GATE 2026

Civil Engineering-1

Forenoon Session

Memory Based
Questions & Solutions

Exam held on 14-02-2026

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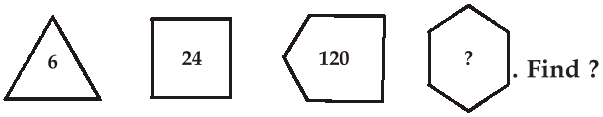
SECTION - A GENERAL APTITUDE

Q.1 

. Find ?

Ans. (720)

No. of sides = 3
3! = 6
No. of sides = 4
4! = 24
No. of sides = 5! = 120
No. of sides = 6! = 720

End of Solution

Q.2 $P^2 = Q^2 + 13$
For positive integers P and Q, the value of $P \times Q$ is
(a) 42 (b) 72
(c) 56 (d) 44

Ans. (a)

$$[P^2 - Q^2] = 13$$
$$(P - Q)(P + Q) = 13 = 1 \times 13$$
$$P - Q = 1$$
$$P + Q = 13$$
$$P = 7$$
and $$Q = 6$$
$$P \times Q = 42$$

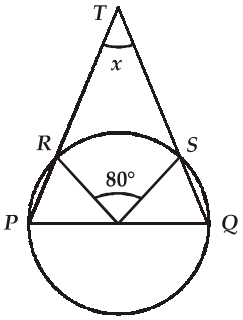
End of Solution

Q.3 How many 3 digit number can be formed using 3 different single digit prime numbers?
(a) 24 (b) 28
(c) 30 (d) 32

Ans. (a)
Single digit prime number's 2, 3, 5, 7
Required number = ${}^4P_3 = 24$

End of Solution

Q.4 Consider the following figure:



Find the value of x.

(a) 50° (b) 60°
(c) 80° (d) 40°

Ans. (a)

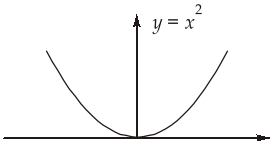
$$\frac{1}{2}(180° - 80°) = 50°$$

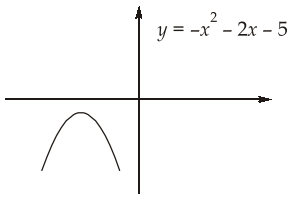
End of Solution

Q.5 $y = x^2$, $y = -x^2 - 2x - 5$. Number of points of intersection.

(a) 3 (b) 0
(c) 1 (d) 2

Ans. (b)





No intersection points,

$y = x^2$ Always positive
$y = -x^2 - 2x - 5$ Always negative

End of Solution

Q.6 A shopkeeper sells lemon. Here lemon is

(a) Subject
(b) Object
(c) Verb
(d) Predicate

Ans. (b)

A shopkeeper sells lemon
Subject Verb Object

End of Solution

Q.7 Match the following:

List-I		List-II
A. LETHAL		1. VERBATIM
B. LITERAL		2. SOLITARY
C. LONELY		3. TERRIBLE
D. LOUSY		4. DEADLY

Code:

	A	B	C	D
(a)	4	1	2	3
(b)	2	3	4	1
(c)	1	2	4	3
(d)	4	2	3	1

Ans. (a)

LETHAL → DEADLY
LITERAL → VERBATIM
LONELY → SOLITARY
LOUSY → TERRIBLE

End of Solution

■■■■

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SECTION - B TECHNICAL

8. Let

$$P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

Which of the following statements is/are correct?
Select the correct option.

(a) $P^TP = I$
(b) P is skew-symmetric
(c) The value of each eigenvalue of P is 1
(d) The trace of P is equal to the sum of its eigen values

Ans. (d)

$$P^T = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

$$P^TP = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 2 \\ 0 & 1 & 0 \\ 2 & 0 & 2 \end{bmatrix}$$

$$P^TP \neq 1$$

$$P^T = \text{P} = \text{Symmetric not skew symbolic}$$

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 1-\lambda & 0 & 1 \\ 0 & 1-\lambda & 0 \\ 1 & 0 & 1-\lambda \end{vmatrix} = (1 - \lambda)\lambda(\lambda - 2) = 0$$

$$\lambda = 0, 1, 2$$

End of Solution

9. $(y + 3x - 13)^2 + (x + y - 7)^2 = 0$

where x and y are integers

The value of $x^3 + y^3$ is _____.

Ans. (91)

$(y + 3x - 13)^2 + (x + y - 7)^2 = 0$

So, for sum = 0

$$y + 3x - 13 = 0$$
$$x + y - 7 = 0$$
$$\Rightarrow \quad y + 3x = 13$$
$$x + y = 7$$
$$2x = 6$$
$$x = 3,\ x = 4$$

Now, $x^3 + y^3 = (3)^3 + (4)^3$
$= 27 + 64 = 91$

End of Solution

10. **Consider the differential equation**

$$x^2 \frac{d^2y}{dx^2} = 6y$$

The general solution of the above equation is

(a) $y = ax^3 + \frac{b}{x^2}$ (b) $y = ax^3 + \frac{b}{x^3}$

(c) $y = ax^3 + b\ ln\ x$ (d) $y = ax^2 + b\ ln\ x$

Ans. **(a)**

Given:differential equation

$$\frac{x^2d^2y}{dx^2} - 6y = 0$$

Let $x = e^z$

$$x^2D^2y - 6y = 0$$
$$(x^2D^2 - 6)y = 0$$
$$(D^2 - D - 6)y = 0$$

Auxillary equation,

$$m^2 - m - 6 = 0$$
$$m = -2 \text{ and } 3$$
$$y = c_1e^{-2t} + c_2\ e^{+3t}$$
$$y = c_1e^{-2z} + c_2\ e^{3z}$$
$$y = \frac{c_1}{x^2} + c_2x^3$$

End of Solution

11. **Consider the homogeneous system of linear equations:**

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

What does the solution set of this system represent geometrically?

(a) A point (b) A line

(c) A plane (d) A cone

Ans. (b)

$$x_1 + x_2 + x_3 = 0$$
$$x_1 + 2x_3 = 0$$

Let, $x_2 = \alpha$

$$x_1 + x_3 = -\alpha$$
$$x_1 + 2x_3 = 0$$
$$x_3 = \alpha$$
$$x_1 = -2\alpha$$

$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -2\alpha \\ \alpha \\ \alpha \end{bmatrix} = \alpha \begin{bmatrix} -2 \\ 1 \\ 1 \end{bmatrix}$$

It represent the line.

End of Solution

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12. **Consider the function**

$$f(x) = e^{-x} - x$$

Using the Newton-Raphson method, obtain the first improved approximation starting from the initial guess, $x_0 = 0.5$.

Enter the value of second approximation correct to two decimal places.

Ans. **(0.56631)**

$$f_{(x)} = e^{-x} - x$$
$$x_0 = 0.5$$
$$x_1 = ?$$

by N.R. method,

$$f_x = e^{-x} - x$$
$$f'(x) = -e^{-x} - 1$$

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$

$$\Rightarrow \quad x_1 = 0.5 - \frac{\left(e^{-0.5} - 0.5\right)}{-e^{-0.5} - 1}$$

$$\Rightarrow \quad x_1 = 0.5 - \frac{[0.6065 - 0.5]}{-[0.6065 + 1]} = 0.56631$$

End of Solution

13. A function $f(x)$ is defined on the interval [0, 2] with values in R.
It satisfies

$$\int_0^2 f(x)\left[x - f(x)\right]dx = \frac{2}{3}$$

Find the value of $f(1)$.
(Enter the numerical value only.)

Ans. (0.5)

$$\int_0^2 f(x)\left[x - f(x)\right]dx = \frac{2}{3}$$

$$\int_0^2 \left[xf(x) - f(x)^2\right]dx$$

$$\int_0^2 \left[\frac{x^2}{4} - \left(\frac{x}{2} - f(x)\right)^2\right]dx = \frac{2}{3}$$

$$\int_0^2 \frac{x^2}{4}dx - \int_0^2 \left(\frac{x}{2} - f(x)\right)^2 dx = \frac{2}{3}$$

$$\left[\frac{x^3}{3\times 4}\right]_0^2 - \int_0^2 \left[\frac{x}{2} - f(x)\right]^2 dx = \frac{2}{3}$$

$$\frac{2}{3} - \int_0^2 \left[\frac{x}{2} - f(x)\right]^2 dx = \frac{2}{3}$$

$$\int_0^2 \left(\frac{x}{2} - f(x)\right)^2 dx = 0$$

$x = [0, 2]$

$$f(x) - \frac{x}{2} = 0$$

$$f(x) = \frac{x}{2}$$

at $x = 1$, $\quad f(1) = \frac{1}{2}$

End of Solution

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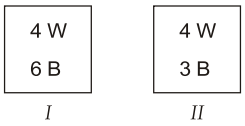
14. **Bag-I contains 4 white and 6 black balls, Bag-II contains 4 white and 3 black balls. A ball is selected at random and it comes out to be a black ball. What is the probability that it is from Bag-I?**

Ans. **(0.583)**



Baye's theorem
Drawn balls is black.
P (that it was done from bag 1)

$$P\left(\frac{I}{B}\right) = \frac{P(I)P\left(\frac{B}{I}\right)}{P(I)P\left(\frac{B}{I}\right) + P(II)P\left(\frac{B}{II}\right)}$$

$$P\left(\frac{I}{B}\right) = \frac{\frac{6}{10}\times\frac{1}{2}}{\frac{1}{2}\times\frac{6}{10}+\frac{1}{2}\times\frac{3}{7}} = 0.583$$

End of Solution

15. **Consider the matrix**

$$A = \begin{bmatrix} 9 & 15 \\ 15 & 50 \end{bmatrix}$$

The matrix A is decomposed using Cholesky decomposition. Determine the value of l_{22}.

(Enter the numerical value only.)

Ans. **(5)**

$$A = LL^T$$

$$= \begin{bmatrix} L_{11} & 0 \\ L_{21} & L_{22} \end{bmatrix}\begin{bmatrix} L_{11} & L_{21} \\ L_0 & L_{22} \end{bmatrix}$$

$$\begin{bmatrix} 9 & 15 \\ 15 & 50 \end{bmatrix} = \begin{bmatrix} L_{11}^2 & L_{11}L_{21} \\ L_{11}L_{21} & L_{21}^2 + L_{22}^2 \end{bmatrix}$$

$$L_{11} = 3$$
$$L_{11}L_{21} = 15$$
$$L_{21} = 5$$
$$L_{21}^2 + L_{22}^2 = 50$$
$$5^2 + L_{22}^2 = 50$$

$$L_{22}^2 = 25$$

$$L_{22} = 5$$

End of Solution

16. **Given the following data:**

x	–2	1	2
y	22	4	16

Let $P_2(x)$ be the quadratic interpolating polynomial passing through the above three points.
Find the value of $P_2(0)$.
Enter the numerical value

Ans. **(2)**

–2	1	2
28	4	16

2nd degree polynominal

Since it is not equals spaced
So we can apply lagrange's interpolation

x_0	x_1	x_2
–2	1	2
28	4	16
y_0	y_1	y_2

$$f(x) = \frac{(x-x_1)(x-x_2)}{(x_0-x_1)(x_0-x_2)}y_0 + \frac{(x-x_0)(x-x_2)}{(x_1-x_0)(x_1-x_2)}y_1 + \frac{(x-x_0)(x-x_1)}{(x_2-x_0)(x_2-x_1)}y_2$$

$$f(x) = \frac{(0-1)(0-2)}{(-2-1)(-2-2)}28 + \frac{(0+2)(0-2)}{(1+2)(1-2)}4 + \frac{(0+2)(0-1)}{(2+2)(2-1)}\times 16$$

$$\Rightarrow \quad f(0) = \frac{2}{3\times 4}\times 28 + \frac{2x-2}{3x-1}\times 4 + \frac{2x-1}{4\times 1}\times 16$$

$$\Rightarrow \quad f(0) = \frac{14}{3} + \frac{16}{3} - 8$$

$$\Rightarrow \quad f(0) = \frac{30-24}{3} = \frac{6}{3} = 2$$

End of Solution

17. Two blocks A and B are connected by a light, massless inextensible rod passing over a smooth guide as shown in the figure.

Block A is pressed against a vertical rough wall.

Block B rests on a rough horizontal floor.

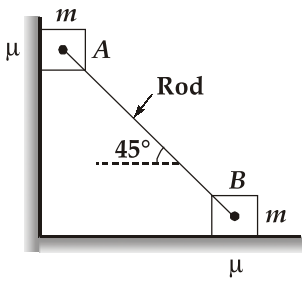
The string makes an angle of 45° with the horizontal, at which the blocks are at the verge of sliding

Assuming both contact surfaces (wall and floor) have the same coefficient of static friction, determine the coefficient of static friction (μ_s) when the blocks are about to slide.

Ans. (0.414)

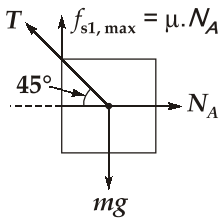
End of Solution

18.



Ans. (0.414)

Block A (F.B.D.)



For equilibrium: $T \cos 45° = N_A$

$$N_A = \frac{T}{\sqrt{2}}$$

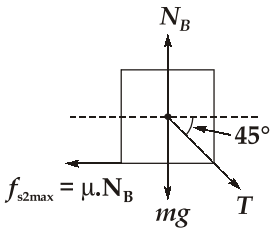
$$T \sin 45° + \mu N_A = mg$$

$$\frac{T}{\sqrt{2}} + \mu N_A = mg$$

$$\frac{T}{\sqrt{2}} + \mu \frac{T}{\sqrt{2}} = mg$$

$$\frac{T}{\sqrt{2}}(1 + \mu) = mg \quad \text{...(i)}$$

Block B (F.B.D.)



For equilibrium: $T \cos 45° = F_{s2max} = \mu \cdot N_B$

$$N_B = mg + T \sin 45° = \left(mg + \frac{T}{\sqrt{2}}\right)$$

$$T \cos 45° = \frac{T}{\sqrt{2}} = m\left(mg + \frac{T}{\sqrt{2}}\right) \quad ...(ii)$$

By equation (i) and (ii):

$$\frac{mg}{1+\mu} = \mu\left(mg + \frac{mg}{1+\mu}\right)$$

$$\frac{mg}{1+\mu} = \mu\left(\frac{mg(1+\mu)+mg}{1+\mu}\right)$$

$$1 = \mu\,[1 + \mu + 1]$$

$$1 = \mu\,(2 + \mu)$$

$$\mu^2 + 2\mu - 1 = 0$$

$$\mu = \frac{-2 \pm \sqrt{4+4}}{2} = \frac{-2 \pm \sqrt{8}}{2}$$

μ can not be negative. Taking (+ve) sign.

$$\mu = \frac{-2+\sqrt{8}}{2} = 0.414$$

$$\mu = 0.414$$

End of Solution

19. **A city generates 90 million litres per day (MLD) of sewage. The 5-day average BOD concentration of sewage is 300 mg/L. The average per capita BOD contribution is 0.08 kg/day per person. Estimate the population equivalent of the city.**

(a) 337500 **(b)** 437200
(c) 367600 **(d)** 457500

Ans. **(a)**

Given: $Q = 90$ MLD

$BOD_5 = 300$ mg/l

Average per capita BOD $= 0.08$ kg/day

$$\text{Population equivalent} = \frac{90 \times 10^6 \times 300 \times 10^{-6}}{0.08} = 337500$$

End of Solution

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20. Which of the following are not removed during the secondary treatment of sewage? Select all the correct option(s).

(a) Suspended solids
(b) Fat and grease
(c) Dissolved organic matter
(d) Pathogens

Ans. (a, d)

- Fat and grease remove in skimming tank.
- Pathogen remove in territory treatment.

End of Solution

21. In a Water Treatment Plant (WTP), the settling velocity of discrete inorganic particles under laminar flow conditions is determined using:

(a) Darcy's Law
(b) Stokes' Law
(c) Bernoulli's Equation
(d) Hazen–Williams Formula

Ans. (b)

Settling velocity of discrete inorganic particles under laminar flow conditions is determine by stoke's law.

$$V_s = \frac{\rho g (G_s - 1) d^2}{18\mu}$$

End of Solution

22. A rapid sand filter has a sand bed depth of 0.8 m.

The initial porosity of the sand bed is 40%, and the during the backwashing porosity becomes 70%. Determine the depth of filter after expansion (in metres).

Enter the numerical value of your answer (in m, up to two decimal places).

Ans. (1.6)

Given, $n_i = 0.4,\ n_e = 0.7$

$D = 0.8$ m, $D_e = ?$

$D(1 - n)(G_s - 1) = \text{Constant}$

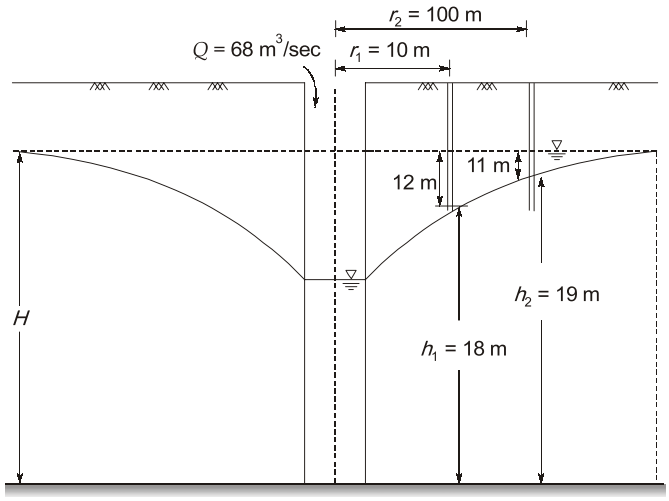
$\Rightarrow \quad 0.8 \times (1 - 0.4) = D_e \times (1 - 0.7)$

$\Rightarrow \quad D_e = \frac{0.8 \times 0.6}{0.3} = 1.6$ m

End of Solution

23. An unconfined aquifer of 30 m depth below water table has a well in it of diameter 20 cm. Two test wells are at a distance of 10 m and 100 m from the pumped well and the drawdowns in the well are 12 m and 11 m respectively. The discharge withdrawn is 68 cumec. The transmissibility of the aquifer (in m^2/sec).

Ans. **(37.44)**



Given, $S_1 = 11$ m

$h_1 = 30 - 11 = 19$ m

$S_2 = 12$ m

$h_2 = 30 - 12 = 18$ m

$$\therefore \quad Q = \frac{\pi k\left(h_1^2 - h_2^2\right)}{\ln\left(\frac{r_2}{r_1}\right)}$$

$r_2 = 100$ m, $r_1 = 10$ m

$$\therefore \quad k = \frac{68 \times \ln\left(\frac{100}{10}\right)}{\pi \times 63 \times \left(19^2 - 18^2\right)} = 1.248 \text{ m/s}$$

$$\therefore \quad T = kB = 1.248 \times 30 = 37.44 \text{ m}^2/\text{sec}$$

End of Solution

24. **Water flows through a circular pipe under laminar flow conditions. The maximum velocity at the centreline is 2 m/s, and the radius of the pipe is 5 cm.**

What is the velocity at a radial distance of 2.5 cm from the pipe centreline?

(a) 1.0 m/s **(b) 1.25 m/s**

(c) 1.5 m/s **(d) 2.0 m/s**

Ans. **(c)**

Given:

Maximum velocity, $u_{max} = 2$ m/sec

radius of pipe, $R = 5$ cm

radial distance, $r = 2.5$ cm

For laminar flow, velocity at any radial distance 'r' is given by

$$u(r) = u_{max}\left(1 - \frac{r^2}{R^2}\right)$$

at r = 2.5 cm

$$u(r = 2.5\text{ cm}) = 2\left[1 - \left(\frac{2.5}{5}\right)^2\right] = 1.5\text{ m/sec}$$

End of Solution

25. **Two circular pipes of diameters 600 mm (larger pipe) and 400 mm (smaller pipe) connect two large reservoirs under the same head difference. The pipes have equal lengths, the same friction factor, and minor losses are neglected.**

Assuming turbulent flow is governed by the Darcy-Weisbach equation, what is the ratio of discharge in the larger pipe to that in the smaller pipe $\left(\frac{Q_L}{Q_S}\right)$?

(a) 1.50 m/sec **(b)** 1.84 m/sec
(c) 2.75 m/sec **(d)** 3.38 m/sec

Ans. **(c)**

Given:

Diameter of larger pipe, D_1 = 600 mm

Diameter of smaller pipe, D_2 = 400 mm

$\therefore$ Pipes are connected in parallel

$\therefore$ Headloss in both the pipes will be same.

$$h_{f1} = h_{f2}$$

$$\frac{8Q_1^2 fL_1}{\pi^2 g D_1^5} = \frac{8Q_2^2 fL_2}{\pi^2 g D_2^5}$$

$$\Rightarrow \left(\frac{Q_1}{Q_2}\right)^2 = \left(\frac{D_1}{D_2}\right)^5 \qquad \because\ L_1 = L_2$$

$$\Rightarrow \frac{Q_1}{Q_2} = \left(\frac{600}{400}\right)^{5/2} = 2.755$$

End of Solution

26. **A 30 m steel tape is standardized at a temperature of 25°C. The tape was used to measure a line and the measured length was found to be 200 m. During the measurement, the temperature was 35°C. The coefficient of linear expansion of steel is 11 × 10^{-6} per °C. The temperature correction to be applied and the true length of the line.**

Ans. **(22)**

Given: $T_0 = 25°C,\ T_m = 35°C$

$l_0 = 200\ m,\ \alpha = 11 \times 10^{-6}\ /°C$

Temperature correction, $C_T = l_o\alpha(T_m - T_o)$

$= 200 \times 11 \times 10^{-6} \times 10$

$C_T = 0.022\ m = 22\ mm$

End of Solution

27. **The whole circle bearing (WCB) of line AB is 150°. The length of AB is 100 m.**

The latitude and departure for the line AB are respectively

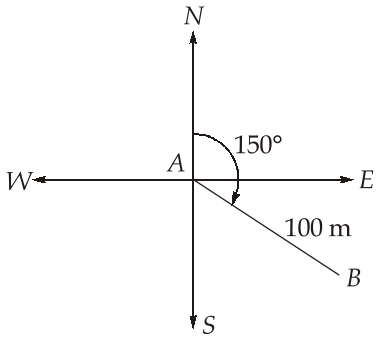
(a) **+86.60, m; –50.00, m**

(b) **–86.60, m; +50.00, m**

(c) **+50.00, m; +86.60, m**

(d) **–50.00, m; +86.60, m**

Ans. **(b)**



Given, $WCB = 150,\ AB = 100\ m = l$

Latitude $= l\cos\theta = 100 \times \cos(150°) = -86.60\ m$

Departure $= l\sin\theta = 100 \times \sin(150°) = +50\ m$

End of Solution

28. **The level of line of collimation above a datum is 100 m. At a point P, a staff is placed and backsight reading is 1.5 m. The reduced level of point P (in m).**

Ans. **(98.5)**

Given: Level of line = 100 m (above datum)

B.S reading = 1.5 m

$\therefore$ P(reduce level) = 100 – 1.5 = 98.5 m

End of Solution

29. **In a differential levelling for a very far off distance between points P and Q, when instrument is near point P the elevation difference between P and Q is 3 m. When instrument is near Q elevation difference is – 1 m. Correction for refraction is same in both the cases. What will be the true height difference between P and Q?**

(a) 4 m (b) 2 m
(c) 1 m (d) 0 m

Ans. (b)

Given,

Case-I: Elevation diff. between P and Q(when instrument is near P) = 3 m

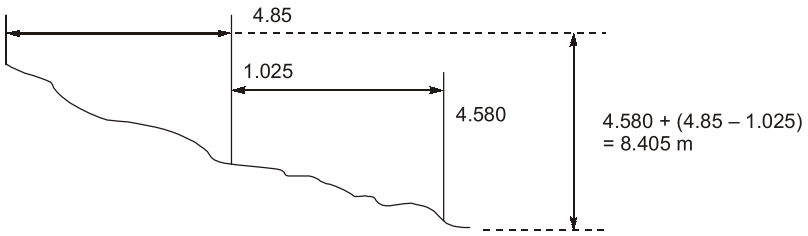
Case-II: Elevation diff. between P and Q(when instrument is near Q) = –1 m

$$\therefore \text{True height difference} = \frac{(P+Q)-(P_1+Q_1)}{2} = \frac{3-(-1)}{2} = 2\,\text{m}$$

End of Solution

30. **Readings are taken at a 20 m interval on a slopy ground.**
0.385, 0.780, ___ , ____ , ____ , 4.850 m, 1.025, 1.450, 4.580 at a 6th reading instrument station is changed. Calculate the gradient (in %) of a ground between last and first reading?

Ans. (5)



True vertical difference = 8.405 – 0.385 = 8.02 m

$$\therefore \quad \text{radiant} = \frac{8.02}{20\times 8} = \frac{8.02}{160} = 0.05 = 5\%$$

End of Solution

31. **Three vehicles travel on the same road section of length 2 km. The travel times recorded for the three vehicles are:**

T_1 = 4 min, T_2 = 5 min, T_3 = 8 min

Determine the space mean speed of the traffic stream in km/h.

Enter the numerical value (in km/h).

Ans. (21.18)

Given: 3 vehicles

$$V_1 = \frac{\text{distance}}{\text{time}} = \frac{2}{4}\,\text{km/min} = 30\,\text{kmph}$$

$$V_2 = \frac{2}{5} \times 60 = 24 \text{ kmph}$$

$$V_3 = \frac{2}{8} \times 60 = 15 \text{ kmph}$$

$$\text{Space mean speed} = \frac{n}{\frac{1}{V_1} + \frac{1}{V_2} + \frac{1}{V_3}} = \frac{3}{\frac{1}{30} + \frac{1}{24} + \frac{1}{15}}$$

$$= 21.176 \text{ kmph}$$

End of Solution

32. **Which of the following option is correct?**

(a) **Grade compensation is provided by increasing the gradient of horizontal curve.**

(b) **Length of summit curve is more in case of uni-directional movement on a road as compared to the case of bi-directional movement.**

(c) **The value of friction is taken lower for horizontal alignment calculation rather than for sight distance consideration.**

(d) **While providing superelevation, centreline of pavement is raised w.r.t. both edges.**

Ans. **(c)**

The value of friction taken lower for horizontal alignment calculation rather than for sight distance.

End of Solution

33. **A bituminous paving mix consists of 58% coarse aggregate (specific gravity = 2.68), 25% fine aggregate (specific gravity = 2.45), 5% bitumen (specific gravity = 1.15), and 12% mineral filler (specific gravity = 2.42), all percentages being by weight of total mix.**

The bulk specific gravity of the compacted mix is 2.2.

The Voids Filled with Bitumen (VFB) of the mix, expressed as a percentage.

Ans. **(50.26)**

Given, $W_{CA} = 58\%,\ W_{FA} = 25\%,\ W_b = 5\%$

$W_{MA} = 12\%$

$$\therefore \quad G_t = \frac{100}{\frac{W_{CA}}{G_{CA}} + \frac{W_{FA}}{G_{FA}} + \frac{W_b}{G_b} + \frac{W_{MA}}{G_{MA}}}$$

$$G_t = \frac{100}{\frac{58}{2.68} + \frac{25}{2.45} + \frac{5}{1.15} + \frac{12}{2.42}} = 2.43$$

$$G_m = 2.2$$

$$V_v(\%) = \left(\frac{G_t - G_m}{G_t}\right) \times 100 = \left(\frac{2.43 - 2.2}{2.2}\right) \times 100 = 9.465\%$$

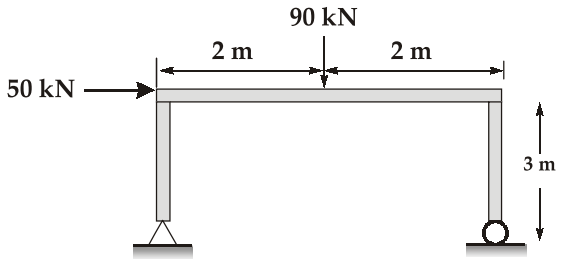
$$V_v(\%) = 9.465\%$$

$$V_b(\%) = \frac{W_b}{G_b} \times G_m = \frac{5}{1.15} \times 2.2 \times 100 = 9.565\%$$

$$\therefore \quad VFB = \frac{V_b}{V_v + V_b} \times 100 = 50.26\%$$

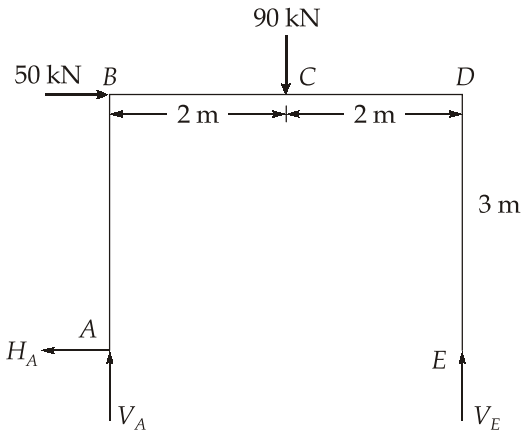
End of Solution

34. **A horizontal load of 50 kN acts at the top left joint. A vertical concentrated load of 90 kN acts at the midspan of the top beam. Determine the absolute value of the maximum bending moment in the frame.**



(a) 150 kN-m **(b) 240 kN-m**
(c) 165 kN-m **(d) 300 kN-m**

Ans. **(c)**



$$\Sigma F_x = 0 \quad \Rightarrow \quad H_A = 50 \text{ kN } (\leftarrow)$$
$$\Sigma F_y = 0 \quad \Rightarrow \quad V_A + V_E = 90 \text{ kN}$$

Taking moment about A,

$$\Sigma M_A = 0$$
$$\Rightarrow \quad 50 \times 3 + 90 \times 2 - V_E \times 4 = 0$$

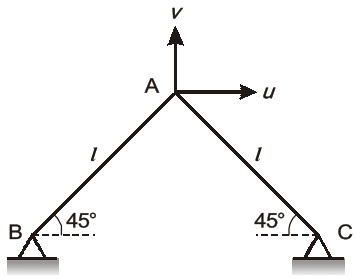
$$V_E = 82.5 \text{ kN } (\uparrow)$$
$$V_A = 7.5 \text{ kN } (\uparrow)$$

Maximum bending moment,

$$(M_{max})_{at\,C} = V_E \times 2 = 82.5 \times 2$$
$$= 165 \text{ kN-m}$$

End of Solution

35. **The stiffness matrix for the given frame is**



Assume constant axial rigidity *AE* for all members.

(a) $\frac{AE}{l}\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$ (b) $\frac{AE}{l}\begin{bmatrix}1 & 1\\ 1 & 1\end{bmatrix}$

(c) $\frac{AE}{l}\begin{bmatrix}1 & 0.5\\ 0.5 & 1\end{bmatrix}$ (d) $\frac{AE}{l}\begin{bmatrix}1 & -0.5\\ -0.5 & 1\end{bmatrix}$

Ans. **(a)**

$$\text{Stiffness matrix, [k]} = \begin{bmatrix}k_{11} & k_{12}\\ k_{21} & k_{22}\end{bmatrix}$$

Here,
$$k_{11} = \Sigma\left(\frac{AE}{l}\cos^2\theta\right)$$
$$k_{11} = \frac{AE}{l}\left(\cos^2 225° + \cos^2 315°\right) = \frac{AE}{l}$$
$$k_{22} = \Sigma\left(\frac{AE}{l}\sin^2\theta\right)$$
$$k_{22} = \frac{AE}{l}\left(\sin^2 225° + \sin^2 315°\right) = \frac{AE}{l}$$
$$k_{12} = k_{21} = \Sigma\left(\frac{AE}{l}\cos\theta\sin\theta\right)$$
$$= \frac{AE}{l}\left(\cos 225° \sin 225 + \cos 315° \sin 315°\right) = 0$$
$$\text{Stiffness matrix, [k]} = \frac{AE}{l}\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

End of Solution

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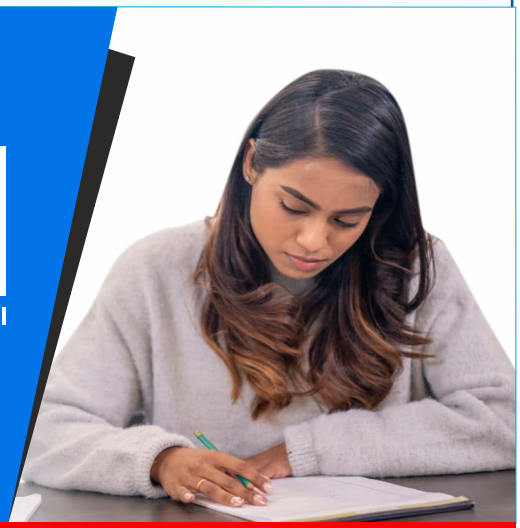

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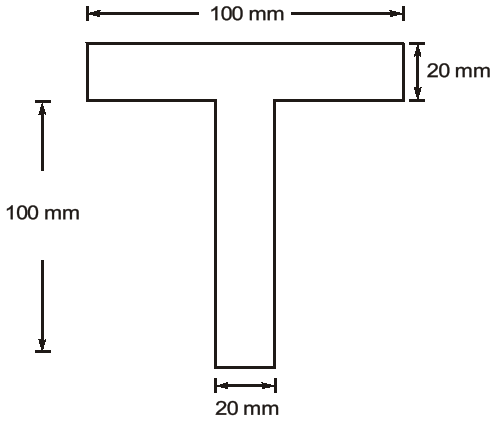
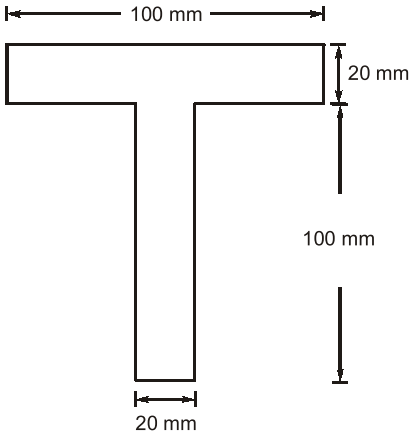
36. A T-section has the following dimensions (in mm):

- Flange width = 100 mm
- Flange thickness = 20 mm
- Web thickness = 20 mm
- Overall depth = 100 mm

The plastic section modulus is _____ $\times 10^4$ mm^3 of the section about the horizontal plastic neutral axis.



Ans. (12)



Plastic section modulus,

$$Z_p = \frac{A}{2}(\bar{y}_c + \bar{y}_t)$$

Here, $A = 2(100 \times 20) = 4000 \text{ mm}^2$

$$\bar{y}_c = \frac{20}{2} = 10 \text{ mm}$$

$$\bar{y}_t = \frac{100}{2} = 50 \text{ mm}$$

$\therefore$ $$Z_p = \frac{4000}{2}(10 + 50) = 12 \times 10^3 \text{ mm}^3$$

End of Solution

37. Two fillet welds of sizes 6 mm and 5 mm are designed to carry the same load. If the effective length of the 5 mm weld is 150 mm, what should be the effective length of the 6 mm weld so that both welds have equal strength?

(a) 100 mm (b) 125 mm
(c) 150 mm (d) 180 mm

Ans. (b)

Here, $\text{Length of weld} = \dfrac{1}{\text{Size of weld}}$

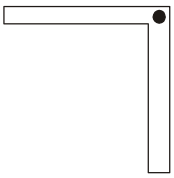
$\therefore \quad l_1 S_1 = l_2 S_2$

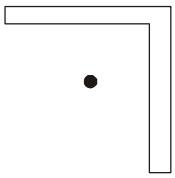
$\Rightarrow \quad 5 \times 150 = l_2 \times 6$

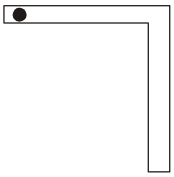
$S_2 = 125 \text{ mm}$

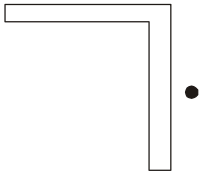
End of Solution

38. Which of the following option currently represents the position of shear centre?

(a) 

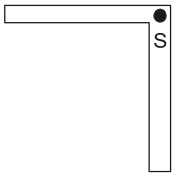
(b) 

(c) 

(d) 

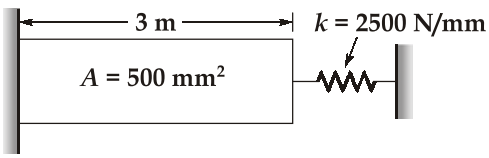
Ans. (a)

Shear center will lie on the axis of symmetry and at the point of intersection of axis of legs.



End of Solution

39. The value of compressive load in bar shown below will be _____(kN).



$\alpha = 12 \times 10^{-6}/\,°C$

$E = 60 \text{ GPa.}$

$\Delta t = 100°C \uparrow$

Ans. (7.2)

Given: $\alpha = 12 \times 10^{-6}/°C$

$E = 60 \times 10^3$ MPa

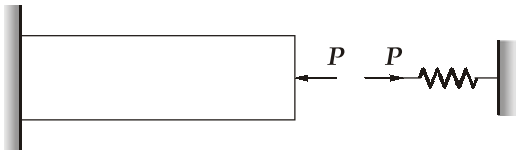
$\Delta T = 100°C$

$L = 3$ m

$A = 500$ mm^3

$k = 2500$ N/mm

Since the system is fixed, net deflection will be zero.



$$\therefore \left[L\alpha\Delta T + \left(\frac{-PL}{AE}\right)\right] + \left[\frac{-P}{k}\right] = 0$$

$$\Rightarrow 3000 \times 10^3 \times 12 \times 10^{-6} \times 100 - \frac{P \times 3000}{500 \times 60 \times 10^3} - \frac{P}{2500} = 0$$

$$\Rightarrow \quad 3.6 = P(5 \times 10^{-4})$$

$$\Rightarrow \quad P = 7200 \text{ N} = 7.2 \text{ kN}$$

End of Solution

40. **A spherical ballon of a radius has a absolute pressure inside ballon as P. What will be maximum tensile stress and shear stress in the ballon?**

(a) $\frac{Pr}{2t}$ and zero

(b) $\frac{Pr}{4t}$ and zero

(c) zero and $\frac{Pr}{2t}$

(d) $\frac{Pr}{2t}$ and $\frac{Pr}{4t}$

Ans. (d)

$$\text{hoop stress} = \text{longitudinal stress} = \frac{PD}{4t}$$

$$\therefore \quad \text{tensile stress} = \frac{P \times (2r)}{4t} = \frac{Pr}{2t}$$

and in plane shear stress = 0

$$\text{Maximum shear stress} = \frac{\frac{Pr}{2t}}{2} = \frac{Pr}{4t}$$

End of Solution

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41. Long-term deformation of a material under sustained constant loading is primarily governed by:

(a) Creep
(b) Modulus of toughness
(c) Modulus of resilience
(d) Yield strength

Ans. (a)

End of Solution

42. In a reinforced concrete slab, 10 mm diameter bars are provided at a centre-to-centre spacing of 150 mm to resist a given design moment.

If instead of 10 mm bars, 12 mm diameter bars of the same grade of steel are used, determine the required centre-to-centre spacing (in mm) so that the slab resists the same design moment.

(Assume effective depth and other parameters remain unchanged. Enter the numerical value only in mm.)

Ans. (216)

Given, $S_{10\text{ mm}} = 150$ mm, $\phi = 10$ mm

$S_{12\text{ mm}} = ?$, $\phi = 12$ mm

$\therefore$ Spacing $\propto \phi^2$

$$\frac{S_{12\text{mm}}}{S_{10\text{mm}}} = \left(\frac{12}{10}\right)^2$$

$$S_{12\text{ mm}} = 150 \times \left(\frac{12}{10}\right)^2$$

$$S_{12\text{ mm}} = 216 \text{ mm}$$

End of Solution

43. Which of the following methods are used to check whether the flexural stresses in a prestressed concrete beam remain within permissible limits at transfer and final stages?

Select all the correct option(s).

(a) Hoyer's effect
(b) Limiting zone of prestress method
(c) Magnel's graph
(d) Load balancing method

Ans. (b, c, d)

Hoyer effect enhance bond strength of tendon and concrete. Nothing to do with flexure stress.

End of Solution

44. Which of the following are correct for the correction to be applied for basic runway length?

(a) $\frac{0.07H}{300}, 0.01T, 0.1G$ (b) $\frac{0.07}{300}, 0.1T, 0.01G$

(c) $\frac{0.7}{100}, 0.1T, 0.1G$ (d) $\frac{0.07}{100}, 0.01T, 0.01G$

Ans. (a)

$$\text{Elevation correction} = 7\% \text{ per } 300 \text{ of height} = \frac{0.07}{300} \times H$$

$$\text{Temperature correction} = 1\% \text{ per degree rise in temperature} = 0.01\,T$$

$$\text{Gradient correction} = 20\% \text{ per } 1\% \text{ of effective gradient} = 0.02G$$

End of Solution

45. For a broad gauge track, cant is calculated as _____.
Here, G is in mm, V is in kmph, R is in m.

(a) $\frac{GV^2}{127R}$ (b) $\frac{13.2V^2}{R}$

(c) $\frac{13.78V^2}{R}$ (d) $\frac{15.2V^2}{R}$

Ans. (a, c)

For B.G. $e = \frac{GV^2}{127R}$

$$= \frac{(1.75 \times 10^3)V^2}{127R} = 13.78\frac{V^2}{R}$$

End of Solution

46. Match the flow profiles listed in Column I with the corresponding slopes of water surface in Column II

List-I	List-II
P. M_1	1. Positive
Q. M_2	2. Negative
R. M_3	3. Zero

	P	Q	R
(a)	1	2	1
(b)	1	3	2
(c)	2	1	3
(d)	3	1	2

Ans. (a)

M_1 – Positive
M_2 – Negative
M_3 – Positive

End of Solution

47. **A hydraulic jump occurs in a horizontal rectangular channel. The sequent depth ratio is given as:**

$$\frac{y_2}{y_1} = 2$$

where
y_1 **= depth before jump (supercritical depth)**
y_2 **= depth after jump (subcritical depth)**
Determine the Froude number of the supercritical flow.

(a) $\sqrt{5}$ (b) $\sqrt{3}$
(c) $\sqrt{8}$ (d) $\sqrt{6}$

Ans. (b)

Given: $\frac{y_2}{y_1} = 2$

$\therefore \quad \frac{y_2}{y_1} = \frac{-1+\sqrt{8F_r^2+1}}{2}$

$(2 \times 2 + 1)^2 = 1 + 8F_r^2$

$\Rightarrow \quad F_r = \sqrt{3}$

End of Solution

48. **For a wide unlined canal, depth of flow is 1 m, unit weight of water is 10 kN/m^3 and critical shear stress is 10 N/m^2. The slope of channel is 1 in n. What is the value of n?**

Ans. (1000)

Critical shear stress, $\tau_0 = \gamma_w R S_0$

$\Rightarrow 10\,\text{N/m}^2 = 10 \times 10^3\,\text{N/m}^3 \times 1 \times \frac{1}{n}$

$\Rightarrow \quad \frac{1}{n} = \frac{1}{10^3}$

$n = 1000$

End of Solution

49. For an irrigation of area of 7500 ha, the design discharge is 10 m^3/s. Canal losses are 50%. Determine the duty (in ha/cumec) at the head of canal.

(a) 1125 (b) 375
(c) 750 (d) 1500

Ans. (b)

$$\text{Duty} = \frac{\text{Area}}{\text{Discharge}}$$

$$= \frac{7500}{10} = 750 \text{ ha/cumec}$$

$$\text{Duty at head of canal} = 750 \times 0.5 = 375 \text{ ha/cumec}$$

End of Solution

50. A bridge has an expected design life of 50 years. It is designed for a flood discharge of 1000 m^3/s, which corresponds to a return period of 100 years.

Determine the risk (probability) that the design flood will be equalled or exceeded at least once during the design life of the bridge.

(Enter the numerical value of risk in decimal form, correct up to three decimal places.)

Ans. (0.39)

$$n = 50 \text{ year}$$
$$T = 100 \text{ year}$$

$$\text{Risk} = 1 - q^n = 1 - \left(1 - \frac{1}{T}\right)^n$$

$$= 1 - \left(1 - \frac{1}{100}\right)^{50} = 0.39$$

End of Solution

51. A rectangular catchment ABCD has an area of 7 hectares.
The times of concentration from the four extreme points A, B, C and D to the outlet are 10, 20, 15 and 25 minutes, respectively.
The rainfall intensity-duration relationship is given by:

$$I = \frac{25}{t + 20}$$

where:
- I = rainfall intensity in cm/hr
- t = time of concentration in minutes

The runoff coefficient of the catchment is 0.6.

Determine the peak discharge from the catchment (in m^3/hr). (Enter the numerical value only.)

Ans. **(1595)**

Given: $k = 0.6$

$t = 10,\ 20,\ 15$ and 25 minutes

$$I = \frac{25}{t+10}$$

$$\therefore \quad I_{10} = \frac{25}{20}\text{cm/hr}$$

$$I_{20} = \frac{25}{30}\text{cm/hr}$$

$$I_{15} = \frac{25}{25}\text{cm/hr}$$

$$I_{25} = \frac{25}{35}\text{cm/hr}$$

$$\therefore \quad Q = \Sigma kiA = k.A(i_1 + i_2 + i_3 + i_4)$$

$$Q = 0.6 \times 7 \times 10^4 \times \left(\frac{25}{20} + \frac{25}{30} + \frac{25}{25} + \frac{25}{35}\right) \times 10^{-2}$$

$$Q = 1595\ \text{m}^3/\text{hr}$$

End of Solution

52. **A circular pile of diameter 600 mm and length 6 m is embedded in saturated clay soil. The soil properties are:**

- **Undrained cohesion, c_u = 80 kPa**
- **Unit weight of soil, γ = 19.2, kN/m^3**
- **Adhesion factor, α = 0.54**

Assume that the pile is a friction pile in clay and neglect end bearing resistance. If the diameter of the pile is increased to 1200 mm, determine the ratio of the ultimate pile capacity of the 1200 mm diameter pile to that of the 600 mm diameter pile. (Enter the numerical value of the ratio only.)

Ans. **(4)**

For friction pile $Q_u = CN_cA_b + \alpha CA_s$

$$\frac{Q_{u1200}}{Q_{u600}} = \frac{\alpha C \times \frac{\pi}{4} \times 1200^2}{\alpha C \times \frac{\pi}{4} \times 600^2}$$

$$\frac{Q_{u1200}}{Q_{u600}} = 4$$

End of Solution

53. Match the scientists listed in Column I with the corresponding tests in Column II

	List-I	List-II
P.	Menard	1. Dilatometer Test
Q.	Marchetti	2. Pressuremeter Test
R.	Casagrande	3. Compaction Test
S.	Proctor	4. Liquid Limit Test

(a) P-2, Q-3, R-4, S-1

(b) P-2, Q-1, R-4, S-3

(c) P-2, Q-4, R-1, S-3

(d) P-4, Q-1, R-2, S-3

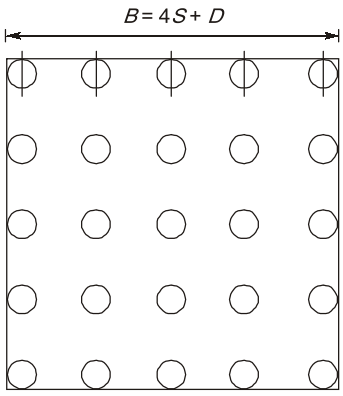
Ans. (b)

Menard	→	Pressuremeter Test
Marchetti	→	Dilatometer Test
Casagrande	→	Liquid Limit Test
Proctor	→	Compaction Test

End of Solution

54. 25 piles are arranged in 5 × 5 square arrangement
Dia of each pile = 1 m
C = 20 kPa
Adhesion factor = 0.75
Length of each pile = 15 m
If efficiency of pile group is equal to unity then the ratio of spacing between piles to the pile diameter is _____.

Ans. (1.75)



$$\eta = \frac{\text{Pile group capacity}}{\text{No. of pile} \times \text{Single pile capacity}}$$

Individual pile capacity, $Q_u = 9CA_b + \alpha CA_s$

$$= 9\times20\times\frac{\pi}{4}\times1^2 + 0.75\times20\times\pi\times1\times15$$

$$= 847.8 \text{ kN}$$

$$\text{Pile group} = 9 \times 20 \times B^2 + 1 \times 20 \times 4B \times 15$$

As efficiency of pile group = 1

$$\Rightarrow 9 \times 20 \times B^2 + 1200B = 25 \times 847.8$$

$$180 \times (4S + 1)^2 + 1200 \times (4S + 1) = 25 \times 847.8$$

$$S = 1.755 \text{ m}$$

Ratio of spacing/pile dia. = 1.755 m

End of Solution

55. **A 2 m wide strip foundation in cohesive soil having angle of internal friction as zero is laid at 1.5 m depth**

Cohesion = 20 kPa

Unit weight of soil = 20 kN/m^3

By using Terzaghi's theory find the percentage difference in net bearing capacity of foundation when water table was at great depth to the when water table is at foundation level

Ans. **(0)**

For clayey soil, $q_{nu} = CN_C$

As independent of water table so change in net bearing capacity = 0

End of Solution

56. **The area ratio of a cutting edge of a soil sampler is 10%. If the outside (cutting edge) diameter is 50.8 mm, what is the inside diameter of the sampler?**

(a) 48.436 mm **(b) 49.42 mm**

(c) 47.90 mm **(d) 46.85 mm**

Ans. **(a)**

$$\text{Area ratio} = \frac{D_2^2 - D_1^2}{D_1^2}\times100$$

$$\Rightarrow 10 = \frac{50.8^2 - D_1^2}{D_1^2}\times100$$

$$\Rightarrow D_1 = 48.436 \text{ mm}$$

End of Solution

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3	ARJUN SHARMA	Mains Online Course
4	BOLLA U NANDAN	Classroom Foundation Course
5	KESHAV	Test Series & IGP
7	TUSHAR AGGARWAL	Classroom Foundation Course
8	AYUSH JAIN	Classroom Foundation Course
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10	PUSHPENDRA RATHORE	Test Series & IGP

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MADE EASY students top in GATE 2025

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2	ME	Gollangi Sateesh	Online Course
2	EE	Kailash Goyal	Classroom Course
2	EC	Ankush Philip John	Postal Package & Test Series
2	IN	S. Bhattacharya	Test Series
2	ES	Jitesh Choudhary	Classroom Course
2	ES	Tarun Yadav	Classroom Course
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3	ME	Nimesh Chandra	Classroom Course
3	PI	Aditya Kr. Prasad	Classroom Course
3	XE	Rohan Kr. Biswal	Test Series
5	CE	Kartik Pokhriyal	Classroom Course
5	PI	Kuldeep Singh Naruka	Classroom Course
5	IN	Sachin Yadav	Test Series
5	EC	M. M. Nafeez	Test Series
5	ES	Sachin Kumar	Classroom Course
6	PI	Kaushal Kr. Kaushik	Online Course
6	CE	Shivanand Chaurasia	Online Course
6	CE	Nimish Upadhyay	Online Course
6	EE	Puneet Soni	Test Series
6	EE	Shivam Kr. Gupta	Test Series
6	EC	Pentela J. Bhavani	Test Series
6	IN	Utkarsh P. Patil	Classroom Course
7	PI	Waleed Shaikh	Test Series
7	ME	Abhinn	Online Course
7	IN	Dev J. Patel	Test Series
7	ES	Ankit Kumar	Classroom Course
8	ME	Goutam Kumar	Test Series
9	CE	Tarun Yadav	Classroom Course
9	CS	Omhari	Test Series
9	EC	Chilukuri S. Charan	Test Series
9	XE	Apar Harsh Chandra	Classroom Course
10	CE	Adnan Quasain	Classroom Course
10	CE	Rahul Singh	Online Course
10	ME	Ashutosh Kumar	Classroom Course
10	ME	Jetti Ganateja	Test Series
10	ME	Muhammed Sinan K	Test Series
10	ME	Pitchika Kr. Vasu	Online Course
10	PI	M Gopu Ganesh	Test Series
10	EE	Neelava Mukherjee	Postal Package & Test Series

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57. A long homogeneous slope is formed in a c-ϕ soil having the following properties:

- Unit weight, $\gamma = 15.72$, kN/m^3
- Cohesion, C = 12, kN/m^2
- Angle of internal friction, $\phi = 15°$
- Slope inclination to the horizontal, $\beta = 22°$

Assuming a planar failure surface and limiting equilibrium conditions (Factor of Safety = 1), determine the critical height of the slope.

Enter the numerical value of the critical height (in metres, up to two decimal places).

Ans. (6.525)

$$FOS = \frac{\text{Shear strength}}{\text{Mobilised shear stress}} = \frac{C+\gamma H\cos^2\beta\tan\phi}{\gamma H\cos\beta\sin\beta}$$

$$1 = \frac{12 + 15.72 \times H_c \cos^2 22° \tan 15°}{15.72 \times H_c \cos 22° \times \sin 22°}$$

$$H_c = 6.525 \text{ m}$$

End of Solution

58. Which of the following option is incorrect regarding Rankine's earth pressure theory?

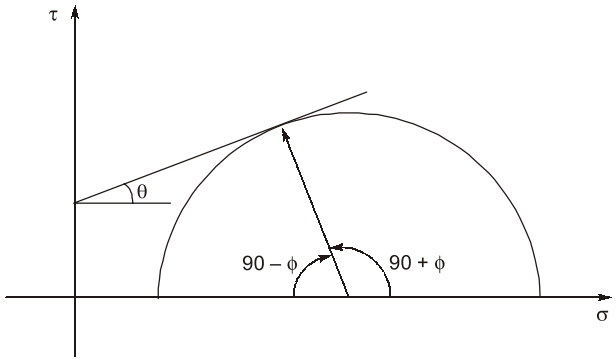
(a) For passive earth pressure, the failure plane is at $45° - \frac{\phi}{2}$ from major principal plane

(b) For passive earth pressure, the failure plane is at $45° + \frac{\phi}{2}$ from major principal plane

(c) For active earth pressure, the failure plane is at $45° - \frac{\phi}{2}$ from major principal plane

(d) For active earth pressure, the failure plane is at $45° + \frac{\phi}{2}$ from major principal plane

Ans. (b, d)



For active earth pressure, failure plane makes $45+\frac{\phi}{2}$ with major principal plane and passive E.P mahe $\left(45-\frac{\phi^\circ}{2}\right)$.

End of Solution