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GATE 2017

Civil Engineering

(Forenoon Session : 12-02-2017)

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CIVIL ENGINEERING

Q.1 A uniformly distributed line load of 500 kN/m is acting on the ground surface. Based on Boussinesq's theory, the ratio of vertical stress at depth 2 m to that at 4 m, right below the line of loading, is

(a) 0.25 (b) 0.5

(c) 2.0 (d) 4.0

Ans. (c)

$q' = 500$ kN/m $\qquad x = 0$ (Just below the line load)

$$\sigma_z = \frac{2q'}{\pi z}\left(\frac{1}{1+\frac{x^2}{z^2}}\right)^2 = \frac{2q'}{\pi z}$$

$$\text{Ratio} = \frac{(\sigma_z)_{at,2m}}{(\sigma_z)_{at,4m}} = \frac{\frac{2q'}{\pi \times 2}}{\frac{2q'}{\pi \times 4}} = \frac{4}{2} = 2$$

End of Solution

Q.2 $\lim\limits_{x\to\infty}\left(\frac{\tan x}{x^2 - x}\right)$ is equal to _____.

Ans. (–1)

$\underset{x\to 0}{Lt}\ \frac{\tan x}{x^2 - x}$ (Applying L'Hospital rule)

$$\underset{x\to 0}{Lt}\ \frac{\sec^2 x}{2x^2 - 1} = \frac{\sec^2 0}{0 - 1} = \frac{1}{-1} = -1$$

End of Solution

Q.3 Consider the following partial differential equation:

$$3\frac{\partial^2\phi}{\partial x^2} + B\frac{\partial^2\phi}{\partial x \partial y} + 3\frac{\partial^2\phi}{\partial y^2} + 4\phi = 0$$

For this equation to be classified as parabolic, the value of B^2 must be _____.

Ans. (36)

Given that the partial differential equation is parabolic.

$\therefore \quad B^2 - 4AC = 0$ Here $A = 3$, $C = 3$

$\therefore \quad B^2 - 4(3)(3) = 0$

$B^2 - 36 = 0$

$B^2 = 36$

End of Solution

Q.4 According to **IS 456-2000**, which one of the following statements about the depth of neutral axis $x_{u,bal}$ for a balanced reinforced concrete section is correct?

(a) $x_{u,bal}$ depends on the grade of concrete only
(b) $x_{u,bal}$ depends on the grade of steel only
(c) $x_{u,bal}$ depends on both the grade of concrete and grade of steel
(d) $x_{u,bal}$ does not depend on the grade of concrete and grade of steel

Ans. (b)

$$x_{u,\ bal} = \frac{700}{1100 + 0.87 f_y} \times d$$

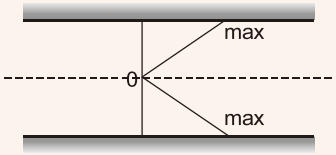
So it depends upon grade of steel only.

End of Solution

Q.5 For a steady incompressible laminar flow between two infinite parallel stationary plates, the shear stress variation is

(a) linear with zero value at the plates
(b) linear with zero value at the center
(c) quadratic with zero value at the plates
(d) quadratic with zero value at the center

Ans. (b)



Shear stress variation between parallel stationary plates.

End of Solution

Q.6 The accuracy of an Electronic Distance Measuring Instrument (EDMI) is specified as ± (*a* mm + *b* ppm). Which one of the following statements is correct?

(a) Both *a* and *b* remain constant, irrespective of the distance being measured.
(b) *a* remains constant and *b* varies in proportion to the distance being measured.
(c) *a* varies in proportion to the distance being measured and *b* remains constant.
(d) Both *a* and *b* vary in proportion to the distance being measured.

Ans. (b)

Accuracy of EDMI is generally stated in terms of constant instruments error and a measuring error proportional to the distance being measured: ± (*a* mm + *b* ppm). The first part indicates a constant instrument error that is independent of the length of the line measured. The second component is the distance related error.

End of Solution

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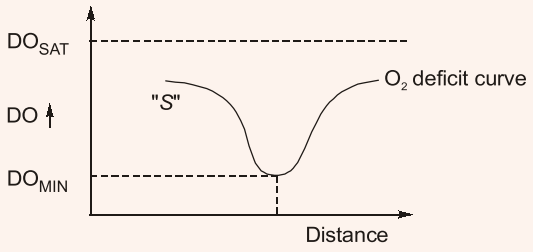
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Q.7 The wastewater from a city, containing a high concentration of biodegradable organics, is being steadily discharged into a flowing river at a location S. If the rate of aeration of the river water is lower than the rate of degradation of the organics, then the dissolved oxygen of the river water.

(a) is lowest at the location S.
(b) is lowest at a point upstream of the location S.
(c) remains constant all along the length of the river.
(d) is lowest at a point downstream of the location S.

Ans. (d)



As given rate of areation is less than rate of degradation which decreases with time/distance, minimum *DO* is observed downstream of point of disposal '*S*' where both rate of a reaction and degradation becomes equal.

End of Solution

Q.8 **Group I** lists the type of gain or loss of strength in soils. **Group II** lists the property or process responsible for the loss or gain of strength in soils.

Group I	Group II
P. Regain of strength with time	1. Boiling
Q. Loss of strength due to cyclic loading	2. Liquefaction
R. Loss of strength due to upward seepage	3. Thixotropy
S. Loss of strength due to remoulding	4. Sensitivity

The correct match between Group I and Group II is

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

Ans. (c)

- Loss in strength of soil due to remoulding at same water content is termed as sensitivity.
- Over a period of time soil regain a part of its lost strength is termed as thixotropy.
- When seepage takes place in upward direction, seepage pressure acts in upward direction and effective stress is reduced, consequently shear strength is reduced.
- In liquefaction, due to dynamic/cyclic loading in loose saturated sand, effective stress decreases and decrease in shear strength is recorded.

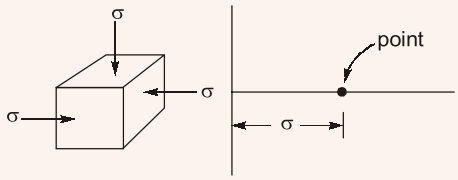
End of Solution

Q.9 A soil sample is subjected to a hydrostatic pressure, σ. The Mohr circle for any point in the soil sample would be

(a) a circle of radius σ and center at the origin
(b) a circle of radius σ and center at a distance σ from the origin
(c) a point at a distance σ from the origin
(d) a circle of diameter σ and center at the origin

Ans. (c)

Hydrostatic pressure acts equally in all directions.



End of Solution

Q.10 Vehicles arriving at an intersection from one of the approach roads follow the Poisson distribution. The mean rate of arrival is 900 vehicles per hour. If a gap is defined as the time difference between two successive vehicle arrivals (with vehicles assumed to be points), the probability (up to four decimal places) that the gap is greater than 8 seconds is _____.

Ans. (0.1353)

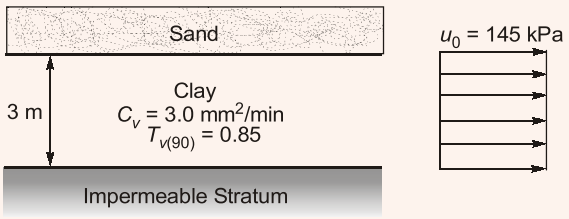
$$\lambda = 900 \text{ veh/hour} = \frac{900}{3600} = \frac{1}{4} \text{veh/sec}$$

$$P[t \geq 8 \text{ sec}] = e^{-\lambda t}$$

$$= e^{-\frac{1}{4} \times 8} = e^{-2} = 0.1353$$

End of Solution

Q.11 A 3 m thick clay layer is subjected to an initial uniform pore pressure of 145 kPa as shown in the figure.



For the given ground conditions, the time (in days, rounded to the nearest integer) required for 90% consolidation would be _____.

Ans. (1771)

As per Terzaghi's 1–D consolidation theory.

$$T_v = C_v \frac{t}{d^2}$$

One way drainage condition $d = 3$ m

For 90% consolidation

$$(T_v)_{90} = C_v \cdot \frac{t_{90}}{d^2}$$

$$0.85 = 3\times10^{-6} \times \frac{t_{90}}{(3)^2}$$

$$t_{90} = \frac{0.85\times9}{3\times10^{-6}} \text{ min}$$

$$t_{90} = 1770.83 \approx 1771 \text{ days}$$

End of Solution

Q.12 A super-elevation e is provided on a circular horizontal curve such that a vehicle can be stopped on the curve without sliding. Assuming a design speed v and maximum coefficient of side friction f_{max}, which one of the following criteria should be satisfied?

(a) $e \le f_{max}$ (b) $e > f_{max}$

(c) no limit on e can be set (d) $e = \dfrac{1-(f_{max})^2}{f_{max}}$

Ans. (a)

Sliding occurs if

$$f < e$$

and $$f < \frac{V^2}{gR}$$

Overturning occurs if

$$f > e$$

and $$e < \frac{V^2}{gR}$$

Hence, option (a) is correct.

End of Solution

Q.13 The number of parameters in the univariate exponential and Gaussian distributions, respectively, are

(a) 2 and 2 (b) 1 and 2

(c) 2 and 1 (d) 1 and 1

Ans. **(b)**

In exponential, $f(x) = \lambda e^{-\lambda x}$; $x = 0$

The parameter is λ.

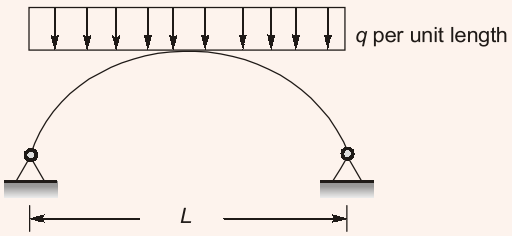
In Gaussian, $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$; $-\infty < x < \infty$

The parameters are μ and σ.

Therefore, answer is (b).

End of Solution

Q.14 The figure shows a two-hinged parabolic arch span L subjected to a uniformly distributed load of intensity q per unit length.



The maximum bending moment in the arch is equal to

(a) $\frac{qL^2}{8}$ (b) $\frac{qL^2}{12}$

(c) zero (d) $\frac{qL^2}{10}$

Ans. **(c)**

If a two hinged or three hinged parabolic arch is subjected to UDL throughout its length, bending moment is zero everywhere.

End of Solution

Q.15 The ordinates of a 2-hour unit hydrograph for a catchment are given as

Time (h)	0	1	2	3	4
Ordinate (m^3/s)	0	5	12	25	41

The ordinate (in m^3/s) of a 4-hour unit hydrograph for this catchment at the time of 3h would be_____.

Ans. (15)

Time (hr)	Ordinate of 2 hr Unit Hydrograph	Ordinate of 2 hr Unit Hydrograph lag by 2 hr	Ordinate of 4 hr DRH	Ordinate of 4 hr Unit Hydrograph $= \frac{\text{Ordinate of given DRH}}{2\text{ cm}}$
0	0	-	0	0
1	5	-	5	2.5
2	12	0	12	6.0
3	25	5	30	15
4	41	12	53	26.5
		25	25	12.5
		41	41	20.5

$\therefore$ Ordinate of 4 hr U.H. at 3 hr duration = 15.0 m^3/sec.

End of Solution

Q.16 A runway is being constructed in a new airport as per the International Civil Aviation Organization (ICAO) recommendations. The elevation and the airport reference temperature of this airport are 535 m above the mean sea level and 22.65°C, respectively. Consider the effective gradient of runway as 1%. The length of runway required for a design-aircraft under the standard conditions is 2000 m. Within the framework of applying sequential corrections as per the ICAO recommendations, the length of runway corrected for the temperature is

(a) 2223 m (b) 2250 m

(c) 2500 m (d) 2750 m

Ans. (c)

Elevation = 535 m

Airport Reference Temperature = 22.65° C

Effective Gradient = 1%

Runway length = 2000 m under standard conditions.

Runway length correction for T°C.

$$\Rightarrow \text{Correction for elevation} = \frac{7}{100}\times 2000 \times \frac{535}{300} = 249.67 \text{ m}$$

Corrected runway length = 2249.67 m

$\Rightarrow$ Corrected standard T° at 535 m elevation

$$= 15°C - (0.0065 \times 535) = 11.52°C$$

$$\text{Correction for T°} = \frac{1}{100}\times 2249.67 \times \frac{\Delta T°C}{1°C}$$

$$\Delta T°C = 22.65 - 11.52 = 11.13°C$$

$$= \frac{1}{100}\times 2249.67 \times \frac{11.13°c}{1°c} = 250.39 \text{ m}$$

Corrected Runway length = 2249.67 + 250.39 = 2500.06 m

End of Solution

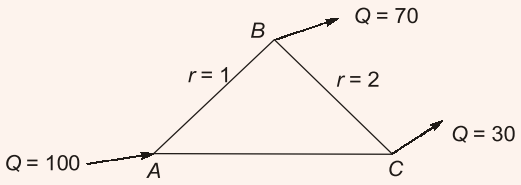
Q.17 A simply supported beam is subjected to a uniformly distributed load. Which one of the following statements is true?

(a) Maximum or minimum shear force occurs where the curvature is zero.
(b) Maximum or minimum bending moment occurs where the shear force is zero.
(c) Maximum or minimum bending moment occurs where the curvature is zero.
(d) Maximum bending moment and maximum shear force occur at the same section.

Ans. (b)

End of Solution

Q.18 A triangular pipe network is shown in the figure



The head loss in each pipe is given by $h_f = rQ^{1.8}$, with the variables expressed in a consistent set of units. The value of r for the pipe AB is 1 and for the pipe BC is 2. If the discharge supplied at the point A (i.e., 100) is equally divided between the pipes AB and AC, the value of r (up to 2 decimal places) for the pipe AC should be _____.

Ans. (0.62)

Given $h_f = r \cdot Q^{1.8}$

Because of the given condition of equal discharge distribution in pipe AB & AC, the discharge in AB and AC will be 50 and 50. Now satisfy continuity at point B and C

For close Loop $ABCA$

$$\Sigma h_f = 0$$

$$\Rightarrow 1(50)^{1.8} - 2(20)^{1.8} - r(50)^{1.8} = 0$$

$$\Rightarrow \quad 1143.26 - 439.42 = r\,(50)^{1.8}$$

$$r = 0.62$$

End of Solution

Q.19 A strip footing is resting on the ground surface of a pure clay bed having an undrained cohesion c_u. The ultimate bearing capacity of the footing is equal to

(a) $2\pi c_u$ (b) πc_u
(c) $(\pi + 1)\, c_u$ (d) $(\pi + 2)\, c_u$

Ans. (d)

Footing is at surface

Hence, $D_f = 0$

$$q_u = CN_c + \gamma D_f N_q + 0.5\, B\gamma N_\gamma$$

$\Rightarrow$ For clay $N_\gamma = 0,\ N_q = 1$

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$\therefore \quad q_u = CN_c$

As per Terzaghi $N_c = 5.7$

and as per Meyerhoff and Prandtl, $N_c = 5.14$

$\therefore \quad q_u = (\pi + 2)C_u = (3.14 + 2)C_u = 5.14\ C_u$

End of Solution

Q.20 Let x be a continuous variable defined over the interval $(-\infty, \infty)$, and $f(x) = e^{-x-e^{-x}}$. The integral $g(x) = \int f(x)dx$ is equal to

(a) $e^{e^{-x}}$ (b) $e^{-e^{-x}}$

(c) $e^{-e^{x}}$ (d) e^{-x}

Ans. (b)

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

$$y(x) = \int f(x)dx = \int e^{-x} \cdot e^{-e^{-x}} dx$$

Let $e^{-x} = t$

$-e^{-x}\, dx = dt$

$$\int f(x)dx = \int e^{-t} \cdot (-dt)$$

$$= \frac{e^{-t}}{-1} \cdot (-d)$$

$$= e^{-t}$$

$$= e^{-\left(e^{-x}\right)} = e^{-e^{-x}}$$

End of Solution

Q.21 The reaction rate involving reactants A and B is given by $-k[A]^{\alpha}[B]^{\beta}$. Which one of the following statements is valid for the reaction to be a first-order reaction?

(a) $\alpha = 0$ and $\beta = 0$ (b) $\alpha = 1$ and $\beta = 0$

(c) $\alpha = 1$ and $\beta = 1$ (d) $\alpha = 1$ and $\beta = 2$

Ans. (b)

The order of reaction is the exponent to which its concentration term in the rate equation is raised.

$$\text{Rate, } r = k[A]^{\alpha}[B]^{\beta}$$

For first order reaction,

$$\alpha + \beta = 1$$

End of Solution

Q.22 The number of spectral bands in the Enhanced Thematic Mapper sensor on the remote sensing satellite Landsat-7 is

(a) 64 (b) 10
(c) 8 (d) 15

Ans. **(c)**

Total number of spectrum band in Enhanced Thematic Mapper sensor = 8

End of Solution

Q.23 Which one of the following is NOT present in the acid rain?

(a) HNO_3 (b) H_2SO_4
(c) H_2CO_3 (d) CH_3COOH

Ans. **(d)**

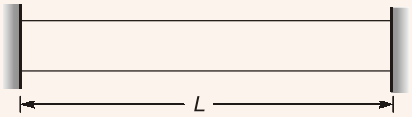
Acid rain primarily consist of HNO_3, H_2SO_4 and H_2CO_3.

End of Solution

Q.24 An elastic bar length L, uniform cross-sectional area A, coefficient of thermal expansion α, and Young's modulus E is fixed at the two ends. The temperature of the bar is increased by T, resulting in an axial stress σ. Keeping all other parameters unchanged, if the length of the bar is doubled, the axial stress would be

(a) σ (b) 2σ
(c) $0.5\,\sigma$ (d) $0.25\,\alpha\,\sigma$

Ans. **(a)**



$\sigma = \alpha TE$

$\therefore$ Length have no effect on thermal stress.

$\therefore$ Axial stress is only 'σ'.

End of Solution

Q.25 The matrix P is the inverse of a matrix Q. If I denotes the identity matrix, which one of the following options is correct?

(a) $PQ = I$ but $QP \neq I$ (b) $QP = I$ but $PQ \neq I$
(c) $PQ = I$ and $QP = I$ (d) $PQ - QP = I$

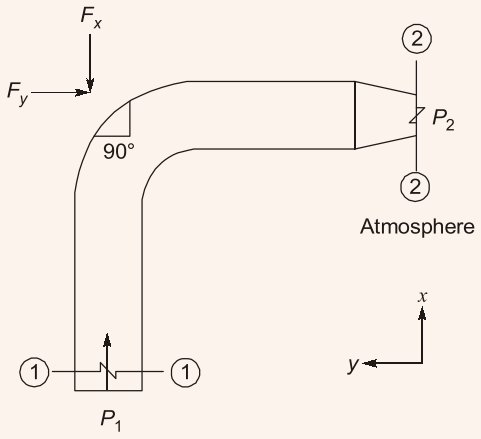
Ans. **(c)**

Given that P is inverse of Q.

$$P = Q^{-1} \qquad P = Q^{-1}$$
$$PQ = Q^{-1}Q \qquad QP = QQ^{-1}$$
$$PQ = I \qquad QP = I$$
$$\therefore \quad PQ = QP = I$$

End of Solution

Q.26 Water flows through a 90° bend in a horizontal plane as depicted in the figure.

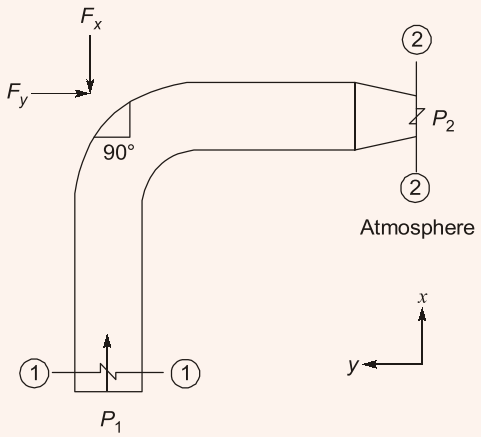


A pressure of 140 kPa is measured at section 1-1. The inlet diameter marked at section 1-1 is $\frac{27}{\sqrt{\pi}}$ cm, while the nozzle diameter marked at section 2-2 is $\frac{14}{\sqrt{\pi}}$ cm. Assume the following:

(i) Acceleration due to gravity = 10 m/s^2.
(ii) Weights of both the bent pipe segment as well as water are negligible.
(iii) Friction across the bend is negligible.

The magnitude of the force (in kN, up to two decimal places) that would be required to hold the pipe section is _____.

Ans. (397.25)



Apply energy equation between (1) and (2)

$$\frac{P_1}{\rho g}+\frac{v_1^2}{2g}+z_1=\frac{P_2}{\rho g}+\frac{v_2^2}{2g}+z_2 \qquad \{z_1=z_2\}$$

$$\frac{140\times10^3}{10^3\times10}+\frac{v_1^2}{2g}=\frac{v_2^2}{2g}$$

$$14 = \frac{1}{2\times 10}\left[v_2^2 - v_1^2\right]$$

$$14 \times 2 \times 10 = Q^2\left[\frac{1}{A_2^2} - \frac{1}{A_1^2}\right]$$

$$280 = Q^2\left[\frac{1}{\frac{\pi}{4}\frac{(0.14)^2}{\pi}} - \frac{1}{\frac{\pi}{4}\frac{(0.27)^2}{\pi}}\right]$$

$$Q = 1.3699 \text{ m}^3/\text{sec}$$

Momentum equation in x-direction

$$P_1A_1 - F_x = \dot{m}\left[v_{2_x} - v_{1_x}\right] \qquad v_{2_x} = 0;\ v_{1_x} = \frac{Q}{A_1}$$

$$P_1A_1 - F_x = \rho Q\left[0 - \frac{Q}{A_1}\right]$$

$$F_x = P_1A_1 + \frac{\rho Q^2}{A_1}$$

$$= \left\{140\times 10^3 \times \frac{\pi}{4}\times\frac{0.27^2}{\pi}\right\} + \left\{\frac{1000\times 1.3699^2}{\frac{\pi}{4}\times\frac{0.27^2}{\pi}}\right\}$$

$$= 105.52 \text{ kN}$$

Moment equation in y-direction

$$F_y = \dot{m}\left[v_{2_y} - v_{1_y}\right] \qquad v_{1_y} = 0;\ v_{2_y} = \frac{Q}{A_2}$$

$$F_y = \rho Q\left[\frac{Q}{A_2}\right]$$

$$= 10^3 \times 1.3699^2 \times \frac{1}{\frac{\pi}{4}\times\frac{0.14^2}{\pi}}$$

$$= 382.98 \text{ kN}$$

Resultant force, $F_R = \sqrt{F_x^2 + F_y^2}$

$$= \sqrt{105.52^2 + 382.98^2}$$

$$= 397.25 \text{ kN}$$

End of Solution

Q.27 The laboratory tests on a soil sample yield the following results; natural moisture content = 18%, liquid limit = 60%, plastic limit = 25%, percentage of clay sized fraction = 25%. The liquidity index and activity (as per the expression proposed by Skempton) of the soil, respectively, are

(a) –0.2 and 1.4 (b) 0.2 and 1.4

(c) –1.2 and 0.714 (d) 1.2 and 0.714

Ans. **(a)**

Given data: w_n = 18%, w_L = 60%, w_p = 25%

% of clay size particle = 25%

$$\text{Liquidity index } I_L = \frac{w_n - w_p}{w_L - w_p} = \frac{0.18 - 0.25}{0.60 - 0.25} = -0.2$$

$$\text{Activity} = \frac{I_p}{\%C} = \frac{w_L - w_p}{\%C} = \frac{60 - 25}{25} = 1.4$$

End of Solution

Q.28 A consolidated undrained $(\overline{CU})$ triaxial compression test is conducted on a normally consolidated clay at a confining pressure of 100 kPa. The deviator stress at failure is 80 kPa, and the pore-water pressure measured at failure is 50 kPa. The effective angle of internal friction (in degrees, up to one decimal place) of the soil is _____.

Ans. **(26.4)**

CU test is conducted.

σ_3 = 100 kPa, σ_d = 80 kPa, u = 50 kPa

$$\sigma_1 = \sigma_3 + \sigma_d = 100 + 80 = 180 \text{ kPa}$$

$$\bar{\sigma}_1 = \sigma_1 - u = 180 - 50 = 130 \text{ kPa}$$

$$\bar{\sigma}_3 = \sigma_3 - u = 100 - 50 = 50 \text{ kPa}$$

$$\bar{\sigma}_1 = \bar{\sigma}_3 \tan^2\left(45 + \frac{\phi'}{2}\right) + 2C' \tan\left(45 + \frac{\phi'}{2}\right)$$

Assume $C' = 0$

$$\bar{\sigma}_1 = \bar{\sigma}_3 \tan^2\left(45 + \frac{\phi'}{2}\right)$$

$$130 = 50 \tan^2\left(45 + \frac{\phi'}{2}\right)$$

$$\phi' = 26.4^\circ$$

End of Solution

Q.29 For the function $f(x) = a + bx$, $0 \le x \le 1$, to be a valid probability density function, which one of the following statements is correct?

(a) $a = 1, b = 4$ (b) $a = 0.5, b = 1$

(c) $a = 0, b = 1$ (d) $a = 1, b = -1$

Ans. (b)

$$\int_{-\infty}^{\infty} f(x)dx = 1$$

$$\int_{0}^{1} (a+bx)dx = 1$$

$$\left(ax + \frac{bx^2}{2}\right)\Big|_0^1 = 1$$

$$a + \frac{b}{2} = 1$$

Option (b) is satisfying the above equation.

End of Solution

Q.30 Two wastewater streams *A* and *B*, having an indentical ultimate BOD are getting mixed to form the stream *C*. The temperature of the stream *A* is 20°C and the temperature of the stream *C* is 10°C. It is given that

- the 5-day BOD of the stream *A* measured at 20°C = 50 mg/*l*
- BOD rate constant (base 10) at 20°C = 0.115 per day
- temperature coefficient = 1.135

The 5-day BOD (in mg/*l*, up to one decimal place) of the stream *C*, calculated at 10°C, is _____.

Ans. (21.21)

$$\text{At } A,\ (BOD_5)_{20^\circ C} = L(1-10^{-k_D 20^\circ C \times 5})$$

$$50 = L(1 - 10^{-0.115 \times 5})$$

$$L = 68.129 \text{ mg/}l$$

Here, $k_{D_{10}} = k_{D_{20}} \times [1.135]^{10-20}$

$$= 0.115 \times (1.135)^{-10} = 0.0324$$

For C, $(BOD_5)_{10^\circ C} = L\left[1-10^{-k_{D10} \times t}\right]$

$$= 68.13\left[1-10^{-0.0324 \times 5}\right]$$

$$= 21.21 \text{ mg/}l$$

End of Solution

Q.31 **Group I** contains three broad classes of irrigation supply canal outlets. **Group II** presents hydraulic performance attributes.

Group I	Group II
P. Non-modular outlet	1. Outlet discharge depends on the water levels in both the supply canal as well as the receiving water course
Q. Semi-modular outlet	2. Outlet discharge is fixed and is independent of the water levels in both the supply canal as well as the receiving water course
R. Modular outlet	3. Outlet discharge depends only on the water level in the supply canal

The correct match of the items in **Group I** with the items in **Group II** is

(a) P-1; Q-2; R-3 (b) P-3; Q-1; R-2

(c) P-2; Q-3; R-1 (d) P-1; Q-3; R-2

Ans. (d)

Non-modular outlet : These are the outlets whose discharge depends on the difference in water levels in the distributing channel and the water course. The discharge of such outlets, therefore, varies with the variation of the water levels in the distributing channel and the water course.

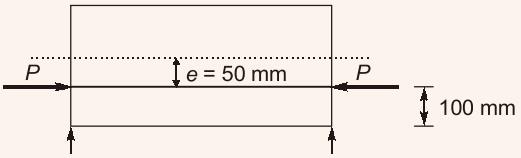
Semi-modular outlet : These are the outlets whose discharge varies with the variation of the water level in the distribution channel but it is independent of the water level in the water course, so long as the minimum working head required for their working is available.

Modular outlet : These are the outlets whose discharge is independent of the water levels in the distributing channel and the water course, within reasonable working limits. In other words modular outlets maintain a constant discharge irrespective of variation of the water levels in the distributing channel and the water course.

End of Solution

Q.32 A pre-tensioned rectangular concrete beam 150 mm wide and 300 depth is prestressed with three straight tendons, each having a cross-sectional area of 50 mm^2, to an initial stress of 1200 N/mm^2. The tendons are located at 100 mm from the soffit of the beam. If the modular ratio is 6, the loss of prestressing force (in kN, up to one decimal place) due to the elastic deformation of concrete only is _____.

Ans. (4.8)



Prestressing force $P = 3 \times 50 \times 1200 = 180000$ N.

$$e = \left(\frac{D}{2} - 100\right) = \left(\frac{300}{2} - 100\right) = 50 \text{ mm}$$

Stress in concrete at the location of steel

$$= \frac{P}{A} + \frac{P \cdot e}{I} e = \frac{180000}{150 \times 300} + \frac{180000 \times 50^2}{\left(\frac{150 \times 300^3}{12}\right)}$$

$$= 4.0 + 1.33 = 5.333$$

$$\text{Loss of stress} = m \times f_c$$

$$= 6 \times 5.3333 = 32 \text{ N/mm}^2$$

Loss of prestressing force

$$= \frac{3 \times 50 \times 32}{1000} \text{ kN} = 4.8 \text{ kN}$$

End of Solution

Q.33 The spherical grit particles, having a radius of 0.01 mm and specific gravity of 3.0, need to be separated in a settling chamber. It is given that

- g = 9.81 m/s^2
- the density of the liquid in the settling chamber = 1000 kg/m^3
- the kinematic viscosity of the liquid in the settling chamber = 10^{-6} m^2/s

Assuming laminar conditions, the settling velocity (in mm/s, up to one decimal place) is _____.

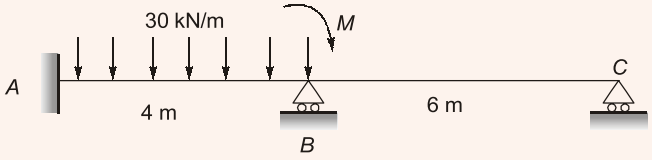
Ans. (0.436)

$$v_s = \frac{(G-1)gd^2}{18\nu} = \frac{(3-1)9.81(0.02 \times 10^{-3})^2}{18 \times 10^{-6}} \times 10^3$$

$$= 0.436 \text{ mm/sec}$$

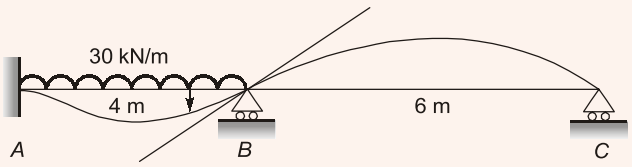
End of Solution

Q.34 The value of M in the beam ABC shown in the figure is such that the joint B does not rotate.



The value of support reaction (in kN) at *B* should be equal to _____.

Ans. (60)



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CE	10 Selections in Top 10	Jatin Kumar	Bivek Joishi	Rachit Jain	Adarsh R.S.	Mahipal Singh	Nitish Garg	Shivam D.	Amrit Anand	Avdhesh	Himanshu Tiwari
ME	9 Selections in Top 10	Mohd Idul Ahmad		Chirag Srivastav	Taronjot Singh	Deepak Vijay	Dheeraj Kumar	Tarun Kumar	JGMV Pramod	Gaurav Kant	Jivitesh Anand
EE	10 Selections in Top 10	Gaurav	B Venkatesh	Tanuj K Sharma	Varsha	Ashish Verma	Mufeed Khan	Shyamji D.	Sk Taushifur R.	Arvind Biswal	Gaurav Tyagi
E&T	10 Selections in Top 10	Naveen B. Sharma	Amit Rawat	Aswathy S.	Thaduri Naveen	Vinit Ranjan	Harshit Jain	Akash Chhikara	Vivek Jain	Jadugurla N.	Prabhakar

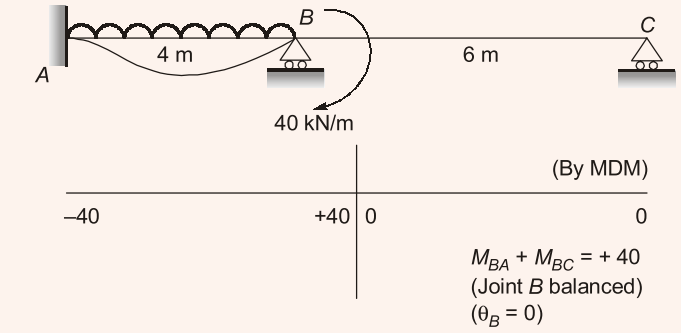
39 Selections in Top 10 | **76** Selections in Top 20 | **505** Selections out of total 604 vacancies

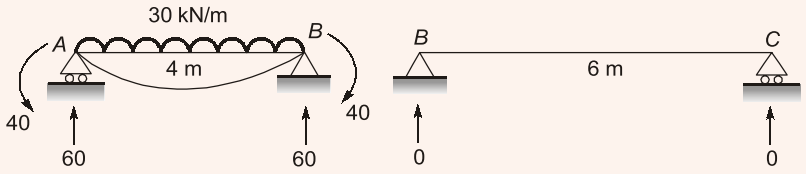
CE	Selections in Top 10 **10**	MADE EASY Selections **182** Out of **225** Vacancies	MADE EASY Percentage **81%**
ME	Selections in Top 10 **9**	MADE EASY Selections **159** Out of **179** Vacancies	MADE EASY Percentage **89%**
EE	Selections in Top 10 **10**	MADE EASY Selections **86** Out of **106** Vacancies	MADE EASY Percentage **81%**
E&T	Selections in Top 10 **10**	MADE EASY Selections **78** Out of **94** Vacancies	MADE EASY Percentage **83%**

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As the slope θ_B is an anticlockwise sense hence the momment at joint B must be applied in clockwise sense = 40 kNm to make $\theta_B = 0$





$\therefore$ $R_B = 60$ kN

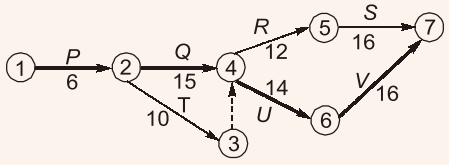
End of Solution

Q.35 The activity details of a project are given below:

Activity	Depends on	Duration (in days)
P	--	6
Q	P	15
R	Q, T	12
S	R	16
T	P	10
U	Q, T	14
V	U	16

The estimated minimum time (in days) for the completion of the project will be _____.

Ans. (51)



The minimum time for project completion is with respect to critical path.

Critical Path $\rightarrow P - Q - U - V$

$T_{cp} = 6 + 15 + 14 + 16 = 51$ days

End of Solution

Q.36 The solution of the equation $\frac{dQ}{dt}+Q=1$ with $Q = 0$ at $t = 0$ is

(a) $Q(t) = e^{-t} - 1$ (b) $Q(t) = 1 + e^{-t}$

(c) $Q(t) = 1 - e^{t}$ (d) $Q(t) = 1 - e^{-t}$

Ans. **(d)**

$$\frac{dQ}{dt}+Q = 1$$

Comparing with standard form

$$\text{I.F.} = e^{\int 1dt} = e^{t}$$

Solution is

$$Q.e^{t} = \int 1\cdot e^{t}dt$$

$$= e^{t} + C$$

$$Q = 1 + Ce^{-t} \quad ...(i)$$

When $t = 0$, $Q = 0$

$\Rightarrow$ $0 = 1 + C$

$\Rightarrow$ $C = -1$

Therefore, $Q(t) = 1 - e^{-t}$

End of Solution

Q.37 The radius of a horizontal circular curve on a highway is 120 m. The design speed is 60 km/hour, and the design coefficient of lateral friction between the tyre and the road surface is 0.15. The estimated value of superelevation required (if full lateral friction is assumed to develop), and the value of coefficient of friction needed (if no superelevation is provided) will, respectively, be

(a) $\frac{1}{11.6}$ and 0.10 (b) $\frac{1}{10.5}$ and 0.37

(c) $\frac{1}{11.6}$ and 0.24 (d) $\frac{1}{12.9}$ and 0.24

Ans. **(c)**

Given, $R = 120$ m, $V = 60$ kmph and $f = 0.15$

$\Rightarrow$ $e + f = \frac{V^2}{127R}$

$\Rightarrow$ $e + 0.15 = \frac{60^2}{127\times120}$

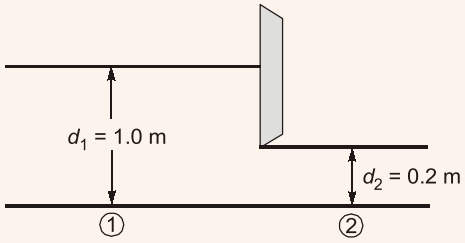
$\Rightarrow$ $e = \frac{1}{11.6}$

Also, if $e = 0$

$\Rightarrow$ $f = \frac{V^2}{127R} = \frac{60^2}{127\times120} \simeq 0.24$

End of Solution

Q.38 A sluice gate used to control the flow in a horizontal channel of unit width is shown in the figure.



It is obeserved that the depth of flow is 1.0 m upstream of the gate, while the depth is 0.2 m downstream of the gate. Assuming a smooth flow transition across the sluice gate, i.e., without any energy loss, and the acceleration due to gravity as 10 m/s^2, the discharge (in m^3/s, up to two decimal places) passing under the sluice gate is _____.

Ans. (0.816)

Applying Bernoulli's energy balance equation

$$y_1 + \frac{Q^2}{2gA_1^2} = y_2 + \frac{Q^2}{2gA_2^2}$$

Given $y_1 = 1$ m, $b = 1$ m, $y_2 = 0.2$

$$\Rightarrow \quad 1 + \frac{q^2 \times 1^2}{2g(1\times 1)^2} = 0.2 + \frac{q^2 \times 1^2}{2g \times (0.2 \times 1)^2}$$

$$\Rightarrow \quad 0.8 = \frac{q^2}{2g}\left(\frac{1}{(0.2)^2} - 1\right)$$

$$0.8 = \frac{q^2}{20} \times 24$$

$$q = 0.816 \text{ m}^2/\text{s}$$

End of Solution

Q.39 The observed bearings of a traverse are given below

Line	Bearing		Line	Bearing
PQ	46°15′		QP	226°15′
QR	108°15′		RQ	286°15′
RS	201°30′		SR	20°30′
ST	321°45′		TS	141°45′

The station(s) most likely to be affected by the local attraction is/are

(a) Only R
(b) Only S
(c) R and S
(d) P and Q

Ans. (a)

Line	FB	BB	$\Delta = \lvert FB - BB \rvert$
PQ	46°15′	226°15′	180°
QR	108°15′	286°15′	178°
RS	201°30′	20°30′	181°
ST	321°45′	141°45′	180°

Station R is most likely to be affected.

End of Solution

Q.40 The following observations are made while testing aggregate for its suitability in pavement construction:

(i) Mass of oven-dry aggregate in air = 1000 g

(ii) Mass of saturated surface-dry aggregate in air = 1025 g

(iii) Mass of saturated surface-dry aggregate under water = 625 g

Based on the above observations, the correct statement is

(a) bulk specific gravity of aggregate = 2.5 and water absorption = 2.5%

(b) bulk specific gravity of aggregate = 2.5 and water absorption = 2.4%

(c) apparent specific gravity of aggregate = 2.5 and water absorption = 2.5%

(d) apparent specific gravity of aggregate = 2.5 and water absorption = 2.4%

Ans. (a)

$$\text{Bulk specific gravity} = \frac{A}{B - C}$$

$$\text{Apparent specific gravity} = \frac{A}{A - C}$$

Where,

A = Mass of oven dry aggregate in air

B = Mass of Saturated surface dry aggregate in air

C = Mass of Saturated surface dry aggregate under water

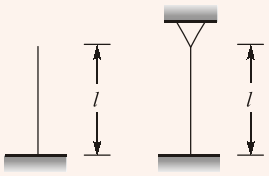
$$\therefore \text{ Bulk specific gravity} = \frac{1000}{1025 - 625} = \frac{1000}{400} = 2.5$$

$$\text{Water absorption} = \frac{1025 - 1000}{1000} \times 100 = 2.5\%$$

End of Solution

Q.41 Consider two axially loaded columns, namely, 1 and 2, made of a linear elastic material with Young's modulus 2×10^5 MPa, square cross-section with side 10 mm, and length 1 m. For Column 1, one end is fixed and the other end is free. For Column 2, one end is fixed and the other end is pinned. Based on the Euler's theory, the ratio (up to one decimal place) of the buckling load of Column 2 to the buckling load of Column 1 is _____.

Ans. (8)



$$P_{cr1} = \frac{\pi^2 E.I}{(2l)^2} = \frac{\pi^2 EI}{4l^2}$$

$$P_{cr2} = \frac{\pi^2 E.I}{\left(\frac{l}{\sqrt{2}}\right)^2} = \frac{2\pi^2 EI}{l^2}$$

$$\therefore \quad \text{Required ratio} = \frac{P_{cr2}}{P_{cr1}} = \frac{\frac{2\pi^2 EI}{l^2}}{\frac{\pi^2 EI}{4l^2}} = 8$$

End of Solution

Q.42 Consider the matrix $\begin{bmatrix} 5 & -1 \\ 4 & 1 \end{bmatrix}$. Which one of the following statements is TRUE for the eigenvalues and eigen vectors of this matrix?

(a) Eigenvalue 3 has a multiplicity of 2, and only one independent eigenvector exists.
(b) Eigenvalue 3 has a multiplicity of 2, and two independent eigenvector exists.
(c) Eigenvalue 3 has a multiplicity of 2, and no independent eigenvector exists.
(d) Eigenvalue are 3 and –3, and two indepedent eigenvectors exist.

Ans. (a)

$$A = \begin{bmatrix} 5 & -1 \\ 4 & 1 \end{bmatrix}$$

Ch. equation is $|A - \lambda I| = 0$

$$\begin{vmatrix} 5-\lambda & -1 \\ 4 & 1-\lambda \end{vmatrix} = 0$$

$$5 - 5\lambda - \lambda + \lambda^2 + 4 = 0$$
$$\lambda^2 - 6\lambda + 9 = 0$$
$$\lambda = 3, 3$$

Algebraic multiplicity of eigen value 3 is 2. It has only one independent eigen vector exists.

End of Solution

Q.43 The wastewater having an organic concentration of 54 mg/*l* is flowing at a steady rate of 0.8 m^3/day through a detention tank of dimensions 2 m × 4 m × 2 m. If the contents of the tank are well mixed and the decay contant is 0.1 per day, the outlet concentration (in mg/*l*, up to one decimal place) is _____.

Ans. (7.3)

$$Q = 0.8\ m^3/d$$

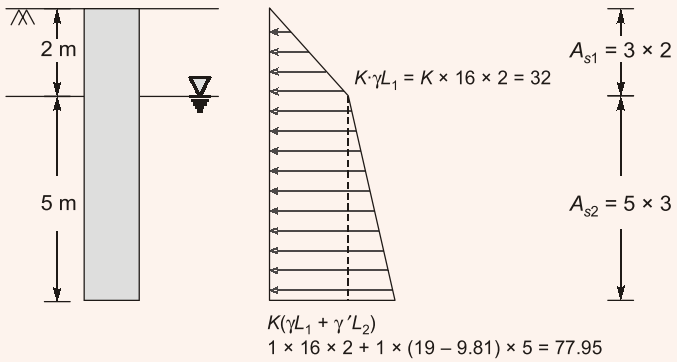
$$\text{Detention time, } D_t = \frac{V}{Q} = \frac{4\times2\times2\ m^3}{0.8\ m^3/day} = 20\ days$$

$$L_t = 54e^{-0.1\times20}$$
$$= 7.3\ mg/l$$

End of Solution

Q.44 It is proposed to drive H-piles up to a depth of 7 m at a construction site. The average surface area of the H-pile is 3 m^2 per meter length. The soil at the site is homogeneous sand, having an effective friction angle of 32°. The ground water table (GWT) is at a depth of 2 m below the ground surface. The unit weights of the soil above and below the GWT are 16 kN/m^3 and 19 kN/m^3, respectively. Assume the earth pressure coefficient, K = 1.0, and the angle of wall friction, δ = 23°. The total axial frictional resistance (in kN, up to one decimal place) mobilized on the pile against the driving is _____.

Ans. (390.8)



$$Q_{sf} = \frac{1}{2}k\gamma L_1 \tan\delta\, A_{s_1} + \frac{1}{2}K\left[\gamma L_1 + \gamma' L_2\right]\tan\delta A_{s_2}$$

$$= \frac{1}{2}\times1\times16\times2\tan23°(3\times2) + \frac{1}{2}\times1\left[16\times2+77.95\right]\times\tan23°(5\times3)$$

$$= 390.8\ kN$$

End of Solution

Q.45 An effective rainfall of 2-hour duration produced a flood hydrograph peak of 200 m^3/s. The flood hydrograph has a base flow of 20 m^3/s. If the spatial average rainfall in the watershed for the duration of storm is 2 cm and the average loss rate is 0.4 cm/hour, the peak of 2-hour unit hydrograph (in m^3/s-cm, up to one decimal place) is _____.

Ans. (150)

Peak of 2 hr direct runoff hydrograph = Peak of 2 hr flood hydrograph – Base flow

$= 200 - 20$

$= 180\ m^3/s$

The rainfall excess depth for a given duration of 2 hr effective storm/rainfall is given by

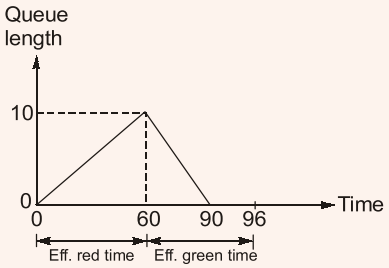
$$\text{Rainfall excess depth} = 2\ \text{cm} - 0.4\ \frac{\text{cm}}{\text{hr}} \times 2\ \text{hr}$$

$$= 1.2\ \text{cm}$$

$$\therefore \quad \text{Peak of 2 hr UH} = \frac{180}{1.2} = 150\ m^3/\text{s-cm}$$

End of Solution

Q.46 The queue length (in number of vehicles) versus time (in seconds) plot for an approach to a signalized intersection with the cycle length of 96 seconds is shown in the figure (not drawn to scale).



At time, $t = 0$, the light has just turned red. The effective green time is 36 seconds, during which vehicles discharge at the saturation flow rate, s (in vph). Vehicles arrive at a uniform rate, v (in vph), throughout the cycle. Which one of the following statements is TRUE?

(a) $v = 600$ vph, and for this cycle, the average stopped delay per vehicle = 30 seconds.

(b) $s = 1800$ vph, and for this cycle, the average stopped delay per vehicle = 28.125 seconds.

(c) $v = 600$ vph, and for this cycle, the average stopped delay per vehicle = 45 seconds.

(d) $s = 1200$ vph, and for this cycle, the average stopped delay per vehicle = 28.125 seconds.

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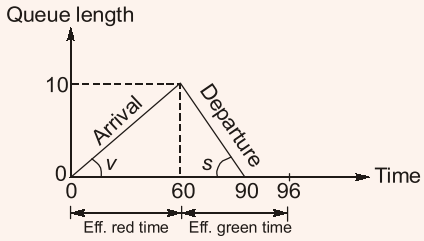
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Ans. (a)



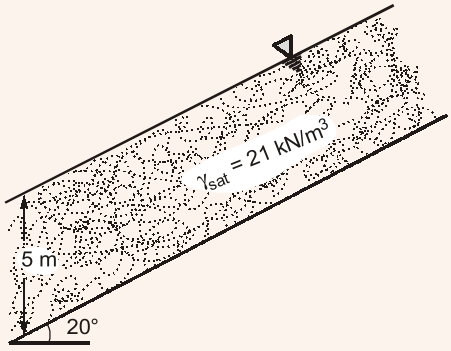
$$v = \frac{10 \text{ veh}}{60 \text{ sec}} = \frac{1}{6} \text{ veh/sec} = 600 \text{ veh/hr}$$

$$s = \frac{10}{30} \text{ veh/sec} = \frac{1}{3} \text{ veh/sec} = 1200 \text{ veh/hr}$$

$$\text{Average stopped delay} = \frac{0+60}{2} = 30 \text{ sec}$$

End of Solution

Q.47 The infinite sand slope shown in the figure is on the verge of sliding failure. The ground water table coincides with the ground surface. Unit weight of water $\gamma_w = 9.81$ kN/m^3.



The value of the effective angle of internal friction (in degrees, up to one decimal place) of the sand is _____.

Ans. (34.3)

Infinite sand slope:

GWT coincides with the ground surface, therefore

$$\text{F.O.S.} = \frac{\gamma'}{\gamma_{sat}} \times \frac{\tan\phi'}{\tan\beta}$$

As slope is on the verge of sliding failure hence,

$$\text{F.O.S.} = \frac{\gamma' \tan\phi'}{\gamma_{sat} \tan\beta} = 1$$

$$(21 - 9.81)\tan\phi' = 21 \tan 20°$$

$$\phi' = 34.3°$$

End of Solution

Q.48 Consider the equation $\frac{du}{dt} = 3t^2 + 1$ with $u = 0$ at $t = 0$. This is numerically solved by using the forward Euler method with a step size. $\Delta t = 2$. The absolute error in the solution in the end of the first time step is _____.

Ans. (8)

$$\frac{du}{dt} = 3t^2 + 1$$

$f(u, t) = 3t^2 + 1$

$u_0 = 0$

$t_0 = 0$

$\Delta t = 2$

By Euler's method

$$u_1 = u_0 + hf(u_0 t_0) \qquad t_1 = t_0 + h$$

$$= u_0 + h\left(3t_0^2 + 1\right) \qquad = 0 + 2$$

$$= 0 + 2\left(3(0)^2 + 1\right) \qquad = 2$$

$$= 2$$

After first iteration $u = 2$ when $t = 2$

$$\frac{du}{dt} = 3t^2 + 1$$

$$du = \left(3t^2 + 1\right) dt$$

$$\int du = \int_0^2 \left(3t^2 + 1\right) dt$$

$$u = \left(3\frac{t^3}{3} + t\right)\Bigg|_0^2$$

$$= 8 + 2 = 10$$

Absolute error = Exact value – approx value

$$= 10 - 2$$

$$= 8$$

End of Solution

Q.49 A particle of mass 2 kg is travelling at a velocity of 1.5 m/s. A force $f(t) = 3t^2$ (in N) is applied to it in the direction of motion for a duration of 2 seconds, where t denotes time in seconds. The velocity (in m/s, up to one decimal place) of the particle immediately after the removal of the force is _____.

Ans. (5.5)

$m = 2$ kg, $V_0 = 1.5$ m/sec

$$\int_0^t F(t)dt = m(V - V_0)$$

$$\int_0^2 3t^2 dt = 2(V - 1.5)$$

$$[t^3]_0^2 = 2(V - 1.5)$$

$$\Rightarrow \quad (8 - 0) = 2(V - 1.5)$$

$$V = 5.5 \text{ m/s}$$

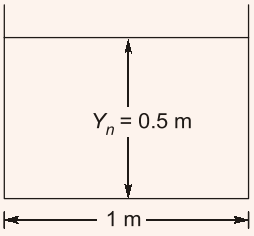
End of Solution

Q.50 A 1 m wide rectangular channel has a bed slope of 0.0016 and the Manning's roughness coefficient is 0.04. Uniform flow takes place in the channel at a flow depth of 0.5 m. At a particular section, gradually varied flow (GVF) is observed and the flow depth is measured as 0.6 m. The GVF profile at that section is classified as

(a) S_1 (b) S_2

(c) M_1 (d) M_2

Ans. (c)



$$Q = \frac{1}{n} \times A \times R^{2/3} \times S^{1/2}$$

$A = 1 \times 0.5 = 0.5 \text{ m}^2$

$P = 1 + (0.5 \times 2) = 2\text{m}$

$$Q = \frac{1}{0.04} \times 0.5 \times \left(\frac{0.5}{2}\right)^{2/3} \times (0.0016)^{1/2}$$

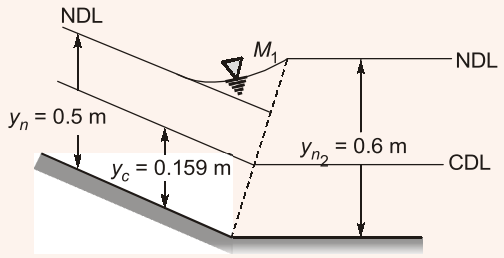
$$= 0.1984 \text{ m}^3/\text{s}$$

$$q = \frac{Q}{1} = 0.1984 \text{ m}^3/\text{s/m}$$

For rectangular channel

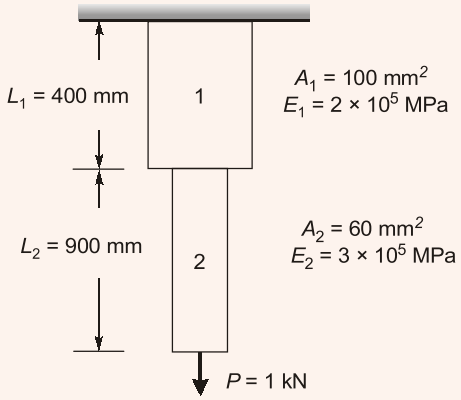
$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{0.1984^2}{9.81}\right)^{1/3} = 0.159 \text{ m}$$

Since, $y_n > y_c$ (Thus it is Mild Slope)



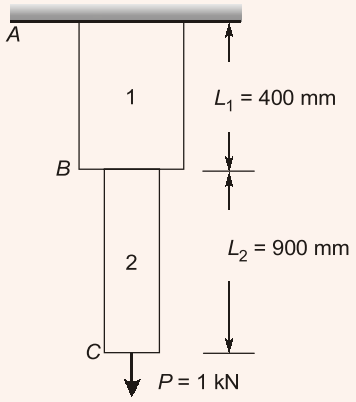
End of Solution

Q.51 Consider the stepped bar made with a linear elastic material and subjected to an axial load of 1 kN, as shown in the figure.



Segments 1 and 2 have cross-sectional area of 100 m^2 and 60 mm^2. Young's modulus of 2 × 10^5 MPa and 3 × 10^5 MPa, and length of 400 mm and 900 mm, respectively. The stain energy (in N-mm up to one decimal place) in the bar due to the axial load is _____.

Ans. (35)



$A_1 = 100\ mm^2,\ EI = 2 \times 10^5$ MPa

$A_2 = 60\ mm^2,\ EI = 3 \times 10^5$ MPa

$$\Delta_{AC} = \Delta_{AB} + \Delta_{BC}$$

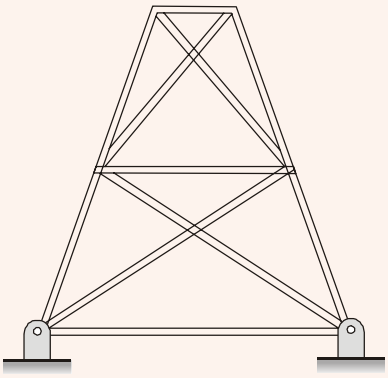
$$= \frac{1\times10^3\times400}{100\times2\times10^5} + \frac{1\times10^3\times900}{60\times3\times10^5}$$

$$= 0.02 + 0.05 = 0.07 \text{ mm}$$

$$U = \frac{1}{2}\times P\times\Delta = \frac{1}{2}\times1\times1000\times0.07 = 35 \text{ N-mm}$$

End of Solution

Q.52 A planar truss tower structure is shown in the figure.



Consider the following statements about the external and internal determinacies of the truss.

P. Externally Determinate
Q. External Static Indeterminacy = 1
R. External Static Indeterminacy = 2
S. Internally Determinate
T. Internal Static Indeterminacy = 1
U. Internal Static Indeterminacy = 2

Which one of the following options is correct?

(a) P-False; Q-True; R-False; S-False; T-False; U-True
(b) P-False; Q-True; R-False; S-False; T-True; U-False
(c) P-False; Q-False; R-True; S-False; T-False; U-True
(d) P-True; Q-True; R-False; S-True; T-False; U-True

Ans. (a)

$D_{se} = r - s = 4 - 3 = 1$ degree

$D_{si} = m - (2j - 3) = 15 - (2 \times 8 - 3) = 2$ degrees

End of Solution

Q.53 The equivalent sound power level (in dB) of the four sources with the noise levels of 60 dB, 69 dB, 70 dB and 79 dB is _____.

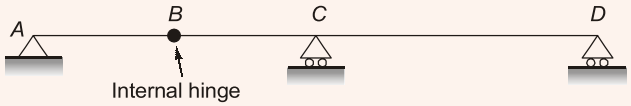
Ans. (79.9)

$$L_{eq} = 10 \log_{10}\left[\sum 10^{\frac{L_i}{10}}\right]$$

$$= 10\log_{10}\left(10^{\frac{60}{10}} + 10^{\frac{69}{10}} + 10^{\frac{70}{10}} + 10^{\frac{79}{10}}\right) = 79.9\ dB$$

End of Solution

Q.54 Consider the beam *ABCD* shown in the figure

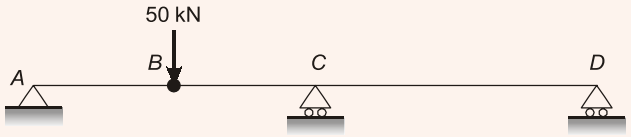


AB = BC = 4 m
CD = 10 m

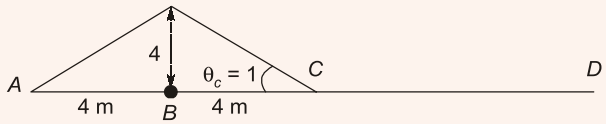
For a moving concentrated load of 50 kN on the beam, the magnitude of the maximum bending moment (in kN-m) obtained at the support *C* will be equal to _____.

Ans. (200)

B.M. at $C = 50 \times 4 = 200$ kNm

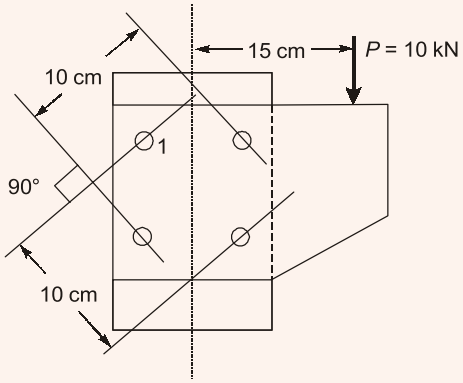


ILD for BM at *C*



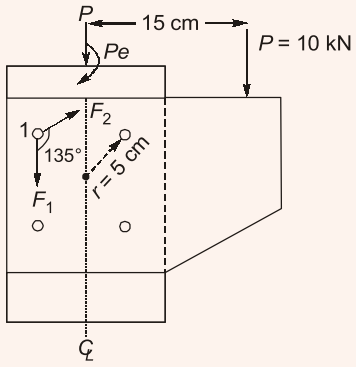
End of Solution

Q.55 A column is subjected to a load through a bracket as shown in the figure



The resultant force (in kN, up to one decimal place) in the bolt 1 is _____.

Ans. (6.0)



$$F_1 = \frac{P}{n} = \frac{10}{4} = 2.5 \text{ kN}$$

$$F_2 = \frac{Pe}{\Sigma r_i^2} \times r_1 = \frac{10 \times 15}{4 \times 5^2} \times 5 = 7.5 \text{ kN}$$

$$F_R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

$$= \sqrt{2.5^2 + 7.5^2 + 2 \times 2.5 \times 7.5 \times \cos 135^\circ}$$

$$= 6 \text{ kN}$$

End of Solution

GENERAL APTITUDE

Q.1 The following sequence of numbers is arranged in increasing order: 1, x, x, x, y, y, 9, 16, 18. Given that the mean and median are equal, and are also equal to twice the mode, the value of y is

(a) 5 (b) 6

(c) 7 (d) 8

Ans. (d)

1, x, x, x, y, y, 9, 16, 18

$$\text{Mean} = \frac{1+3x+2y+9+16+18}{9} = \frac{3x+2y+44}{9} \quad \ldots(i)$$

Median $\Rightarrow$ As number of terms are odd i.e. 9, so median will be middle i.e. y.

Mode $\Rightarrow$ Number showing maximum frequency of repetition. So mode is x.

Given $\Rightarrow$ Mean = Median = 2 Mode

$\Rightarrow$ $y = 2x$ ...(ii)

From equation (i) and (ii), we get

$x = 4$, $y = 8$

Value of y is 8

End of Solution

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Q.2 The bacteria in milk are destroyed when it _____ heated to 80 degree Celsius.

(a) would be (b) will be
(c) is (d) was

Ans. (c)

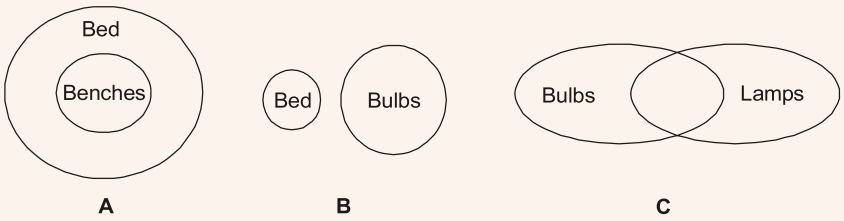
The bacteria is in milk are destroyed when it is heated to 80° celcius. Use of simple present tense is apt for indication factual statements / scientifically proven statements / universal truth.

End of Solution

Q.3 Consider the following sentences:
All benches are beds. No bed is a bulb. Some bulbs are lamps.
Which of the following can be inferred?
(i) Some beds are lamps.
(ii) Some lamps are beds.

(a) Only (i) (b) Only (ii)
(c) Both (i) and (ii) (d) Neither (i) nor (ii)

Ans. (d)



Since there is no direct relation given between **lamps** and **beds**. So, neither will be correct.

End of Solution

Q.4 If the radius of a right circular cone is increased by 50%, its volume increases by

(a) 75% (b) 100%
(c) 125% (d) 237.5%

Ans. (c)

$$V = \frac{1}{3}\pi(R)^2 H$$

$$V' = \frac{1}{3}\pi(1.5R)^2 H$$

$$= \frac{1}{3}\pi\, 2.25\, R^2\, H = 2.25\ V$$

Hence increase 125% as $\left[\frac{2.25V - V}{V}\right] \times 100 = 125\%$

End of Solution

Q.5 _____ with someone else's email account is now a very serious offense.

(a) Involving (b) Assisting

(c) Tampering (d) Incubating

Ans. (c)

Tampering with someone else's email account is a very serious offence. Tampering refers to interfering in a harmful or disruptive manner.

End of Solution

Q.6 Two machines M1 and M2 are able to execute any of four jobs, P, Q, R and S. The machines can perform one job on one object at a time, Jobs P, Q, R and S take 30 minutes, 20 minutes, 60 minutes and 15 minutes each respectively. There are 10 objects each requiring exactly 1 job. Job P is to be performed on 2 objects, Job Q on 3 objects, Job R on 1 object and Job S on 4 objects. What is the minimum time needed to complete all the jobs?

(a) 2 hours (b) 2.5 hours

(c) 3 hours (d) 3.5 hours

Ans. (a)

P 30 min × 2 = 60 min

Q 20 min × 3 = 60 min

R 60 min × 1 = 60 min

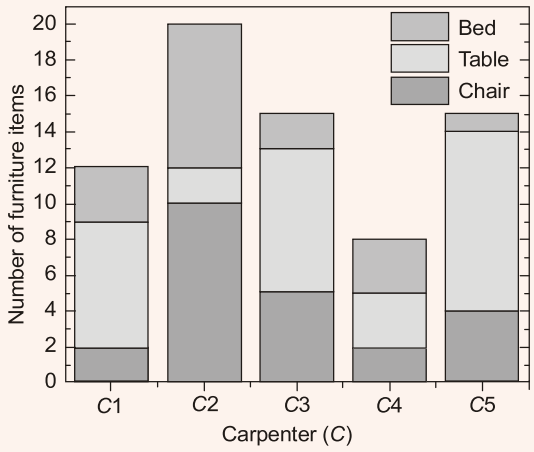
S 15 min × 4 = 60 min

M_1 | P | Q | = 2 hrs

M_2 | R | S | = 2 hrs

End of Solution

Q.7 The bar graph below shows the output of five carpenters over one month, each of whom made different items of furniture; chairs, tables and beds.



Consider the following statements:

(i) The number of beds made by carpenter C2 is exactly the same as the number of tables made by carpenter C3.

(ii) The total number of chairs made by all carpenters is less than the total number of tables.

Which one of the following is true?

(a) Only (i)
(b) Only (ii)
(c) Both (i) and (ii)
(d) Neither (i) nor (ii)

Ans. **(c)**

Clearly we can see from graph both (i) and (ii) are correct.

End of Solution

Q.8 Students applying for hostel rooms are alloted rooms in order of seniority. Students already staying in a room will move if they get a room in their preferred list. Preferences of lower ranked applicants are ignored during allocation.

Given the data below, which room will Ajit stay in?

Names	Student Seniority	Current room	Room preference list
Amar	1	P	R, S, Q
Akbar	2	None	R, S
Anthony	3	Q	P
Ajit	4	S	Q, P, R

(a) P
(b) Q
(c) R
(d) S

Ans. **(b)**

Amar $\longrightarrow R$
Akbar $\longrightarrow S$
Antony $\longrightarrow P$
Ajit $\longrightarrow Q$

As per their preferences given.

End of Solution

Q.9 The old concert hall was demolished because of fears that the foundation would be affected by the construction of the new metro line in the area. Modern technology for underground metro construction tried to mitigate the impact of pressurized air pockets created by the excavation of large amounts of soil. But even with these safeguards, it was feared that the soil below the concert hall would not be stable.

From this, one can infer that

(a) the foundations of old buildings create pressurized air pockets underground, which are different to handle during metro construction.

(b) metro construction has to be done carefully considering its impact on the foundations of existing buildings.

(c) old buildings in an area form an impossible hurdle to metro construction in that area.
(d) pressurized air can be used to excavate large amount of soil from underground areas.

Ans. (b)

End of Solution

Q.10 The last digit of $(2171)^7 + (2172)^9 + (2173)^{11} + (2174)^{13}$ is
(a) 2 (b) 4
(c) 6 (d) 8

Ans. (b)

$$\begin{array}{lcccccc} & (2171)^7 & + & (2172)^9 & + & (2173)^{11} & + & (2174)^{13} \\ \text{Unit digit} & (1)^{any} & + & (2)^{4n+1} & + & (3)^{4n+3} & + & (4)^{2n+1} \\ & 1 & + & 2 & + & 7 & + & 4 \end{array} = 14$$

End of Solution

■■■■