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GATE 2017

Civil Engineering

(Afternoon Session : 12-02-2017)

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SECTION : CIVIL ENGINEERING

Q.1 Let $w = f(x, y)$, where x and y are functions of t. Then, according to the chain rule, $\frac{dw}{dt}$ is equal

(a) $\frac{dw}{dx}\frac{dx}{dt}+\frac{dw}{dy}\frac{dt}{dt}$ (b) $\frac{\partial w}{\partial x}\frac{\partial x}{\partial t}+\frac{\partial w}{\partial y}\frac{\partial y}{\partial t}$

(c) $\frac{\partial w}{\partial x}\frac{dx}{dt}+\frac{\partial w}{\partial y}\frac{dy}{dt}$ (d) $\frac{dw}{dx}\frac{\partial x}{\partial t}+\frac{dw}{dy}\frac{\partial y}{\partial t}$

Ans. (c)

$$w = f(x, y)$$

By chain rule, $$\frac{dw}{dt} = \frac{\partial w}{\partial x}\times\frac{dx}{dt}+\frac{\partial w}{\partial y}\times\frac{dy}{dt}$$

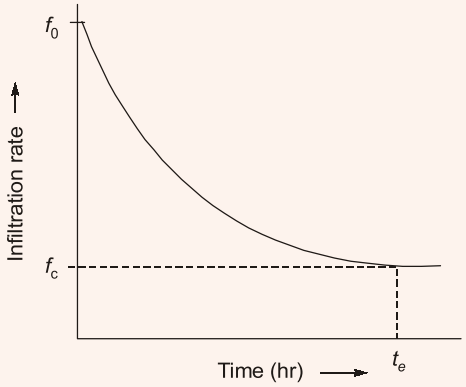
End of Solution

Q.2 The infiltration capacity of a soil follows the Horton's exponential model, $f = c_1 + c_2e^{-kt}$. During an experiment, the initial infiltration capacity was observed to be 200 mm/h. After a long time, the infiltration capacity was reduced to 25 mm/h. If the infiltration capacity after 1 hour was 90 mm/h, the value of the decay rate constant, k (in h^{-1}, up to two decimal places) is _____.

Ans. (0.9904)

Horton's expression for infiltration capacity of a soil is given as

$$f = C_1 + C_2 .e^{-kt}$$



Here, C_1 = Constant or steady stage infiltration capacity

C_2 = Difference between initial and steady stage infiltration capacity $= (f_0 - f_c)$

f = Infiltration capacity of any time 't'

$\therefore$ $f_p = f_c + (f_0 - f_c)\, e^{-k_h t}$

$\Rightarrow$ $90 = 25 + (200 - 25)\, e^{-k_h 1}$

$\Rightarrow$ $k_h = 0.9904\ hr^{-1}$

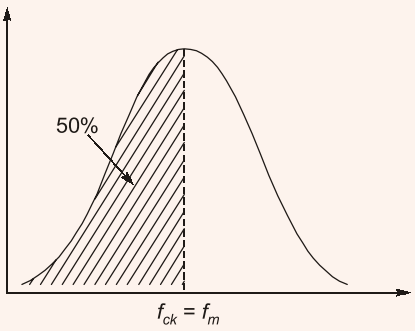
End of Solution

Q.3 Let the characteristic strength be defined as that value, below which not more than 50% of the results are expected to fall. Assuming a standard deviation of 4 MPa, the target mean strength (in MPa) to be considered in the mix design of a M25 concrete would be

(a) 18.42 (b) 21.00

(c) 25.00 (d) 31.58

Ans. (c)



If f_{ck} is the value below which not more than 50% of test results are expected then

$$f_m = f_{ck}$$

[Mean strength = Characteristics strength]

So target mean strength of concrete to be considered in design mix.

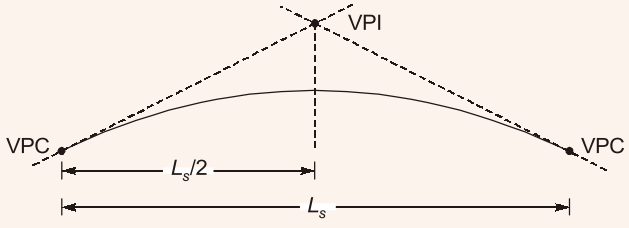
= Mean strength

= $f_m = f_{ck}$ = 25 MPa

End of Solution

Q.4 The VPI (vertical point of intersection) is 100 m away (when measured the horizontal) from the VPC (vertical point of curvature). If the vertical curve parabolic, the length of the curve (in meters and measured along the horizontal) is _____.

Ans. (200)



$L_s = 2 \times 100 = 200$ m

End of Solution

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Q.5 The most important type of species involved in the degradation of organic matter in the case of activated sludge process is

(a) autotrophs (b) heterotrophs
(c) prototrophs (d) photo-autotrophs

Ans. (b)

Activated sludge process is designed primarily for satisfaction of carbonaceous BOD which is done by heterotrophs.

End of Solution

Q.6 A two-faced coin has its faces designated as head (H) and tail (T). This coin is tossed three times in succession to record the following outcomes; H, H, H. If the coin is tossed one more time, the probability (up to one decimal place) of obtaining H again, given the previous realizations of H, H and H, would be _____.

Ans. (0.5)

End of Solution

Q.7 For a broad gauge railway track on a horizontal curve of radius R (in m), the equilibrium cant e required for a train moving at a speed of V (in km per hour) is

(a) $e = 1.676\frac{V^2}{R}$ (b) $e = 1.315\frac{V^2}{R}$

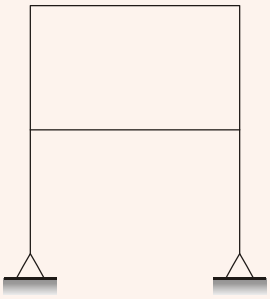
(c) $e = 0.80\frac{V^2}{R}$ (d) $e = 0.60\frac{V^2}{R}$

Ans. (b)

$$e \text{ (in cm)} = \frac{GV^2}{127R} = \frac{1.676V^2}{127R} \times 100 = 1.315\ \frac{V^2}{R}$$

End of Solution

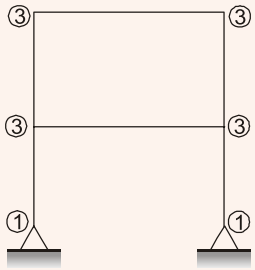
Q.8 Consider the frame shown in the figure



If the axial and shear deformations in different members of the frame are assumed to be negligible, the reduction in the degree of kinematic indeterminacy would be equal to

(a) 5 (b) 6
(c) 7 (d) 8

Ans. (b)



D_k (when extensible) = 14

D_k (when inextensible) = D_k (when extensible) – No. of axially rigid member

= 14 – 6 = 8

Shear deformation are already neglected. They have no significance on D_k.

So reduction in D_k is 6.

End of Solution

Q.9 A sheet pile has an embedment depth of 12 m in a homogeneous soil stratum. The coefficient of permeability of soil is 10^{-6} m/s. Difference in the water levels between the two sides of the sheet pile is 4 m. The flow net is constructed with five number of flow lines and eleven number of equipotential lines. The quantity of seepage (in cm^3/s per m), up to one decimal place) under the sheet pile is _____.

Ans. (1.6)

N_f = No. of flow lines – 1 = 5 – 1 = 4

N_d = No. of equipotential lines – 1 = 11 – 1 = 10

H = 4 m

Discharge, $q = \frac{KHN_f}{N_d} = 10^{-6} \times 4 \times \frac{4}{10} = 16 \times 10^{-7}\ m^3/sec/m$

$q = 16 \times 10^{-7} \times 10^6\ cm^3/sec/m$

q = 1.6 cm^3/s per meter length of dam

End of Solution

Q.10 The plate load test was conducted on a clayey strata by using a plate of 0.3 m × 0.3 m dimensions, and the ultimate load per unit area for the plate was found to be 180 kPa. The ultimate bearing capacity (in kPa) of a 2 m wide square footing would be

(a) 27 (b) 180
(c) 1200 (d) 2000

Ans. (b)

- Plate load test was conducted on a clay strata.
- Bearing capacity for the plate is 180 kPa.
- Ultimate bearing capacity in case of clay is independent of width of footing, hence ultimate bearing capacity for footing will be 180 kPa.

End of Solution

Q.11 As per Noise Pollution (Regulation and Control) Rules 2000 of India, the day time noise limit for a residential zone, expressed in dB (A) L_{eq}, is

(a) 55 (b) 65

(c) 75 (d) 85

Ans. (a)

End of Solution

Q.12 Consider the following statements related to the pore pressure parameters, A and B

P. A always lies between 0 and 1.0

Q. A can be less than 0 or greater than 1.0

R. B always lies between 0 and 1.0

S. B can be less than 0 or greater than 1.0

For these statements, which one of the following options is correct?

(a) P and R (b) P and S

(c) Q and R (d) Q and S

Ans. (c)

Pore pressure parameter B lies in between 0 to 1 and pore pressure parameter A may be as low as –0.5 and may be as high as 3.

End of Solution

Q.13 If a centrifugal pump has an impeller speed of N (in rpm), discharge Q (in m^3/s) and the total head H (in m), the expression for the specific speed N_s of the pump is given by

(a) $N_s = \dfrac{NQ^{0.5}}{H^{0.5}}$ (b) $N_s = \dfrac{NQ^{0.5}}{H}$

(c) $N_s = \dfrac{NQ^{0.5}}{H^{0.75}}$ (d) $N_s = \dfrac{NQ}{H^{0.75}}$

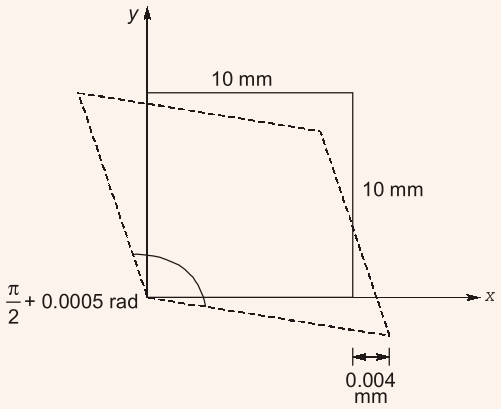
Ans. (c)

Specific speed (N_s) of pump

$$N_s = \frac{N\sqrt{Q}}{H^{3/4}} = \frac{NQ^{0.5}}{H^{0.75}}$$

End of Solution

Q.14 In a material under a state of plane stain, a 10 × 10 mm square centered at a point gets deformed as shown in the figure.



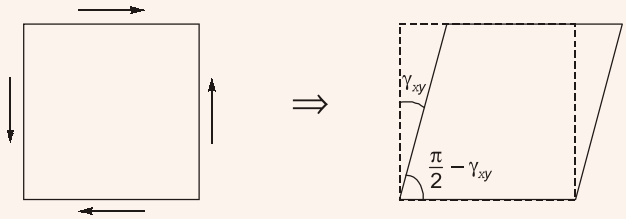
If the shear stain γ_{xy} at this point is expressed as 0.001 k (in rad), the value of k is

(a) 0.50 (b) 0.25

(c) –0.25 (d) –0.50

Ans. **(d)**

According the the sivn convention.



+ve shear stress +ve shear strain

In question since angle has been increase therefore shear strain should be negative.

$\therefore \quad \gamma_{xy} = -0.0005$ rad

$= 0.001k$

$-0.0005 = 0.001k$

$\Rightarrow \quad k = -0.50$

End of Solution

Q.15 Consider the following simultaneous equations (with c_1 and c_2 being constants):

$3x_1 + 2x_2 = c_1$

$4x_1 + x_2 = c_2$

The characteristics equation for these simultaneous equations is

(a) $\lambda^2 - 4\lambda - 5 = 0$ (b) $\lambda^2 - 4\lambda + 5 = 0$

(c) $\lambda^2 + 4\lambda - 5 = 0$ (d) $\lambda^2 + 4\lambda + 5 = 0$

Ans. (a)

$$[A] = \begin{bmatrix} 3 & 2 \\ 4 & 1 \end{bmatrix}$$

$$[A - \lambda I] = \begin{bmatrix} 3-\lambda & 2 \\ 4 & 1-\lambda \end{bmatrix}$$

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

$$(3 - \lambda)(1 - \lambda) - 8 = 0$$

$$3 - 4\lambda + \lambda^2 - 8 = 0$$

$$\lambda^2 - 4\lambda - 5 = 0$$

End of Solution

Q.16 The divergence of the vector field $V = x^2 i + 2y^3 j + z^4 k$ at $x = 1$, $y = 2$, $z = 3$ is _____.

Ans. (134)

$$\vec{V} = x^2\hat{i} + 2y^3\hat{j} + z^4\hat{k}$$

$$\vec{\nabla}.\vec{V} = \left[\frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}\right].\left[x^2\hat{i} + 2y^3\hat{j} + z^4\hat{k}\right]$$

$$= 2x + 6y^2 + 4z^3$$

At (1, 2, 3), $\vec{\nabla}.\vec{V} = 2 + 6(2)^2 + 4(3)^3$

$$= 134$$

End of Solution

Q.17 During a storm event in a certain period, the rainfall intensity is 3.5 cm/hour and the ϕ-index is 1.5 cm/hour. The intensity of effective rainfall (in cm/hour, up to one decimal place) for this period is _____.

Ans. (2.0)

Let the rainfall duration is 't' hours

$\therefore$ Total rainfall = 3.5 cm/hr × t hr = 3.5 t

Total infiltration = ϕ-index × t = 1.5 t

$\therefore$ Intensity of rainfall excess = $\dfrac{\text{Total rainfall excess}}{\text{Time period}}$

$$= \frac{3.5t - 1.5t}{t} \text{ cm/hr} = 2.0 \text{ cm/hr}$$

End of Solution

Q.18 The method of orientation used, when the plane table occupies a position not yet located on the map, is called as

(a) traversing
(b) radiation
(c) levelling
(d) resection

Ans. (d)

End of Solution

Q.19 Following observations have been made for the elevation and temperature to ascertain the stability of the atmosphere:

Elevation (in m)	Temperature (in °C)
10	15.5
60	15.0
130	14.3

The atmosphere is classified as

(a) Stable
(b) Unstable
(c) Neutral
(d) Inverse

Ans. (b)

$$ELR_{1-2} = \frac{15.5-15}{(60-10)\times 10^{-3}} = 10°C/km$$

$$ELR_{2-3} = \frac{15-14.3}{(130-60)\times 10^{-3}} = 10°C/km$$

Since ELR > ALR (9.8°C/km)

Atmosphere is unstable.

End of Solution

Q.20 Given that the scope of the construction work is well-defined with all its drawings, specifications, quantities and estimates, which one of the following types of contract would be most preferred?

(a) EPC contract
(b) Percentage rate contract
(c) Item rate contract
(d) Lump sum contract

Ans. (c)

In item rate contract, contractor only fill its rate against given item and its quantity and contract does not change the item make, drawing, specification during construction without consent of owner/department.

Item rate contract is also called "unit price contract" where contractor bids cost per unit of each item. These works are carried out in accordance with contract documents. The contractor has to perform the quantities of the work actually required in the field at his quoted unit prices, whether they are less or greater than "owner/department" estimates.

End of Solution

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Q.21 For a construction project, the mean and standard deviation of the completion time are 200 days and 6.1 days, respectively. Assume normal distribution and use the value of standard normal deviate, $z = 1.64$ for the 95% confidence level. The maximum time required (in days) for the completion of the project would be _____.

Ans. (210)

Expected completion time of project, $t_{E\,project} = 200$ days

Standard deviation of project, $\sigma_{project} = 6.1$ days

$$Z = \frac{T_S - T_E}{\sigma_{project}} = \frac{T_S - t_{E\,project}}{\sigma_{project}}$$

$$1.64 = \frac{T_S - 200}{6.1}$$

$$T_S = 200 + 6.1 \times 1.64$$

$$= 200 + 10.004$$

$$= 210.004 \simeq 210 \text{ days}$$

End of Solution

Q.22 Let G be the specific gravity of soil solids, w is the water content in the soil sample, γ_w the unit weight of water, and γ_d the dry unit weight of the soil. The equation for the zero air voids line in a compaction test plot is

(a) $\gamma_d = \frac{G\gamma_w}{1+Gw}$ (b) $\gamma_d = \frac{G\gamma_w}{Gw}$

(c) $\gamma_d = \frac{Gw}{1+\gamma_w}$ (d) $\gamma_d = \frac{Gw}{1-\gamma_w}$

Ans. (a)

Percentage air void line is relation between dry unit weight and water content at constant air void. Hence equation of zero air void line is

$$\gamma_d = (1-n_a)\frac{G\gamma_w}{1+wG} \qquad (n_a = 0)$$

$$\gamma_d = \frac{G\gamma_w}{1+wG}$$

End of Solution

Q.23 While aligning a hill road with a ruling gradient of 6%, a horizontal curve of radius 50 m is encountered. The grade compensation (in percentage, up to two decimal places) to be provided for this case would be _____.

Ans. (1.5)

$$\text{G.C.} = \text{Minimum of}\left(\frac{75}{R} \text{ or } \frac{30+R}{R}\right)$$

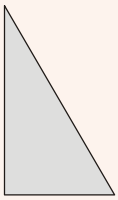
$$= \text{Minimum of}\left(\frac{75}{50} \text{ or } \frac{30+50}{50}\right)$$

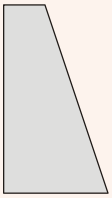
$$= \text{Minimum of } (1.5 \text{ or } 1.6)$$

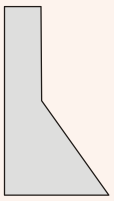
$\therefore$ Grade compensation = 1.5%

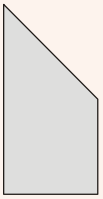
End of Solution

Q.24 Consider a rigid retaining wall with partially submerged cohesionless backfill with a surcharge. Which one of the following diagrams closely represents the Rankine's active earth pressure distribution against this wall?

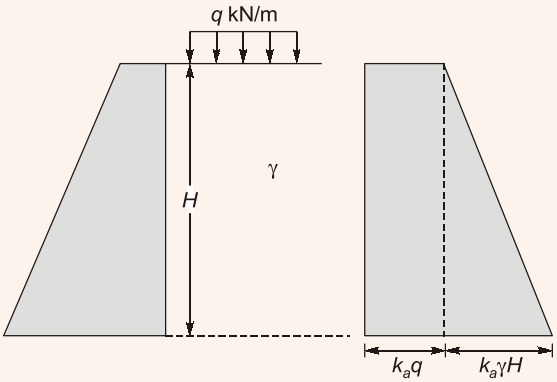
(a) 

(b) 

(c) 

(d) 

Ans. (b)



End of Solution

Q.25 The safety within a roundabout and the efficiency of a roundabout can be increased, respectively by

(a) increasing the entry radius and increasing the exit radius
(b) increasing the entry radius and decreasing the exit radius
(c) decreasing the entry radius and increasing the exit radius
(d) decreasing the entry radius and decreasing the exit radius

Ans. (c)

End of Solution

Q.26 For a given water sample, the ratio between $BOD_{5\text{-day, }20^\circ C}$ and the ultimate BOD is 0.68. The value of the reaction rate constant k (on base e) (in day^{-1}, up to two decimal places) is _____.

Ans. (0.23)

$$BOD/20^\circ C = C_0\,(1 - e^{-k\,20^\circ C \times 5})$$

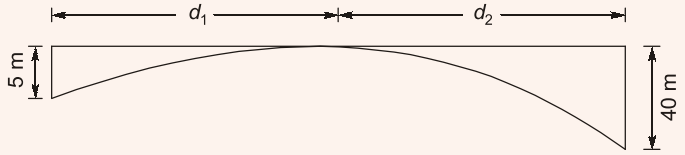
$$\frac{BOD\,/\,20^\circ}{C_0} = 0.68 = (1 - e^{-k\,20^\circ C \times 5})$$

$$K\,20^\circ C = 0.227\ day^{-1} \simeq 0.23\ day^{-1}$$

End of Solution

Q.27 An observer standing on the deck of a ship just sees the top of a lighthouse. The top of the lighthouse is 40 m above the sea level and the height of the observer's eye is 5 m above the sea level. The distance (in km, up to one decimal place) of the observer from the lighthouse is _____.

Ans. (33.0012)



Distance of observer from the lighthouse,

$$d = d_1 + d_2$$

$$= 3.855\left(\sqrt{h_1} + \sqrt{h_2}\right)$$

$$= 3.855\left(\sqrt{5} + \sqrt{40}\right)$$

$$= 33.0012\ km$$

End of Solution

Q.28 A municipal corporation is required to treat 1000 m^3/day of water. It is found that an overflow rate of 20 m/day will produce a satisfactory removal of the discrete suspended particles at a depth of 3 m. The diameter (in meters, rounded to the nearest integer) of a circular settling tank designed for the removal of these particles would be _____.

Ans. (8)

$$Q_0 = 1000\ m^3/d$$
$$OFR = 20\ MLD$$

$$SA = \frac{Q_o}{OFR} = \frac{1000}{20} = 50\ m^2$$

$$SA = \frac{\pi D^2}{4} = 50$$

$$\Rightarrow \quad D = 7.98\ m \simeq 8\ m$$

End of Solution

Q.29 Group I gives a list of test methods and test apparatus for evaluating some of the properties of Ordinary Portland Cement (OPC) and concrete. Group II gives the list of these properties.

Group I		Group II	
P.	Le Chattier test	1.	Soundless of OPC
Q.	Vee-Bee test	2.	Consistency and setting time of OPC
R.	Blaine air permeability test	3.	Consistency or workability of concrete
S.	The Vicat apparatus	4.	Fineness of OPC

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

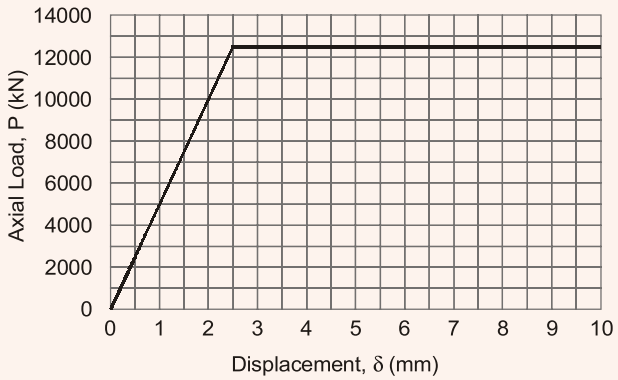
(a) P-1, Q-3, R-4, S-2 (b) P-2, Q-3, R-1, S-4

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

Ans. (a)

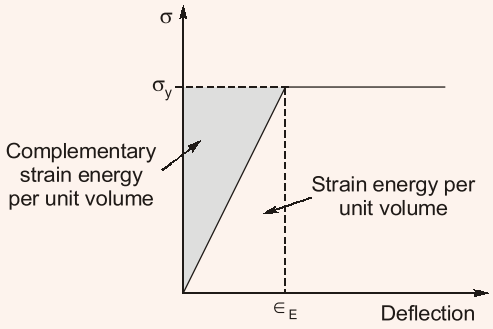
End of Solution

Q.30 A 2 m long, axially loaded mild steel rod of 8 mm diameter exhibits the load-displacement (P-δ) behavior as shown in the figure.



Assume the yield stress of steel as 250 MPa. The complementary strain energy (in N-mm) stored in the bar up to its linear elastic behaviour will be _____.

Ans. (15707.96)



Elastic strain, $\epsilon_E = \frac{\Delta L}{L} = \frac{2.5}{2000} = 1.25 \times 10^{-2}$

$\therefore$ Elastic strain energy $= \frac{1}{2}\sigma_y \epsilon_E AL$

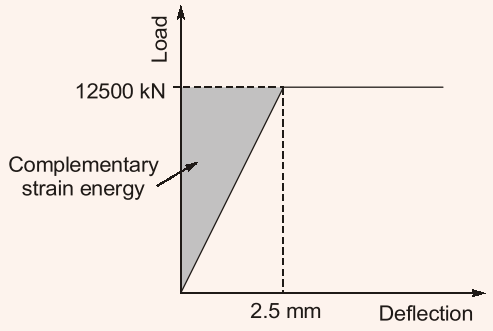
$= \frac{1}{2} \times 250 \times 1.25 \times 10^{-3} \times \frac{\pi}{4} \times 8^2 \times 2000$

$= 15707.96$ Nmm

Note: For linear elastic material both complementary energy and strain energy is same.

OR

By considering given graph in question, between Axial Load and Displacement the solution will be as follows:



Complementary stain energy, $U = \frac{1}{2}P\delta = \frac{1}{2}\left(12500 \times 10^3\right) \times 2.5 = 15625000$ Nmm

It means there seems some error in the given data.

End of Solution

Q.31 Consider the following statements:

P. Walls of one brick thick are measured in square meters.

Q. Walls of one brick thick are measured in cubic meters.

R. No deduction in the brickwork quantity is made for openings in walls up to 0.1 m^2 area.

S. For the measurement of excavation from the borrow pit in a fairly uniform ground, deadman are left at suitable intervals.

For the above statements, the correct option is

(a) P-False; Q-True; R-False; S-True (b) P-False; Q-True; R-False; S-False

(c) P-True; Q-False; R-True; S-False (d) P-True; Q-False; R-True; S-True

Ans. (d)

1. One brick wall → 20 cm (Nominal thickness)
2. 1.5 brick wall → 30 cm (Nominal thickness)
3. 2 brick wall → 40 cm (Nominal thickness)

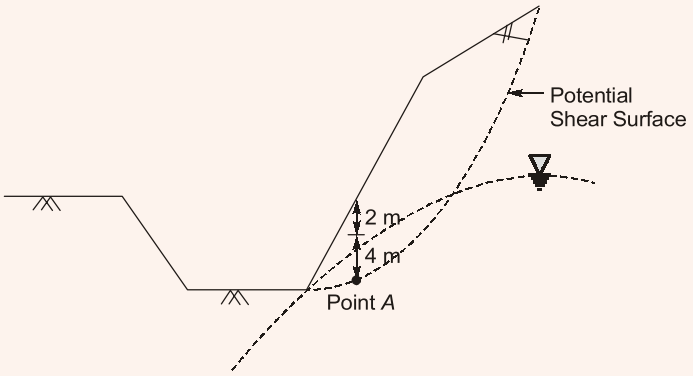
where "Nominal thickness" is considered for measuring of wall work.

- Brick wall is measured in m^2 is the brick wall thickness is 10 cm (half brick wall) and 20 cm (full brick wall/one brick wall) and for brick wall greater than one brick wall i.e., 1.5 or 2 brick wall. The brick wall is measured in m^3.
- No deduction for openings and bearings in masonry works is made when
  (a) opening each upto 1000 sq. cm or 0.1 m^2
  (b) ends of beam, post, rafters upto 500 sq./m or 0.05 m^2
  (c) Bed plate, wall, plate, bearing of balcony (chajja) and like upto 10 cm depth, bearing of floor and roof slab are not deducted from masonry.

As per 151200 (Part-I) : 1992, "deadmen and tell tales" in borrow pits is not measured separately and its removal is done after measurement.

End of Solution

Q.32 For the construction of a highway, a cut is to be made as shown in the figure.



The soil exhibits $c' = 20$ kPA, $\phi' = 18°$, and the undrained shear strength = 80 kPa. The unit weight of water is 9.81 kN/m^3. The unit weights of the soil above and below the ground water table are 18 and 20 kN/m^3, respectively. If the shear stress at point A is 50 kPa, the factors of safety against the shear failure at this point, considering the undrained and drained conditions, respectively, would be

(a) 1.6 and 0.9 (b) 0.9 and 1.6
(c) 0.6 and 1.2 (d) 1.2 and 0.6

Ans. (a)

Drained parameters: $c' = 20$ kPa, $\phi' = 18°$

Undrained shear strength, $S = 80$ kPa

Normal stress at point A, $\bar{\sigma}_n = \sigma_n - u = 2 \times \gamma_b + 4\gamma'$

$$\bar{\sigma}_n = 2 \times 18 + 4\,(20 - 9.81) = 76.76 \text{ kN/m}^2$$

Shear stress at point A = 50 kPa

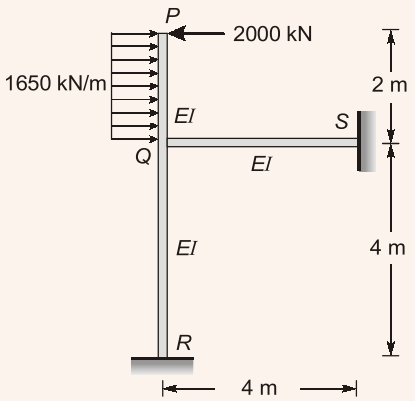
$$\text{FOS under undrained condition} = \frac{\text{Shear strength}}{\text{Sthear stress}} = \frac{80}{50} = 1.6$$

$$\text{FOS in drained condition} = \frac{c + \bar{\sigma}_n \tan\phi'}{\tau}$$

$$= \frac{20 + 76.76 \tan 18°}{50} = 0.9788$$

End of Solution

Q.33 Consider the portal frame shown in the figure and assume the modulus of elasticity, $E = 2.5 \times 10^4$ MPa and the moment of inertia, $I = 8 \times 10^8$ mm^4 for all the members of the frame.



The rotation (in degrees, up to one decimal place) at the rigid joint Q would be _____.

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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

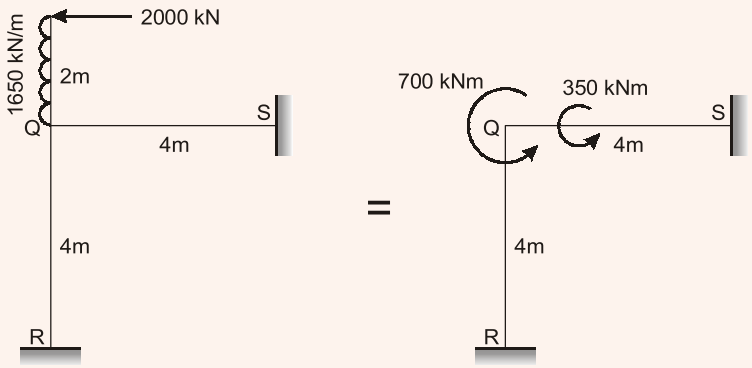
39 Selections in Top 10 | **76** Selections in Top 20 | **505** Selections out of total 604 vacancies

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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Ans. (1.0027)



$$\text{Moment at } Q = \frac{1650 \times 2^2}{2} - 2000 \times 2 = -700 \text{ kNm(anticlockwise)}$$

$$EI = 2.5 \times 10^4 \times 8 \times 10^8$$

$$= 20 \times 10^{12} \text{ Nmm}^2 = 20000 \text{ kNm}^2$$

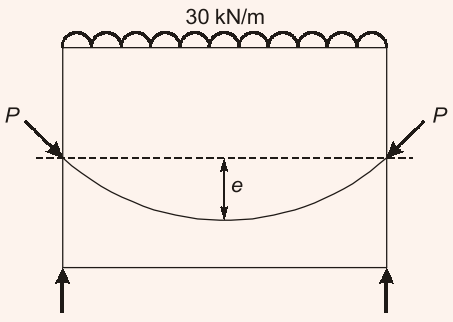
$$\theta_Q = \frac{MI}{4EI} = \frac{350 \times 4}{4 \times 20000} = 0.0175 \text{ rad}$$

$$= \frac{0.0175 \times 180^\circ}{\pi} = 1.0027^\circ$$

End of Solution

Q.34 A simply supported rectangular concrete beam of span 8 m has to be prestressed with a force of 1600 kN. The tendon is of parabolic having zero eccentricity at the supports. The beam has to carry an external uniformly distributed load of intensity 30 kN/m. Neglecting the self-weight of the beam, the maximum dip (in meters, up to two decimal places) of the tendon at the mid-span to balance the external load should be _____.

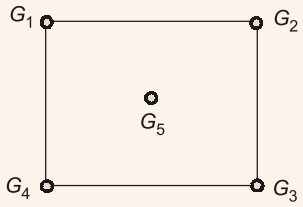
Ans. (0.15)



Central dip, $e = \frac{wl^2}{8P} = \frac{30 \times 8^2}{8 \times 1600} = 0.15$ m

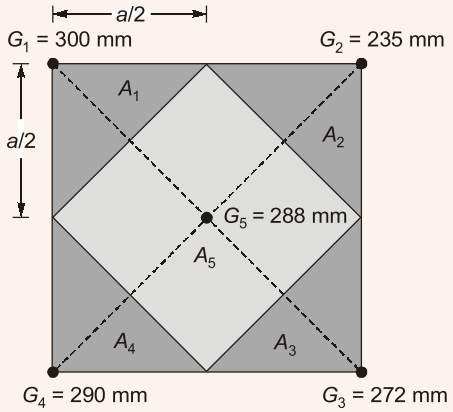
End of Solution

Q.35 A catchment is idealized as a 25 km × 25 km square. It has five rain gauges, one at each corner and one at the center, as shown in the figure.



During a month, the precipitation at these gauges is measured as G_1 = 300 mm, G_2 = 285 mm, G_3 = 272 mm, G_4 = 290 mm and G_5 = 288 mm. The average precipitation (in mm, up to one decimal place) over the catchment during this month by using the Thiessen polygon method is _____.

Ans. (287.375)



Let sides of square as, $a = 25$ km

Now area of the polygon is calculated as

$$A_1 = A_2 = A_3 = A_4$$

$$= \frac{1}{2} \times \frac{a}{2} \times \frac{a}{2} = \frac{a^2}{8} = \frac{25^2}{8} = 78.125$$

A_5 = Area of square of sides $\frac{\sqrt{2}\,a}{2} = \frac{a}{\sqrt{2}}$

$$= \frac{a^2}{2} = \frac{25^2}{2} = 312.5 \text{ km}^2$$

$\therefore$ Mean precipitation, $\bar{P} = \dfrac{G_1A_1 + G_2A_2 + G_3A_3 + G_4A_4 + G_5A_5}{A_1 + A_2 + A_3 + A_4 + A_5}$

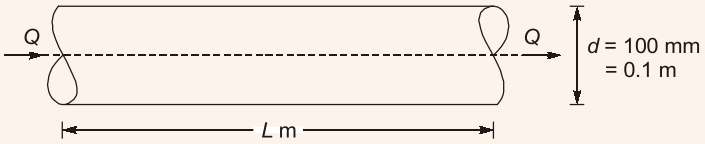
$\therefore$ $\bar{P} = \dfrac{(300 + 255 + 272 + 290) \times 78.125 + 288 \times 312.5}{(4 \times 78.125) + 312.5}$

$= 287.375$ mm

End of Solution

Q.36 Water is pumped at a steady uniform flow rate of 0.01 m^3/s through a horizontal smooth circular pipe of 100 mm diameter. Given that the Reynolds number is 800 and g is 9.81 m/s^2, the head loss (in meters, up to one decimal place) per km length due to friction would be _____.

Ans. (66.11)



Head loss due to frictions,

$$h_L = \frac{fLQ^2}{12.1d^5}$$

Here, f = friction factor $= \dfrac{64}{Re} = \dfrac{64}{800} = 0.08$

$\therefore$ Head loss per metre length

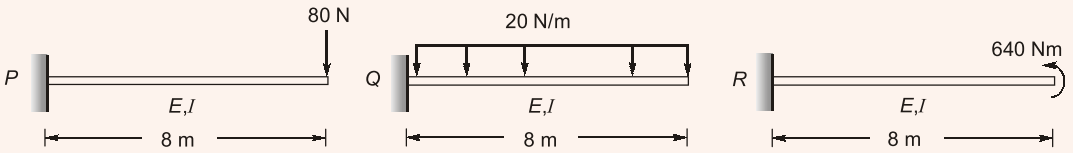
$$\frac{h_L}{L} = \frac{fQ^2}{12.1d^5} = \frac{0.08 \times (0.01)^3}{12.1 \times (0.1)^5}$$

$$\frac{h_L}{L} = \frac{0.8}{12.1} = 0.06611 \text{ meter/meter}$$

$= 66.11$ meter/km

End of Solution

Q.37 Consider the three prismatic beams with the clamped supports P, Q and R as shown in the figures.

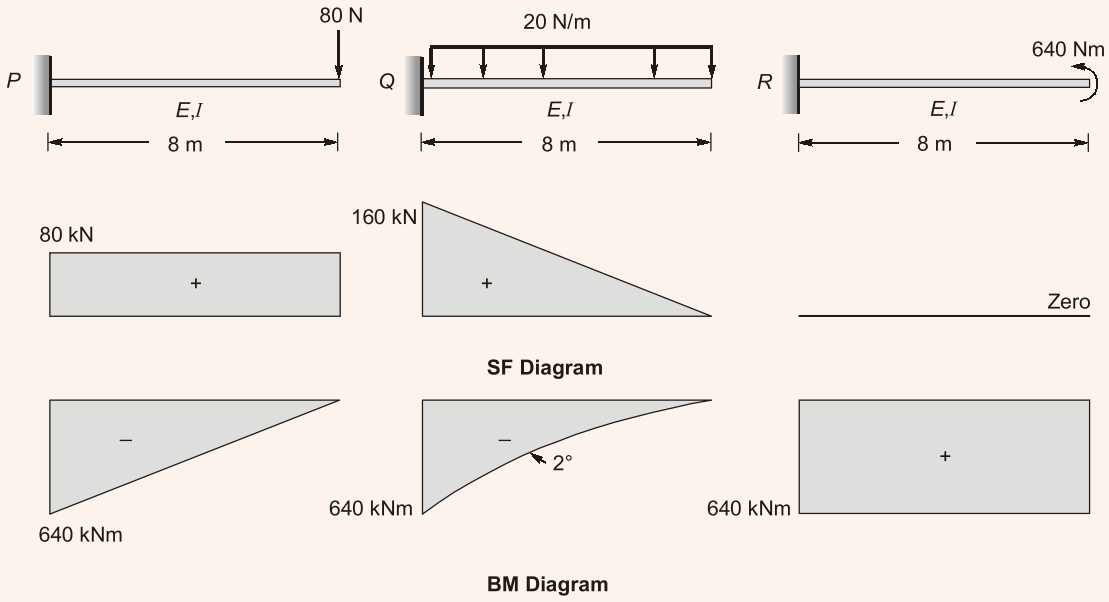


Given that the modulus of elasticity, E is 2.5×10^4 MPa; and the moment of inertia, I is 8×10^8 mm^4, the correct comparison of the magnitudes of the shear force S and the bending moment M developed at the supports is

(a) $S_P < S_Q < S_R$; $M_P = M_Q = M_R$ (b) $S_P = S_Q < S_R$; $M_P = M_Q > M_R$

(c) $S_P < S_Q > S_R$; $M_P = M_Q = M_R$ (d) $S_P < S_Q < S_R$; $M_P < M_Q < M_R$

Ans. (c)



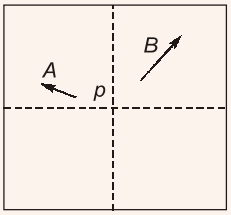
$$S_P < S_Q > S_R$$

$$M_P = M_Q = M_R$$

Hence correct option is (c)

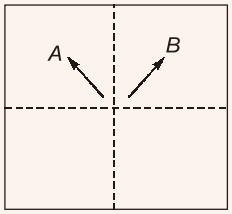
End of Solution

Q.38 Two towers, A and B, standing vertically on a horizontal ground, appear in a vertical aerial photograph as shown in the figure.



The length of the image of the tower *A* on the photograph is 1.5 cm and of the tower *B* is 2.0 cm. The distance of the top of the tower *A* (as shown by the arrowhead) is 4.0 cm and the distance of the top of the tower *B* is 6.0 cm, as measured from the principal point *p* of the photograph. If the height of the tower *B* is 80 m, the height (in meters) of the tower *A* is _____.

Ans. (90)



For Tower A:

Relief displacement, $d_A = 1.5$ cm

$r_A = 4$ cm

$h_A = ?$

For Tower B:

Relief displacement, $d_B = 2.0$ cm

$r_B = 6$ cm

$h_B = 80$ m

Relief displacement, $d = \dfrac{h.r}{(H - h_{avg})}$

For A: $d_A = \dfrac{h_A.r_A}{(H - h_{avg})}$

$1.5 = \dfrac{h_A \times 4}{240}$

$h_A = 90$ m

For B: $d_B = \dfrac{h_B.r_B}{(H - h_{avg})}$

$2 = \dfrac{80 \times 6}{(H - h_{avg})}$

$\Rightarrow (H - h_{avg}) = 240$ m

End of Solution

Q.39 The radii of relative stiffness of the rigid pavements *P* and *Q* are denoted by l_P and l_Q, respectively. The geometric and material properties of the concrete slab and underlying soil are given below:

	Concrete					Soil
Pavement	Length of Slab	Breadth of Slab	Thickness of Slab	Modulus of Elasticity	Poisson's Ratio	Subgrade Reaction Modulus
P	*L*	*B*	*h*	*E*	μ	*K*
Q	*L*	*B*	0.5 *h*	*E*	μ	2 *K*

The ratio (up to one decimal place) of $\dfrac{l_P}{l_Q}$ is _____.

Ans. (2.0)

Relative stiffness, $l = \left[\frac{Eh^3}{12k\left(1-\mu^2\right)}\right]^{1/4} \Rightarrow \frac{I_P}{I_Q} = \frac{\left(\frac{h^3}{k}\right)^{1/4}}{\left[\frac{(0.5h)^3}{2k}\right]^{1/4}} = 2$

End of Solution

Q.40 Consider the following second-order differential equation:

$y'' - 4y' + 3y = 2t - 3t^2$

The particular solution of the differential equation is

(a) $-2 - 2t - t^2$ (b) $-2t - t^2$

(c) $2t - t^2$ (d) $-2 - 2t - 3t^2$

Ans. (a)

$y'' - 4y' + 3y = 2t - 3t^2$

$(D^2 - 4D + 3)y = 2t - 3t^2$

$$\text{P.I.} = \frac{1}{D^2-4D+3}\left(2t-3t^2\right)$$

$$= \frac{1}{(1-D)(3-D)}\left(2t-3t^2\right)$$

$$= \left(\frac{1/2}{1-D} - \frac{1/2}{3-D}\right)\left(2t-3t^2\right)$$

$$= \frac{1}{2}(1-D)^{-1}\left(2t-3t^2\right) - \frac{1}{6}\left(1-\frac{D}{3}\right)^{-1}\left(2t-3t^2\right)$$

$$= \frac{1}{2}\left(1+D+D^2\right)\left(2t-3t^2\right)\frac{1}{6}\left(1+\frac{D}{3}+\frac{D^2}{9}\right)\left(2t-3t^2\right)$$

$$= \frac{1}{2}(2t-3t^2+D(2t-3t^2)+D^2(2t-3t^2)$$

$$-\frac{1}{6}\left(2t-3t^2\right)+\frac{D(2t-3t)^2}{3}+\frac{D^2\left(2t-3t^2\right)}{9}$$

$$= \frac{1}{2}\left[2t-3t^2+2-6t-6\right]-\frac{1}{6}\left[2t-3t^2+\frac{2-6t}{3}+\frac{-6}{9}\right]$$

$$= \frac{1}{2}\left(-4-4t-3t^2\right)-\frac{1}{6}\left(-3t^2\right)$$

$$= -2 - 2t - t^2$$

End of Solution

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Q.41 The tangent to the curve represented by $y = x \ln x$ is required to have 45° inclination with the x-axis. The coordinates of the tangent point would be

(a) (1, 0) (b) (0, 1)

(c) (1, 1) (d) $\left(\sqrt{2}, \sqrt{2}\right)$

Ans. (a)

$$\tan\theta = \frac{dy}{dx} = \ln x + 1$$

$$\tan 45° = \ln x + 1$$

$$1 = \ln x + 1$$

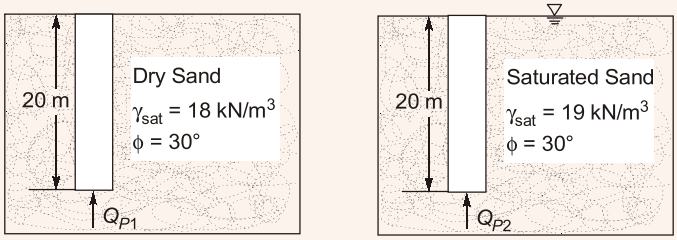
$$\Rightarrow \quad \ln x = 0$$

$$\therefore \quad x = 1$$

Putting $x = 1$ in the eq. of curve, we get $y = 0$.

End of Solution

Q.42 Two identical concrete piles having the plan dimensions 50 cm × 50 cm are driven into a homogeneous sandy layer as shown in the figures. Consider the bearing capacity factor N_q for $\phi = 30°$ as 24.



If Q_{P1} and Q_{P2} represent the ultimate point bearing resistances of the piles under dry and submerged conditions, respectively, which one of the following statements is correct?

(a) $Q_{P1} > Q_{P2}$ by about 100% (b) $Q_{P1} < Q_{P2}$ by about 100%

(c) $Q_{P1} > Q_{P2}$ by about 5% (d) $Q_{P1} > Q_{P2}$ by about 5%

Ans. (a)

End bearing resistance = Effective stress at base × N_q = $\gamma_l \times N_q$

$$Q_{P_1} = qN_q = \gamma D_f N_q$$

$$Q_{P_1} = 18 \times 20 \times 24 = 8640 \text{ kN}$$

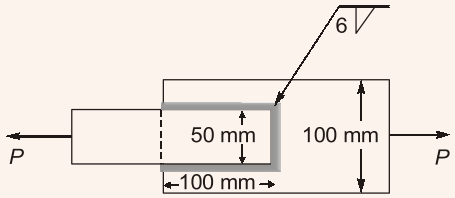
$$Q_{P_2} = (19 - 10) \times 20 \times 24 \qquad (\because \gamma_w = 10 \text{ kN/m}^3)$$

$$= 4320 \text{ kN}$$

$$\therefore \quad Q_{P_1} > Q_{P_2} \text{ by about } 100\%$$

End of Solution

Q.43 Two plates of 8 mm thickness each are connected by a fillet weld of 6 mm thickness as shown in the figure.



The permissible stresses in the plate and the weld are 150 MPa and 110 MPa, respectively. Assuming the length of the weld shown in the figure to be the effective length, the permissible load P (in kN) is _____.

Ans. (60)

$$P_w = f_b \times l_{eff} \times t_t$$
$$= 110\ (100 + 100 + 50) \times 0.7 \times 6 = 115.5 \text{ kN}$$
$$P_{plate} = \sigma_{at} \times A_{net} = 150 \times (50 \times 8) = 60 \text{ kN}$$

So permissible load = 60 kN

End of Solution

Q.44 The composition of a municipal solid waste sample is given below:

Component	Percent by Mass	Moisture Content (%)	Energy content (kJ/kg. on as-discarded basis)
Food Waste	20	70	2500
Paper	10	4	10000
Cardboard	10	4	8000
Plastics	10	1	14000
Garden Trimmings	40	60	3500
Wood	5	20	14000
Tin Cans	5	2	100

The difference between the energy content of the waste sample calculated on dry basis and as discarded basis (in kJ/kg) would be _____.

Ans. (3870)

Component	Percentage by mass	Moisture content (in %)	Dry content (in %)	Energy as discarded (kJ/kg)	Total dry mass	Total energy as discarded (in kJ/kg)
Food waste	20	70	30	2500	6	500
Paper	10	4	96	10000	9.6	1000
Card board	10	4	96	8000	9.6	800
Plastics	10	1	99	14000	9.9	1400
Garden trimming	40	60	40	3500	16	1400
Wood	5	20	80	1400	4	700
Tin cars	5	2	98	10	4.9	5
					$\Sigma = 60$	$\Sigma = 5805$

Energy on dry basis: It will be the total energy when whole mass is dry

In current situation only 60% mass is dry energy corresponding to 60% dry mass = 5805 kJ/kg

Energy corresponding to 100% dry mass = $\frac{5805}{60} \times 100 = 9675$ kJ/kg

So, energy as on dry basis = 9675 kJ/kg

Energy based on as discarded basis = 5805 kJ/kg

So, difference = 9675 – 5805 = 3870 kJ/kg

End of Solution

Q.45 A hollow circular shaft has an outer diameter of 100 mm and inner diameter of 50 mm. If the allowable shear stress is 125 MPa, the maximum torque (in kN-m) that the shaft can resist is _____.

Ans. (23)

$$\frac{T}{I_p} = \frac{\tau}{r}$$

$$\Rightarrow \quad \tau = \frac{T}{Z_p} = \frac{T}{\frac{\pi\left(D^4 - d^4\right)}{16 \times D}} = \frac{16T}{\frac{\pi}{D}\left(D^4 - d^4\right)}$$

$$\Rightarrow \quad \tau = \frac{16T}{\pi D^3\left[1 - \left(\frac{d}{D}\right)^4\right]}$$

$$\Rightarrow \quad 125 = \frac{16T}{\pi (100)^3\left[1 - \left(\frac{50}{100}\right)^4\right]}$$

$$\Rightarrow \quad T = 23 \text{ kNm}$$

End of Solution

Q.46 Consider the following definite integral:

$$I = \int_0^1 \frac{\left(\sin^{-1} x\right)^2}{\sqrt{1 - x^2}} dx$$

The value of the integral is

(a) $\frac{\pi^3}{24}$ (b) $\frac{\pi^3}{12}$

(c) $\frac{\pi^3}{48}$ (d) $\frac{\pi^3}{64}$

Ans. (a)

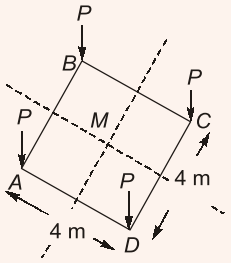
Let, $\sin^{-1}x = t$

$$\frac{dx}{\sqrt{1-x^2}} = dt$$

$$I = \int_0^{\pi/2} t^2\,dt = \left[\frac{t^3}{3}\right]_0^{\pi/2} = \frac{\pi^3}{24}$$

End of Solution

Q.47 Consider a square-shaped area *ABCD* on the ground with its centre at *M* as shown in the figure. Four concentrated vertical loads of *P* = 5000 kN are applied on this area, one at each corner.

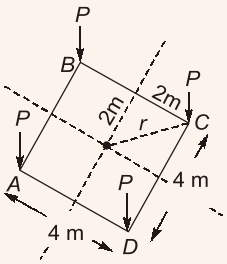


The vertical stress increment (in kPa, up to one decimal place) due to these loads according to the Boussinesq's equation, at a point 5 right below *M*, is _____.

Ans. (190.8)

$P = 5000$ kN

$r = \sqrt{2^2+2^2} = 2\sqrt{2}$ m



According to Boussinesq's

$$\sigma_z = k\frac{Q}{z^2} = \frac{3}{2\pi}\left(\frac{1}{1+\frac{r^2}{z^2}}\right)^{5/2}\frac{Q}{z^2}$$

$\Rightarrow$ Vertical stress at 5 m below point *M*.

$$\sigma_z = 4\times\frac{3}{2\pi}\times\left\{\frac{1}{1+\left(\frac{2\sqrt{2}}{5}\right)^2}\right\}^{5/2}\times\frac{5000}{5^2} = 190.8 \text{ kPa}$$

End of Solution

Q.48 Following are the statements related to the stress path in a triaxial testing of soils:

P. If $\sigma_1 = \sigma_3$, the stress point lies at the origin of the *p*-*q* plot.

Q. If $\sigma_1 = \sigma_3$, the stress point lies on the *p*-axis of the *p*-*q* plot.

R. If $\sigma_1 > \sigma_3$, both the stress points *p* and *q* are positive.

for the above statements, the correct combination is

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

Ans. (a)

On stress path in terms of *p*-*q* plot

$$p = \frac{\sigma_1 + \sigma_3}{2}$$

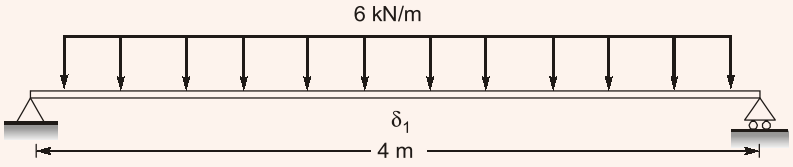
$$q = \frac{\sigma_1 - \sigma_3}{2}$$

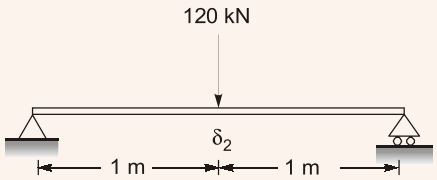
If $\sigma_1 = \sigma_3$ then $q = 0$ and $p \neq 0$ hence point does not lie at origin, point will lies on the p-axis.

If $\sigma_1 > \sigma_3$, both the stress point will be positive.

End of Solution

Q.49 Two prismatic beams having the same flexural rigidity of 1000 kN-m^2 are shown in the figures.





If the mid-span deflections of these beams are denoted by δ_1 and δ_2 (as indicated in the figures), the correct option is

(a) $\delta_1 = \delta_2$
(b) $\delta_1 < \delta_2$
(c) $\delta_1 > \delta_2$
(d) $\delta_1 >> \delta_2$

Ans. (a)

$$\delta_1 = \frac{5}{384} \times \frac{wl^4}{EI} = \frac{5}{384} \times \frac{6(4)^4}{1000} = 20 \times 10^{-3} \text{ m}$$

$$\delta_2 = \frac{Pl^3}{48EI} = \frac{120 \times 2^3}{48 \times 1000} = 20 \times 10^{-3} \text{ m}$$

$\therefore$ $\delta_1 = \delta_2$

End of Solution

Q.50 A 1 m wide rectangular channel carries a discharge of 2 m^3/s. The specific energy-depth diagram is prepared for the channel. It is observed in this diagram that corresponding to a particular specific energy, the subcritical depth is twice the supercritical depth. The subcritical depth (in meters, up to two decimal places) is equal to _____.

Ans. (1.07)

Let Supercritical depth = Y

Subcritical depth = $2Y$

As the specific energy E remains constant for alternate depths

$$\therefore \quad E_1 = E_2$$

$$Y_1 + \frac{Q^2}{2gB^2Y_1^2} = Y_2 + \frac{Q^2}{2gB^2Y_2^2}$$

$$\Rightarrow \quad Y + \frac{2^2}{2\times 9.81\times 1^2\times Y^2} = 2Y + \frac{2^2}{2\times 9.81\times 1\times (2Y)^2}$$

$$\Rightarrow \quad Y + \frac{0.204}{Y^2} = 2Y + \frac{0.051}{Y^2}$$

$$\Rightarrow \quad \frac{0.204 - 0.051}{Y^2} = Y$$

$$\Rightarrow \quad Y^3 = 0.1530$$

$$\Rightarrow \quad Y = 0.534$$

$$\therefore \quad \text{Subcritical depth} = 0.534 \times 2 = 1.0697 \simeq 1.07 \text{ m}$$

End of Solution

Q.51 Two cars P and Q are moving in a racing track continuously for two hours. Assume that no other vehicles are using the track during this time. The expressions relating the distance travelled d (in km) and time t (in hours) for both the vehicles are given as

P : $d = 60t$

Q : $d = 60t^2$

Within the first one hour, the maximum space headway would be

(a) 15 km at 30 minutes (b) 15 km at 15 minutes

(c) 30 km at 30 minutes (d) 30 km at 15 minutes

Ans. (a)

Space headway, $S = 60\,t - 60\,t^2$

$$\frac{dS}{dt} = 60 - 120t = 0$$

$$t = 0.5 \text{ hr} = 30 \text{ minutes}$$

$$\frac{d^2S}{dt^2} = -120 \times 0 \text{ (Maxima)}$$

$\therefore$ Maximum space head

$$S_{max} = 60 \times 0.5 - 60 \times (0.5)^2 = 15 \text{ km}$$

End of Solution

Q.52 If $A = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 7 \\ 8 & 4 \end{bmatrix}$, AB^T is equal to

(a) $\begin{bmatrix} 38 & 28 \\ 32 & 56 \end{bmatrix}$ (b) $\begin{bmatrix} 3 & 40 \\ 42 & 8 \end{bmatrix}$

(c) $\begin{bmatrix} 43 & 27 \\ 34 & 50 \end{bmatrix}$ (d) $\begin{bmatrix} 38 & 32 \\ 28 & 56 \end{bmatrix}$

Ans. (a)

$$AB^T = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}\begin{bmatrix} 7 & 8 \\ 7 & 4 \end{bmatrix} = \begin{bmatrix} 38 & 28 \\ 32 & 56 \end{bmatrix}$$

End of Solution

Q.53 The analysis of a water sample produces the following results:

Ion	Milligram per milli-equivalent for the ion	Concentration (mg/L)
Ca^{2+}	20.0	60
Mg^{2+}	12.2	36.6
Na^{+}	23.0	92
K^{+}	39.1	78.2
Cl^{-}	35.5	71
SO_4^{2-}	48.0	72
HCO_3^{-}	61.0	122

The total hardness (in mg/*l* as $CaCO_3$) of the water sample is _____.

Ans. (300)

$$\text{Total hardness} = \left(\frac{60}{20} + \frac{36.6}{12.2}\right)50 = 300 \text{ mg/}l$$

End of Solution

Q.54 The culturable command area of a canal is 10000 ha. The area grows only two crops-rice in the Kharif season and wheat in the Rabi season. The design discharge of the canal is based on the rice requirements, which has an irrigated area of 2500 ha, base period of 150 days and delta of 130 cm. The maximum permissible irrigated area (in ha) for wheat, with a base period of 120 days and delta of 50 cm, is _____.

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Ans. (5200)

$$\text{CCA} = 10000 \text{ ha}$$

For rice,

$$\Delta_r = 130 \text{ cm} = 1.3 \text{ m}$$

$$A_r = 2500 \text{ ha}$$

$$B_r = 150 \text{ days}$$

Duty,

$$D_r = \frac{8.64 B_r}{\Delta_r} = \frac{8.64 \times 150}{1.30}$$

$$D_r = 996.923 \text{ ha/cumecs}$$

$$D_r = \frac{A}{Q}$$

$$Q = \frac{2500}{996.923} \text{ m}^3/\text{s} = 2.5077 \text{ m}^3/\text{s}$$

For wheat also, discharge is 2.5077 m^3/s

$$B_w = 120 \text{ days}$$

$$\Delta = 50 \text{ cm}$$

$$A_w = Q \times D_w$$

$$D_w = \frac{8.64 \times B_w}{\Delta_w} = \frac{8.64 \times 120}{0.5} = 2073.6$$

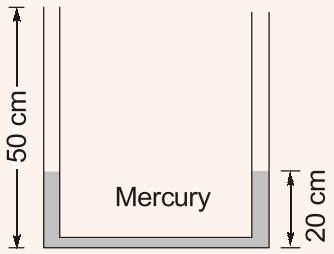
$\therefore$

$$A_w = 2.5077 \times 2073.6$$

$$= 5199.966 \text{ ha} \simeq 5200 \text{ ha}$$

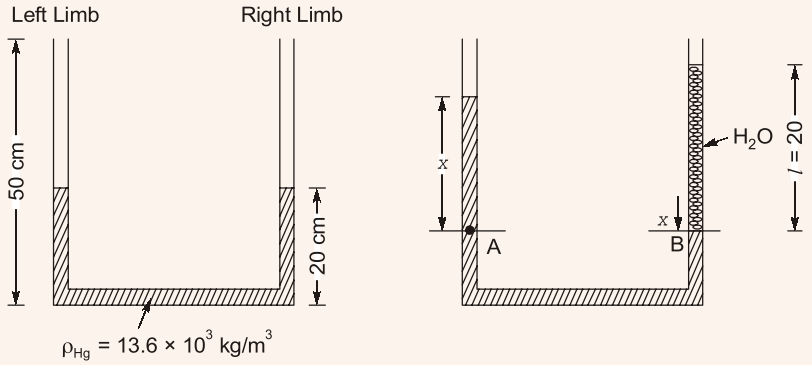
End of Solution

Q.55 The figure shows a U-tube having a 5 mm × 5 mm square cross-section filled with mercury (specific gravity = 13.6) up to a height of 20 cm in each limb (open to the atmosphere).



If 5 cm^3 of water is added to the right limb, the new height (in cm, up to two decimal places) of mercury in the Left limb will be _____.

Ans. (20.74)



$$P_A = P_B$$

$$(13.6 \times 10^3)g \times (2x) = (10^3)\, g\, (20)$$

$$x = \frac{1.0}{3.6} = 0.735 \text{ cm}$$

So, the new height (in cm to two decimal place of mercury in the left limb will be

$$= 20 + 0.74 = 20.74 \text{ cm}$$

End of Solution

SECTION : GENERAL APTITUDE

Q.1 Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is

(a) $\frac{1}{9}$ (b) $\frac{2}{9}$

(c) $\frac{1}{3}$ (d) $\frac{4}{9}$

Ans. (b)

Sample space = 6 × 6 = 36 events = Total chances

Product of numbers on 2 dice have to perfect square = Favourable chances

(1, 1) (2, 2) (3, 3) (4, 4) (5, 5) (6, 6) (1, 4) (4, 1) ⇒ 8 events

$$\text{Probability} = \frac{\text{Favourable chances}}{\text{Total chances}} = \frac{8}{36} = \frac{2}{9}$$

End of Solution

Q.2 Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2, 3, red and blue.

Proposition: If a card has an even value on one side, then its opposite face is red.

The cards which MUST be turned over to verify the above proposition are

(a) 2, red
(b) 2, 3, red
(c) 2, blue
(d) 2, red, blue

Ans. (c)

In order to verify proposition we have to turn to card 2 and blue from given four cards as proposition says it has even an one side opposite is red. Vice-verse might or might not be true so, ans. (c) as all other options are eliminated.

End of Solution

Q.3 The event would have been successful if you _____ able to come.

(a) are
(b) had been
(c) have been
(d) would have been

Ans. (b)

Use of conditional sentence based on past perfect structure. Conditional clause uses (had + V_3), main clause is based on would / should / could + have + V_3.

End of Solution

Q.4 There was no doubt that their work was thorough.

Which of the words below is closest in meaning to the underlined word above?

(a) pretty
(b) complete
(c) sloppy
(d) haphazard

Ans. (b)

Thorough refers to somethings that is exhaustively complete, accurate, careful or absolute.

End of Solution

Q.5 What is the value of x when $81\times\left(\frac{16}{25}\right)^{x+2}\div\left(\frac{3}{5}\right)^{2x+4}=144$?

(a) 1
(b) –1
(c) –2
(d) Cannot be determined

Ans. (b)

Put $(x = -1)$ $\quad \dfrac{81\left[\frac{16}{25}\right]^{1}}{\left[\frac{3}{5}\right]^{2}} = \dfrac{\frac{3^4\times 2^4}{5^2}}{\frac{3^2}{5^2}} = 3^2\times 2^2 = 144$

On putting $(x = -1)$

$\Rightarrow$ LHS = RHS

Hence option (b) is correct.

End of Solution

Q.6 Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people inevitably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: Some people came out in a matter of minutes while for others it took much longer.

From this, what can one conclude?

(a) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.

(b) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.

(c) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.

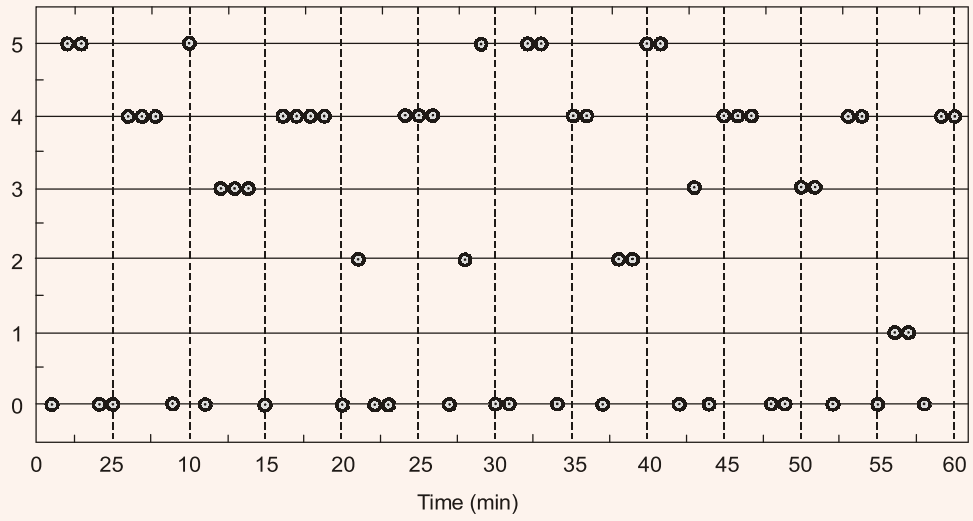
(d) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

Ans. (a)

People coming out in the same order in which they enter indicates that the centre operates on a first-come-first-serve basis.

End of Solution

Q.7 The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour.



Which of the following statements are correct?

(i) The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period.

(ii) The elevator stays on the fourth floor for the longest duration over the one hour period.

(a) Only (i) (b) Only (ii)

(c) Both (i) and (ii) (d) Neither (i) nor (ii)

Ans. (d)

(i) is incorrect as it has move directly.

(ii) is incorrect as it stayed for maximum duration on ground floor.

End of Solution

Q.8 Budhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Budhan walks is

(a) 1 (b) 4

(c) 5 (d) 6

Ans. (d)

Let cycling speed = C

and walking speed = W

$$C\left(\frac{1}{2}\right)+W\left(\frac{3}{2}\right) = 19 \quad \ldots(i)$$

$$C + W = 26 \quad \ldots(ii)$$

On Solving eq. (i) and (ii) We get,

$$W = 6 \text{ km/hr}$$

End of Solution

Q.9 A map shows the elevations of Darjeeling. Gangtok, Kalimpong, Pelling and Siliguri. Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok.

Which of the following statements can be inferred from the paragraph above?

(i) Pelling is at a higher elevation that Kalimpong.

(ii) Kalimpong is at a lower elevation than Darjeeling.

(iii) Kalimpong is at a higher elevation than Siliguri.

(iv) Siliguri is at a lower elevation than Gangtok.

(a) Only (ii) (b) Only (ii) and (iii)

(c) Only (ii) and (iv) (d) Only (iii) and (iv)

Ans. (c)

Following information is given

$K < G$, $P < G$, $S < P$ and $G < D$

From these it can be inferred

$S < P < G < D$ and also $(K < G)$

So, $K < D$ as well but no comparison between K & S or K & P is given

So (ii) and (iv) follows.

End of Solution

Q.10 P, Q, R, S, T and U are seated around a circular table. R is seated two places to the right of Q, P is seated three places to the left R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?

(a) P is immediately to the right of R

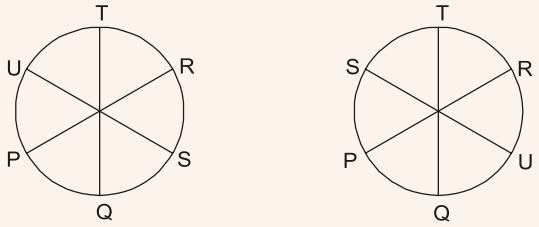
(b) T is immediately to the left of P

(c) T is immediately to the left of P or P is immediately to the right of Q

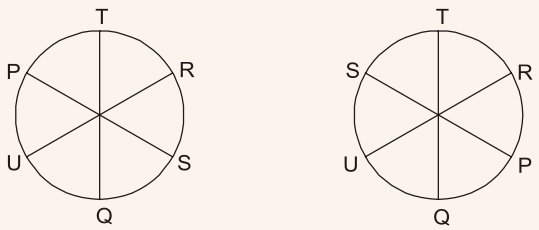
(d) U is immediately to the right of R or P is immediately to the left of T

Ans. (c)

Following two possibilities can be drawn



Given in question P & U interchange then new diagram can be drawn.



Now verify (c) only follows.

End of Solution

■■■■