}{0.483}=413.95$
$(B O D)_{2}=L_{8}\left(1-e^{-L_{2} 2 \pi}\right)=413.95$
$\left(1-e^{-s .23 g}\right)=276.158 \mathrm{mg} / \mathrm{L}$
53. Ans. A.

Given
$\mathrm{y}_{1}=0.30, \mathrm{y}_{2}=0.25, \mathrm{y}_{3}=0.25$

Total cycle time (L) $=10$
By Webster method
Cycle time $\left(C_{8}\right)=\frac{1.5 L+5}{1-y}$
$\left(C_{8}\right)=\frac{1.5 L+5}{1-\left(y_{1}+y_{2}+y_{1}\right)}$
$C_{8}=\frac{1.5 \times 10+5}{1-(0.3+0.25+0.25)}$
$=\frac{15+5}{1-.08}=\frac{20}{0.2}=100 \mathrm{~s}$
$G_{1}=\frac{(C-L)\left(y_{1}\right)}{\Sigma y}=\frac{(100-10) \times 0.30}{0.8}$
$=33.75 \mathrm{sec} \triangleq 34 \mathrm{sec}$
$G_{2}=\frac{(C-L)\left(y_{1}\right)}{\Sigma y}=\frac{(100-10) \times 0.25}{0.8}$
$=28.125 \sec \xlongequal{\underline{\rho}} 28 \mathrm{gec}$
$G_{y}=\frac{(C-L) y_{y}}{\Sigma y}=\frac{(100-10) \times 0.25}{0.8}$
$=28.125 \mathrm{sec} \stackrel{1}{\underline{\rho} 28 \mathrm{gec}}$
54. Ans. A.

Downward gradient, $N=-3 \%$
$\mathbf{f}=0.35$
$S_{b}=\frac{\left(v_{i}\right)^{2}-\left(v_{f}\right)^{2}}{2 g(f-N)}$
But $\mathrm{v}_{\mathrm{i}}=100 \times \frac{5}{18}=27.77 \mathrm{~m} / \mathrm{s}$
$\mathrm{v}_{\mathrm{f}}=50 \times \frac{5}{18}=13.88 \mathrm{~m} / \mathrm{s}$
$\mathrm{S}_{\mathrm{b}}=\frac{27.77^{2}-13.88^{2}}{2 \times 9.81(0.35-3 / 100)}$
$\mathrm{S}_{\mathrm{b}}=92.14 \mathrm{~m}$
55. Ans. A.

Relief displacement is given by, $d=\frac{\mathbf{r} \cdot \mathbf{h}_{2}}{\mathbf{H}-\mathbf{h}_{\text {ma }}}$
$d=112.5-82.40=30.1 \mathrm{~mm}$
$\Rightarrow 30.1=\frac{h \times 112.5}{700-250}$
$\Rightarrow \mathrm{h}=\mathbf{1 2 0 . 4 \mathrm { m }}$

