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GATE 2017

Civil Engineering

Questions with Detailed Solutions

AFTERNOON SESSION

All Queries related to GATE - 2017 key are to be send to the following email address
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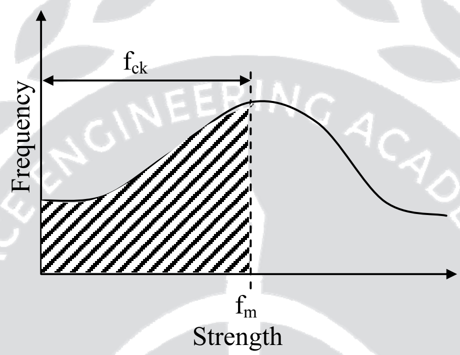
Section: Civil Engineering

01. 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

01. Ans: (C)

Sol:



M25, $f_{ck} = 25$ N/mm^2

$\sigma = 4$ MPa

If 50% of test result are expected to fall then target mean strength $f_m = f_{ck}$

$f_m = 25$ N/mm^2

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

(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) $\frac{dw}{dx}\frac{\partial x}{\partial t}+\frac{dw}{dy}\frac{\partial y}{\partial t}$

02. Ans: (C)

Sol: Let w = f(x,y), where x & y are functions of t

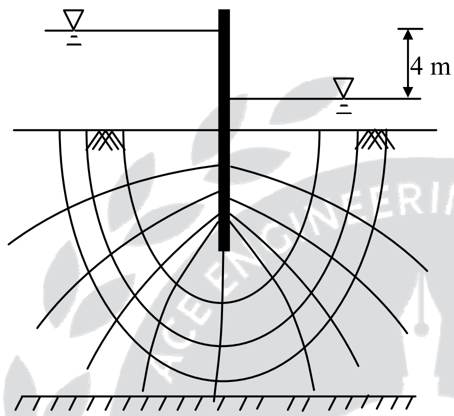
By chain rule, $\frac{dw}{dt}=\frac{\partial w}{\partial x}\frac{dx}{dt}+\frac{\partial w}{\partial y}\frac{dy}{dt}$

Option (C) is correct

03. 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 ______

03. Ans: 1.6

Sol:



$K = 10^{-6}$ m/s, H = 4 m

Number of flow lines = 5 [including boundary flow lines]

$\therefore$ Number of flow channels, $N_f = 5–1 = 4$

Number of equipotential lines = 11 (including boundary equipotential lines)

$\therefore$ Number of potential drops, $N_d = 11 - 1 = 10$

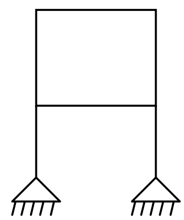
$$\therefore Q = kH \frac{N_f}{N_d}$$

$$= 10^{-6} \times 4 \times \frac{4}{10} = 1.6 \times 10^{-6} \text{ m}^3/\text{s/m}$$

$$= 1.6 \times 10^{-6} \times 10^6 \text{ cm}^3/\text{s/m}$$

$$= 1.6 \text{ cm}^3/\text{s/m}$$

04. Consider the frame shown in the figure.

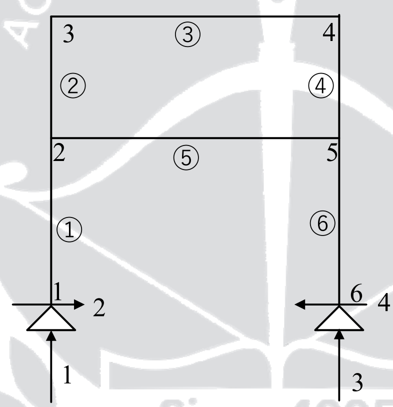


If the axial and shear deformations in different members of the frame are assumed to be negligible, the reduction in the degree of kinematical indeterminacy would be equal to

(A) 5 (B) 6 (C) 7 (D) 8

04. Ans: (B)

Sol:



$r = 4; j = 6; m = 6$

Members axially deformable

$D_K = 3j – r = 3×6 – 4 = 14$

Members axially rigid

$D_K = 3j – (r + m) = 14 – 6 = 8$

Thus, Reduction in kinematic indeterminacy = 14 – 8 = 6

05. 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

05. Ans: (A)

Sol:

As per Indian standard, day time noise level at residential area limited to 55 dB.

06. 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) $e = 0.60\frac{V^2}{R}$

06. Ans: (B)

Sol: The equilibrium cant, $e = \frac{G.V^2}{127R}$

Where e, G, R ------in metres

V -------- in kmph

For BG, G = 1.676 m, $e = \frac{GV^2}{1.27R}$

(e is in cm)

$$\therefore \text{ For BG} \rightarrow e = 1.315\frac{V^2}{R} \text{ (e is in cm)}$$

$$\text{MG} \rightarrow e = 0.8\frac{V^2}{R} \text{ (e is in cm)}$$

$$\text{NG} \rightarrow e = 0.6\ \frac{V^2}{R} \text{ (e is in cm)}$$

Note: In the questions given in the options,

The cant be should have been mentioned in 'cm'. This point is missing in the question.

07. 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______

07. Ans: 1.5

Sol:

Ruling gradient, G = 6% (> 4% grade compensation is allowed as per 1RC)

Radius of curve, R = 50 m

Grade compensation, GC $= \frac{30+R}{R}$

$$= \frac{30+50}{50} = 1.6\%$$

$$= \frac{75}{R} = \frac{75}{50} = 1.5$$

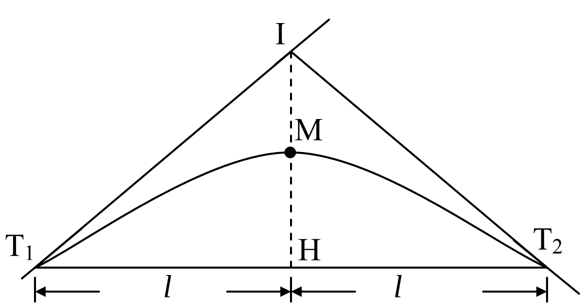
$\therefore$ Use min value of GC = 1.5%

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

08. Ans: 200 m

Sol: Explanation:

Since a vertical curve is quite flat for a parabolic curve, a line IH drawn from I (point of inter section) parallel to the axis on the parabola bisects the long chord joining T_1 and T_2 i.e T_1 H = HT_2 (Shown in figure)



Vertical curve bisects the distance between I and H, the middle point of T_1 T_2 i.e IM = MH

Since the curve is so flat, that the length of the vertical curve $T_1MT_2 = T_1HT_2$ &

$$T_1H = T_1M = IT_1 = IT_2$$

Given IT_1 = 100 m = T_1 H

Length of curve = $MT_1 + MT_2$ = 1.00 + 100 = 200

09. A two-faced fair 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 _____

09. Ans: 0.5

Sol: Here, probability remains same for each toss.

$\therefore$ Probability of getting head in the 4^{th} toss $= \frac{1}{2} = 0.5$

10. 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 = 1.64 for the 95% confidence level. The maximum time required (in days) for the completion of the project would be

10. Ans: 210

Sol:

Mean = (μ)= 200 days

Std. deviation (σ) = 6.1 days

Z= 1.64 (95% confidence level)

Max time required to complete the project (due date) = ?

$$Z = \frac{X - \mu}{\sigma}$$

Where X = due date

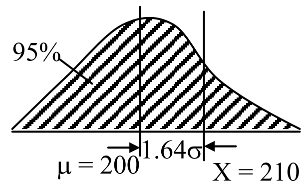
μ = mean

σ = std. deviation

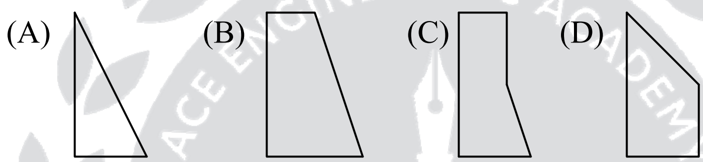
$$1.64 = \frac{X-200}{6.1}$$

X = 210.004

X $\simeq$ 210 days

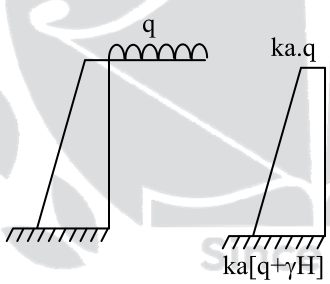


11. Consider a rigid retaining wall with partially submerged cohesionless backfill with a surcharge. Which one of the following diagrams closely represents the Rankine's active earth pressure distribution against this wall?



11. Ans: (B)

Sol:



12. 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

12. Ans: (D)

13. 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________

13. Ans: 0.99

Sol:

$$f_{ct} = f_c + (f_{co} - f_c)\, e^{-kt}$$
$$f = C_1 + C_2\, e^{-kt}$$
$$f = 25 + (200 - 25)\, e^{-kt}$$
$$f = 25 + 175\, e^{-kt}$$
$$f_1 = 25 + 175\, e^{-k\times 1} = 90$$
$$k = \ell n\left[\frac{90-25}{175}\right] = 0.99 \;\; hr^{-1}$$

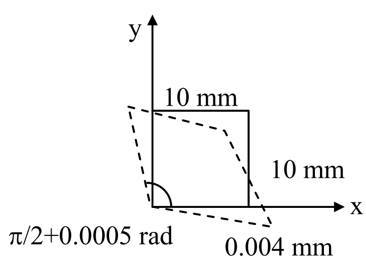
14. The method of orientation used, when the plane table occupies a position not yet located on the map, is called as

(A) Traversing (B) Radiation (C) Levelling (D) Resection

14. Ans: (D)

Sol: Resection is the process of orientation which can be used to locate a point occupied by a plane table as the map with referring to well defined ground stations.

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



If the shear strain 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

15. Ans: (D)

Sol:

The shear strain = –0.0005

$$\gamma_{xy} = 0.001\ (k)$$
$$= 0.001 \times (-0.5)$$
$$\therefore\ k = (-)\ 0.5$$

16. 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

16. Ans: (C)

Sol: $$\text{ELR} = \frac{dT}{dZ} = \frac{T_2 - T_1}{Z_2 - Z_1} = \frac{T_3 - T_2}{Z_3 - Z_1} \times 100$$

$$\frac{15.0 - 15.5}{60 - 10} \times 100 = \frac{14.3 - 15}{130 - 60} \times 100$$

$$\text{ELR} = -1^{o}\text{C}/100\ \text{m}$$

$$\text{ALR} = -9.8°\text{C}/\ \text{km} \simeq -10°\text{C/km} = -1°\text{C}/100\ \text{m}$$

$$\because \text{ELR} = \text{ALR}$$

$\therefore$ Neutral atmospheric condition.

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___

17. Ans: 2

Sol: i = 3.5 cm/hr

ϕ-Index = 1.5 cm/hr

Effective rainfall intensify ERI = $(i - \phi)$

$= (3.5 - 1.5)$

$= 2$ cm/hr

18. Let G be the specific gravity of soil solids, w 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 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) $\gamma_d = \frac{Gw}{1-\gamma_w}$

18. Ans: (A)

Sol: Equation of zero air mids line, $\gamma_d = \frac{\gamma_{w.}G}{1+\omega.G}$

19. 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 characteristic 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) $\lambda^2 + 4\lambda + 5 = 0$

19. Ans: (A)

Sol: Given $3x_1 + 2x_2 = C_1$

$4x_1 + x_2 = C_2$

The given equations can be expressed as

$$\begin{bmatrix} 3 & 2 \\ 4 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix}$$

Where $A = \begin{bmatrix} 3 & 2 \\ 4 & 1 \end{bmatrix}, X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, B = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix}$

The characteristic equation of matrix A is

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

$$\Rightarrow \begin{vmatrix} 3-\lambda & 2 \\ 4 & 1-\lambda \end{vmatrix} = 0$$

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

20. 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

20. Ans: (B)

Sol: For clayey soils, $q_F = q_P$

(i.e. For clayey soil, the bearing capacity is independent of the width.)

21. 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) $N_s = \frac{NQ^{0.5}}{H^{0.5}}$ (B) $N_s = \frac{NQ^{0.5}}{H}$ (C) $N_s = \frac{NQ^{0.5}}{H^{0.75}}$ (D) $N_s = \frac{NQ}{H^{0.75}}$

21. Ans: (C)

Sol:

Specific speed of a centrifugal pump

$$N_{SP} = \frac{N\sqrt{Q}}{(H)^{3/4}} = \frac{N.Q^{0.5}}{H^{0.75}}$$

Where

N = speed of an impeller (rpm)

Q = Discharge (m^3/sec)

H = Total head developed (m)

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

22. Ans: 134

Sol:

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

$$\text{div } \vec{V} = 2x + 6y^2 + 4z^3$$

at x = 1, y = 2, z = 3,

$$\text{div } \vec{V} = 2(1) + 6(4) + 4(27) = 134$$

23. 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

23. Ans: (C)

Sol:

The safety of round about can be achieved by decreasing entry radius (decreases speed at entry) and increasing exit radius (increasing exit speed)

24. 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

24. Ans: (C)

Sol: $0 \leq B \leq 1$

A can be < 0 (i.e. A can be –ve) for heavily OC clays and dense sands

$$\left.\begin{array}{l}\text{A can be} > 0 \\ \text{Also A can be} > 1 \text{ also}\end{array}\right\} \text{For sensitive clays, NC clays, lightly OC clays}$$

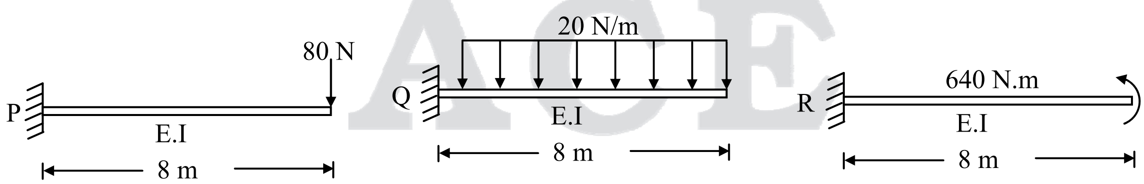
25. The most important type of species involved in the degradation of organic matter in the case of activated sludge process is

(A) autotrophs (B) heterotrophs (C) prototrophs (D) photo-autotrophs

25. Ans: (B)

Sol: ASP host heterotrophic aerobic organisms.

26. 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 8×10^3 mm^4, the correct comparison of 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) $S_F < S_Q > S_R = M_P = M_Q = M_R$

(D) $S_P < S_Q < S_R$; $M_F < M_Q < M_R$

26. Ans: (C)

Sol: Bending moments

$M_P = 80 \times 8 = 640$ kN-m

$M_Q = 20 \times 8 \times 4 = 640$ kN-m

$M_R = 640$ kN-m

$\therefore\ M_P = M_Q = M_R$

Shear force values

$S_P = 80$ kN

$S_Q = 20 \times 8 = 160$ kN

$S_R = 0$

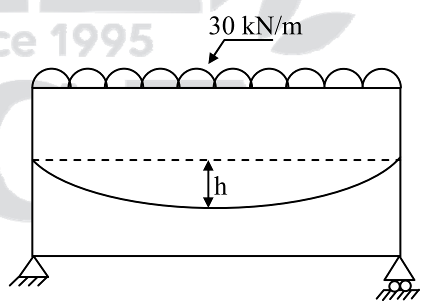
$\therefore\ S_P < S_Q > S_R$

27. 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 profile 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 ___________

27. Ans: 0.15

Sol:

Given:



$l = 8$ m

P = 1600 kN

h = ?

From the load balancing concept

$m_E = m_p$

$$\frac{w\ell^2}{8} = Ph$$

$$h = \frac{w\ell^2}{8P} = \frac{30 \times 8^2}{8 \times 1600} = 0.15\ \text{m}$$

28. For a given water sample, the ratio between $BOD_{5\text{-day}}$, 20°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____

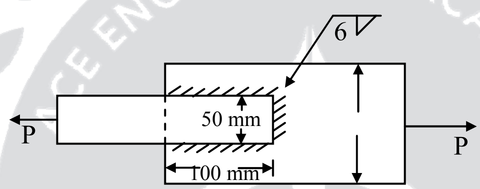
28. Ans: 0.23

Sol: $$\frac{5\,\text{day BOD}20^\circ\text{C}}{\text{ultimate BOD}} = \frac{y_5^{20^\circ C}}{L_o} = 0.68$$

$$\frac{L_o[1-e^{-k_{20}\times 5}]}{L_o} = 0.68$$

$$\Rightarrow K_{20} = 0.2278\ d^{-1}$$

29. 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 _______

29. Ans: 60

Sol: The permissible stress in the plate σ_{at} = 150 Mpa

The permissible stress in the weld τ_{vf} = 110 Mpa

Strength of smaller width plate $P_t = A_g \times \sigma_{at} = 50 \times 8 \times 150 = 60 \times 10^3$ N = 60 kN

(A_g = Gross sectional area of smaller width plate = $50 \times 8 = 400\ mm^2$)

(Since smaller width plate has least sectional area and least strength)

Effective length of fillet weld $L_w = 2 \times 100 + 50 = 250$mm

Size of fillet weld S = 6mm

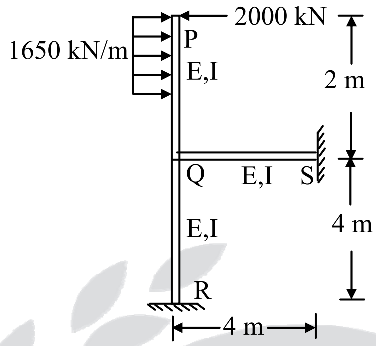
Effective throat thickness $t_t = 0.707 \times S = 0.707 \times 6 = 4.242$ mm

Strength of fillet weld $P_s = L_w \times t_t \times \tau_{vf} = 250 \times 4.242 \times 110 = 116.65 \times 10^3$ N = 116.65 kN

The permissible load P = Smaller of P_t and P_s = 60 kN

The permissible load P (in kN) is <u>60</u>(Answer)

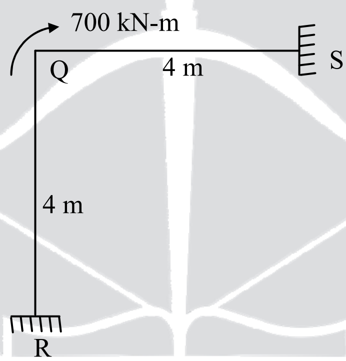
30. Consider the portal frame shown in the figure and assume the modulus of elasticity, $E = 2.5 \times 10^4$ MPa and the moment of inertia, $I = 8 \times 10^8\ mm^4$ for all the members of the frame.



The rotation (in degrees, up to decimal place) at the rigid joint Q would be______

30. Ans: 1

Sol: M = 4000 – 3300 = 700 kN-m



$M_{FQS} = M_{FSQ} = M_{FQR} = M_{FRQ} = 0$

[Fixed end moments]

$\theta_S = \theta_R = 0 \quad \rightarrow$ Fixed supports

$$M_{QS} = M_{FQS} + \frac{2EI}{4}\left[2\theta_Q + \theta_S\right]$$

$M_{QS} = EI\theta_Q$

$E = 2.5 \times 10^4 \times 10^3\ kN/m^2$

$$I = \frac{1}{1250}\ m^4$$

$$M_{QR} = M_{FQR} + \frac{2EI}{4}\left[2\theta_Q + \theta_R\right]$$

$$M_{QR} = EI\theta_Q$$

$$M_{QR} + M_{QS} \neq 700 = 0$$

$$EI\theta_Q + EI\theta_Q = -700$$

$$EI\theta_Q = -350$$

$$\theta_Q = \frac{-350}{2.5\times10^4\times10^3\times\frac{1}{1250}} = -1.75\times10^{-2}\text{ radians} = -1.75\times10^{-2}\times\frac{180}{\pi} = 1.002 \simeq 1$$

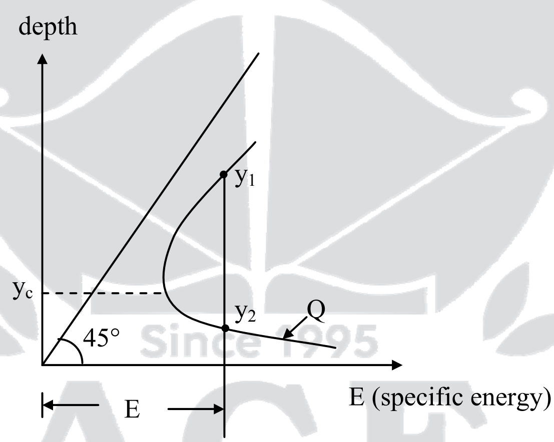
31. A 1 m wide rectangular channel carries a discharge of 2 m^3/s. The specific energy –depth diagram is prepared for the channel. It is observed in this diagram that corresponding to a particular specific energy; the subcritical depth is twice the supercritical depth. The subcritical depth (in meters,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

31. Ans: 1.07

Sol: Given

$Q = 2\ m^3/s$

$B = 4$ m



Given that at a particular specific energy. The sub critical depth is twice the supercritical depth.

$$y_1 = 2y_2$$

$$y_1 + \frac{V_1^2}{2g} = y_2 + \frac{V_2^2}{2g}$$

$$y_1 + \frac{Q^2}{2g(B.y_1)^2} = y_2 + \frac{Q^2}{2g(B.y_2)^2}$$

$$y_1 + \frac{Q^2}{2y(B.y_1)^2} = \frac{y_1}{2} + \frac{Q^2}{2g\left(B.\frac{y_1}{2}\right)^2}$$

$$y_1 + \frac{Q^2}{2g.B^2.y_1^2} = \frac{y_1}{2} + \frac{2Q^2}{gB^2y_1^2}$$

$$\frac{y_1}{2} = \frac{2Q^2}{gB^2y_1^2} - \frac{Q^2}{2gB^2y_1^2}$$

$$\frac{y_1}{2} = \frac{3}{2}\left(\frac{Q^2}{gB^2y_1^2}\right)$$

$$y_1^3 = \frac{3Q^2}{gB^2}$$

$$y_1 = \sqrt[3]{\frac{3Q^2}{gB^2}} = \sqrt[3]{\frac{3\times 2^2}{9.81\times 1^2}}$$

$$y_1 = 1.069 \approx 1.07$$

32. 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

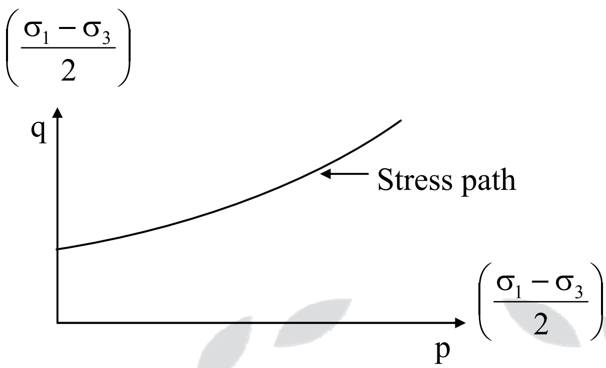
(B) P-True Q – False; R – True

(C) P – False; Q – True; R – False

(D) P– True; Q – False; R – False

32. Ans: (A)

Sol:



33. 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____

33. Ans: 3870

Sol: Total energy as discarded

$$= \frac{\Sigma P_i E_i}{100} = \frac{P_1E_1 + P_2E_2 + \ldots\ldots\ldots + P_nE_n}{100}$$

$$= \frac{[20\times 2500 + 10\times 10000 + 10\times 8000 + 10\times 14000 + 40\times 3500 + 5\times 14000 + 5\times 100]}{100}$$

$= 5805$ kJ/kg

Moisture content of MSW

$$= \frac{20\times 70 + 10\times 4 + 10\times 4 + 10\times 1 + 40\times 60 + 5\times 20\times 2 + 5\times 2}{100}$$

$= 40\%$

Total energy on dry basis

$$= \text{energy as discarded} \times \frac{100}{100 - \%\text{mc}}$$

$$= 5805 \times \frac{100}{100-40} = 9675 \text{ kJ/kg}$$

Difference in energy content = 9675 – 5805

= 3870 kJ/kg

34. 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) $2t - 3t^2$ (D) $-2 - 2t - 3t^2$

34. Ans: (A)

Sol:

$$y^{11} - 4y^1 + 3y = 2t - 3t^2$$

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

$$PI = \frac{1}{(D^2 - 4D + 3)}(2t - 3t^2)$$

$$= \frac{1}{3\left[1 + \left(\frac{D^2 - 4D}{3}\right)\right]}(2t - 3t^2)$$

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

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

(Expanding by binomial theorem up to D^2 terms)

$$= \frac{1}{3}\left\{(2t-3t^2)-\left[\frac{-6-4(2-6t)}{3}\right]+\frac{16}{9}(-6)\right\}$$

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

35. A municipal corporation is required to treat 1000 m^3/day of water. If 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________

35. Ans: 8

Sol: Q = 1000 m^3/day

SOR = 20 m/day

Diameter of settling tank d = ?

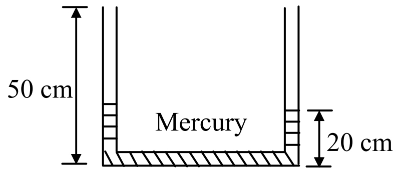
Surface area of settling tank $= \frac{Q}{SOR}$

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

$$\frac{\pi}{4}d^2 = 50$$

$$d = \sqrt{\frac{50\times 4}{\pi}} = 7.978\ m$$

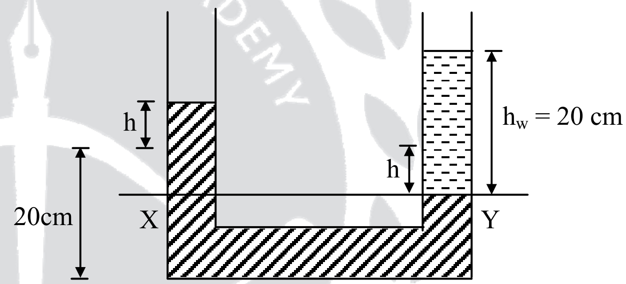
36. The figure shows a U-tube having a 5 mm × 5 mm square cross-section filled with mercury (specific gravity = 13.6) up to a height of 20 cm in each limb (open to the atmosphere).



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 __________

36. Ans: 20.74

Sol:



Volume of water, V = 5 cm^3

$A \times h_w = 5$

$(0.5 \times 0.5) \times h_w = 5$

$h_w = 20$ cm

By the manometry principle

Pressure in left limb = pressure in right limb

$P_x = P_y$

$\rho_w \times g \times h_w = \rho_{Hg} \times g \times h_{Hg}$

$S_w \times h_w = S_{Hg} \times h_{Hg}$

$1 \times 20 = 13.6 \times (2h)$

$h = 0.735$

New height = initial mercury height + h

$= 20 + 0.735$

$= 20.735 \approx 20.74$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10 Saket Saurabh IN
10 Palak Bansal IN
10 Nagesh Verma PI

37. 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 ______

37. Ans: 66.1

Sol:

$$h_L = \frac{f\ell v^2}{2gd} = \frac{f\ell Q^2}{12.1 \times d^5}$$

For laminar flow (Re < 2000),

$$f = \frac{64}{Re} = \frac{64}{800} = 0.08$$

$$h_L = \frac{0.08 \times 1000 \times (0.01)^2}{12.1 \times (0.1)^5}$$

$$= 66.1 \text{ m}$$

38. 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 ___

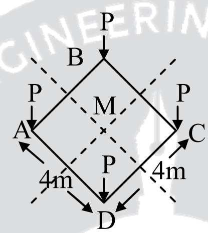
38. Ans: 300

Sol: Total hardness = $Ca^{2+} \times \frac{50}{20} + Mg^{2+} \times \frac{50}{12.2}$

$$= 60 \times \frac{50}{20} + 36.6 \times \frac{50}{12.2}$$

= 300 mg/*l* as $CaCO_3$

39. 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 m right below M. is_______

39. Ans: 190.8

Sol: Concentrated load P = 5000 kN

Depth Z = 5 m

Radial distance, r = $\sqrt{x^2 + y^2}$

$$= \sqrt{2^2 + 2^2} = 2.828\,\text{m}$$

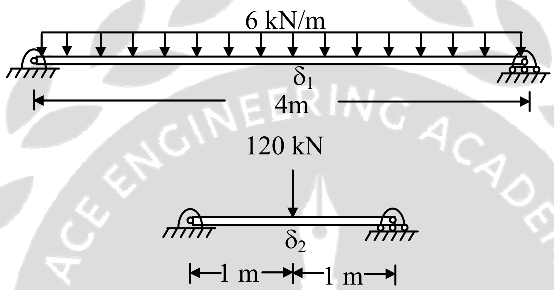
In total, there are four concentrated loads and the stress at point M due to each load (P) is equal.

$$\therefore \text{ Total stress, } \sigma_z = 4 \times \frac{P}{z^2} . \frac{3}{2\pi} \left[\frac{1}{1 + \left(\frac{r}{z}\right)} \right]^{5/2}$$

$$= 4 \times \frac{5000}{5^2} \times \frac{3}{2\pi}\left[\frac{1}{1+\left(\frac{2.828}{5}\right)^2}\right]^{5/2}$$

$= 190.84$ kPa

40. 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) $\delta_1 >> \delta_2$

40. Ans: (A)

Sol:

Central deflection of beam 1

$$\delta_1 = \frac{5 \times 6 \times 4^4}{384EI} = \frac{20}{EI}$$

Central deflection of beam 2

$$\delta_2 = \frac{120(2)^3}{48EI} = \frac{20}{EI}$$

$\delta_1 = \delta_2$

41. 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) $\begin{bmatrix} 38 & 32 \\ 28 & 56 \end{bmatrix}$

41. Ans: (A)

Sol:

$$A = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix} \quad B = \begin{bmatrix} 3 & 7 \\ 8 & 4 \end{bmatrix}, \; B^T = \begin{bmatrix} 3 & 8 \\ 7 & 4 \end{bmatrix}$$

$$AB^T = \begin{bmatrix} 1 & 5 \\ 6 & 2 \end{bmatrix}\begin{bmatrix} 3 & 8 \\ 7 & 4 \end{bmatrix} = \begin{bmatrix} 3+35 & 8+20 \\ 18+14 & 48+8 \end{bmatrix}$$

$$= \begin{bmatrix} 38 & 28 \\ 32 & 56 \end{bmatrix}$$

42. 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 hour) for both the vehicles are given as

P: $d = 60\,t$

Q: $d = 60\,t^2$

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

42. Ans: (A)

Sol: Two cars P and Q are moving continuously for 'two' hours

For P : $d = 60\,t$

For Q : $d = 60\,t^2$

With $\frac{1}{2}$ hour the distance travelled are

$$\text{For P: } d = 60 \times \frac{1}{2} = 30\,\text{km}$$

$$\text{For Q: } d = 60 \times \left(\frac{1}{2}\right)^2 = \frac{60}{4} = 15 \text{ km}$$

Spacing at 30 min = 15 km

43. 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) ($\sqrt{2}$, $\sqrt{2}$)

43. Ans: (A)

Sol:

$$y = x\, log_e\, x$$

$$\frac{dy}{dx} = x\left(\frac{1}{x}\right) + (\log_e x)1 = 1 + \log_e x$$

$$\Rightarrow \tan 45^o = 1 + \log_e x$$

$$\Rightarrow 1 = 1 + \log_e x$$

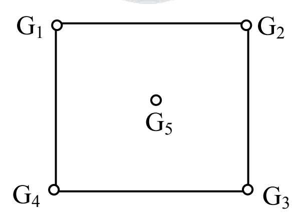
$$\Rightarrow \log_e x = 0$$

$$\Rightarrow x = e^0 = 1$$

$x = 1 \Rightarrow y = 0$ $(\because y = x \log_e x)$

$\therefore$ The point is (1, 0)

44. 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 ______

44. Ans: 287.4 mm

Sol:

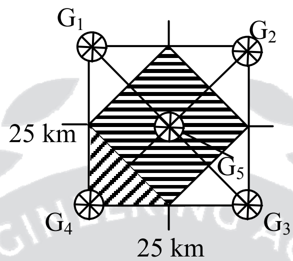
G_1 = 300 mm

G_2 = 285 mm

G_3 = 272 mm

G_4 = 290 mm

G_5 = 288 mm



$$A_1 = A_2 = A_3 = A_4 = \frac{1}{2}\times 12.5\times 12.5$$

$$= 78.125 \text{ km}^2$$

$$A_5 = 17.67 \times 17.67 = 312.5 \text{ km}^2$$

$$\overline{P} = \frac{78.125[300+285+272+290]+312.5\times 288}{(25\times 25)}$$

$= 287.375$ mm

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___

45. Ans: 23 kNm

Sol:

The maximum allowable shear stress on shaft, τ_m = 125 MPa

Outer diameter, D = 100 mm

Inner diameter, d = 50 mm

Torque allowed on the shaft

$$T = \tau_m Z_P$$

$$= \tau_m\left[\frac{\pi}{16D}(D^4 - d^4)\right]$$

$$= 125\left[\frac{\pi}{16\times100}(100^4 - 50^4)\right]$$

$$= 23 \times 10^6 \text{ N-mm}$$

$$= 23 \text{ kN-m}$$

46. 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 _______

46. Ans: 32.9 km

Sol: Distance to visible horizon = D= $\sqrt{\dfrac{h}{0.06735}}$

'h' 'm' & 'D' $\Rightarrow$ 'km'

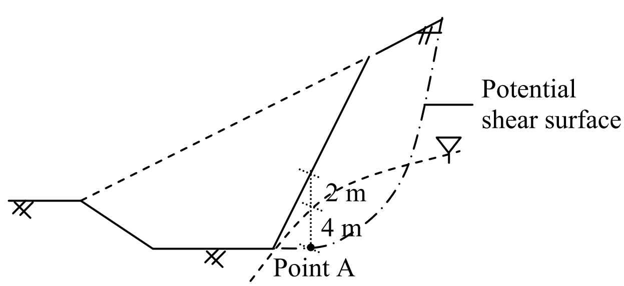
$\therefore$ D = $D_1 + D_2$

$$= \sqrt{\frac{40}{0.06735}} + \sqrt{\frac{5}{0.06735}}$$

$$= 24.370 + 8.616$$

$$= 32.986 \text{ km}$$

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



The soil exhibit $c' = 20$ 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

47. Ans: (A)

Sol: The F.O. safety against shear failure, $F = \frac{S}{\tau}$

Given:

$\tau = 50$ kPa, $C' = 20$ kPa, $\phi' = 18°$, $S_u = 80$ kPa

At point A, the total vertical stress, $\sigma = 2\gamma + 4\gamma_{sat}$

$\sigma = 2 \times 18 + 4 \times 20 = 116$ kPa

At point A, the effective vertical stress, $\sigma' = 2\gamma + 4\gamma'$

$\sigma' = 2 \times \gamma + 4[\gamma_{sat} - \gamma_w]$

$= 2 \times 18 + 4[20 - 9.81] = 76.76$ kPa

Considering undrained condition, $F = \frac{S_u}{\tau} = \frac{80}{50} = 1.6$

Considering drained condition, $F = \frac{S}{\tau} = \frac{C' + \sigma' \tan\phi'}{C}$

$$F = \frac{20 + 76.76 \tan 18°}{50} = 0.9$$

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48. 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:

Pavement	Concrete					Soil
	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	0.5h	E	μ	2K

The ratio (up to one decimal place) of $\frac{\ell_p}{\ell_Q}$ is

48. Ans: 2

Sol:

Westergaard defined the term radius of relative stiffness, *l* which is expressed as

$$\ell = \left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}$$

$$\ell_P = \left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}$$

$$\ell_Q = \left[\frac{E(0.5h)^3}{12(2k)(1-\mu^2)}\right]^{1/4}$$

$$= \left[\frac{(0.5)^3}{2} \times \frac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}$$

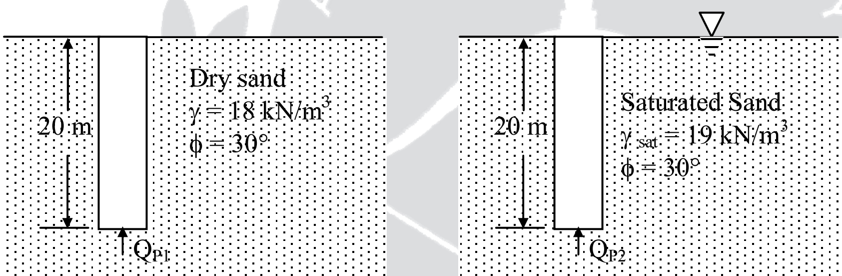
$$\left(\frac{(0.5)^3}{2}\right)^{1/4}\left[\frac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}$$

$$\frac{\ell_P}{\ell_Q} = \frac{\left[\dfrac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}}{\left(\dfrac{(0.5)^3}{2}\right)^{1/4}\left[\dfrac{Eh^3}{12k(1-\mu^2)}\right]^{1/4}}$$

$$= \left(\frac{2}{(0.5)^3}\right)^{1/4}$$

$$\frac{\ell_P}{\ell_Q} = 2$$

49. 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 ϕ = 30° as 24.



If Q_{PI} 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%

49. Ans: (A)

Sol: The point bearing resistance of piles in sandy soils

$Q_P = A_b \,.\, \sigma'_v \,.\, N_q$

As the area at base (A_b) and N_q are same for both the piles given, $Q_P \propto \sigma'_v$

For dry sand condition, $\sigma'_v = \sigma_v = 20 \times \gamma$

For submerged condition, $\sigma'_v = 20\gamma'$

Since $\gamma' \approx \frac{1}{2}$ of γ

$\therefore\ QP_2 \approx \frac{1}{2}$ of QP_1

(or) $QP_1 \approx 2\ QP_2$

(or) $Q_{P1} > QP_2$ by about 100%

50. Consider the following definite integral

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

The value of the integral is

(A) $\frac{\pi^3}{24}$ (B) $\frac{\pi^3}{12}$ (C) $\frac{\pi^3}{48}$ (D) $\frac{\pi^3}{64}$

50. Ans: (A)

Sol:

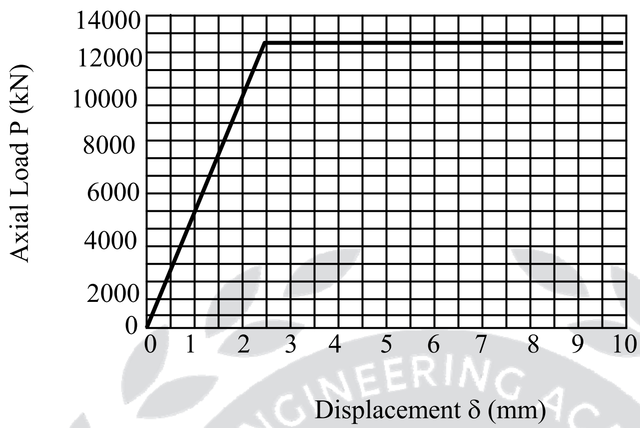
$$I = \int_0^1 \frac{(\sin^{-1} x)^2}{\sqrt{1-x^2}}\,dx$$

put $\sin^{-1} x = t \Rightarrow \frac{1}{\sqrt{1-x^2}}dx = dt$

If x = 0 then t = 0, If x = 1 then $t = \frac{\pi}{2}$

$$I = \int_0^{\frac{\pi}{2}} (t)^2\,dt = \left(\frac{t^3}{3}\right)_0^{\frac{\pi}{2}} = \frac{\pi^3}{24}$$

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

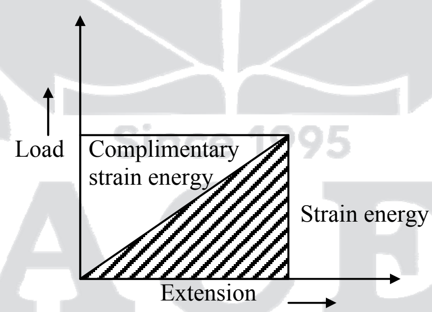


Assume the yield stress of steel as 250 MPa. The complementary strain energy (in N-mm) stored in the bar up to its linear elastic behavior will be ______

51. Ans: 15,707.963

Sol:

Complimentary strain energy for linear materials.



Complimentary strain energy = strain energy

$$= \frac{1}{2}\sigma_y \times \varepsilon \times A \times L$$

$$= \frac{1}{2} \times 250 \times \frac{2.5}{2000} \times \frac{\pi}{4} \times 8^2 \times 2000 \qquad \left(\because \varepsilon = \frac{\delta\ell}{\ell}\right)$$

= 15,707.963 N-mm

52. 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

P. Le Chatelier test

Q. Vee-Bee test

R. Blaine air permeability test

S. The Vicat apparatus

Group – II

1. Soundness of OPC
2. Consistency and setting time of OPC
3. Consistency or workability of concrete
4. Fineness of OPC

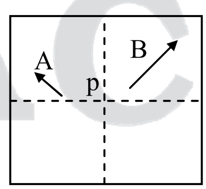
The correct match of the items in Group I with items in Group II is

(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

52. Ans: (A)

53. 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__

53. Ans: 90

Sol: **For Town 'A'**

Relief displacement $d_A = 1.5$ cm ; $T_A = 4$ cm

$$\therefore\ d = \frac{h.r}{\left(H - h_{avg}\right)}$$

For tower 'B'

$d_B = 2$ cm; $r_B = 6$ cm; $h_B = 80$ m

$$d_B = \frac{h_B.r_B}{\left(H - h_{avg}\right)} \Rightarrow \left(H - h_{avg}\right) = 80 \times \frac{6}{2} = 240$$

$$d_A = \frac{h_A r_A}{\left(H - h_{avg}\right)} \Rightarrow h_A = \frac{1.5 \times 240}{4} = 90\,m$$

54. The culturable command area of a canal is 10,000 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 _____

54. Ans: 5200

Sol:

Rice	Wheat
A = 2500 ha	A = ?
B = 150 d	B = 120 d
Δ = 130 cm	Δ = 50 cm

Q = constant

$$Q = \frac{A}{D}\ \&\ D = 8.64\ \frac{B}{\Delta}$$

$$Q = \frac{A\Delta}{8.64B}$$

$$\frac{A_1\Delta}{B_1} = \frac{A_2\Delta_2}{B_2}$$

$$\frac{2500 \times 130}{150} = \frac{A_2 \times 50}{120}$$

$$A_2 = 130 \times 40 = 5200 \text{ ha}$$

55. 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, deadmen 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-False Q – True; R- True; S-False

(D) P-False Q – True; R- True; S-True

55. Ans: (D)

General Aptitude

01. Two dice are thrown simulateneously. The probability that the product o the numbers appearing on the top faces of the dice is a perfect square is

(A) 1/9 (B) 2/9 (C) 1/3 (D) 4/9

01. Ans: (B)

Sol: Total chances = 6×6 = 36 events

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

= (1,1), (2,2), (1,4), (3,3), (4,1), (5,5), (4,4), (6,6) = 8

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

$\therefore$ Option (B) is correct

02. 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

02. Ans: (C)

Sol: Total number of cards = 4

Visible numbers on the cards = 2 and 3

Visible colours on the cards = red and blue

If numbers on the cards = 1,2,3 and 4 then possible colours are blue, red, blue and red respectively.

In order to verify the proposition, we have to turn to card 2 then opposite must be red. In all options except 'C' 2 and red are present

$\therefore$ Option 'C' is correct.

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

(A) 1 (B) –1 (C) –2 (D) Cannot be determined

03. Ans: (B)

Sol:

$$81\times\left(\frac{16}{25}\right)^{x+2}\div\left(\frac{3}{5}\right)^{2x+4}=144$$

$$\frac{\left(\frac{16}{25}\right)^{x+2}}{\left(\frac{3}{5}\right)^{2x+4}}=\frac{144}{81}=\frac{(12)^2}{(9)^2}=\left(\frac{12}{9}\right)^2$$

$$\frac{\left(\frac{4}{5}\right)^{2x+4}}{\left(\frac{3}{5}\right)^{2x+4}}=\left(\frac{12}{9}\right)^2$$

$$\frac{(4)^{2x+4}}{(5)^{2x+4}} \times \frac{(5)^{2x+4}}{(3)^{2x+4}} = \left(\frac{12}{9}\right)^2$$

$$\frac{(4)^{2x+4}}{(3)^{2x+4}} = \left(\frac{12}{9}\right)^2 = \left(\frac{4}{3}\right)^2$$

$$\left(\frac{4}{3}\right)^{2x+4} = \left(\frac{4}{3}\right)^2$$

$2x + 4 = 2$

$2x = -2$

$x = -1$

04. The event would have been successful if you ____able to come.

(A) are (B) had been (C) have been (D) Would have been

04. Ans: (B)

Sol: Conditional tense type (3 had+V3 +would have +V3)

05. There was no doubt that their work was thorough

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

(A) pretty (B) complete (C) sloppy (D) haphazard

05. Ans: (B)

Sol: Through means including every possible detail, parts or complete or absolute.

06. 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 of 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

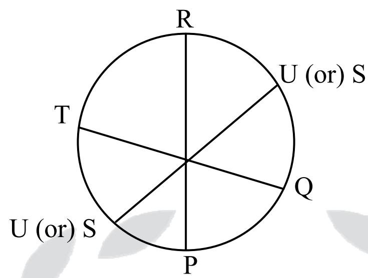
(D) U is immediately to the right of R or P is immediately to the left of T

06. Ans: (C)

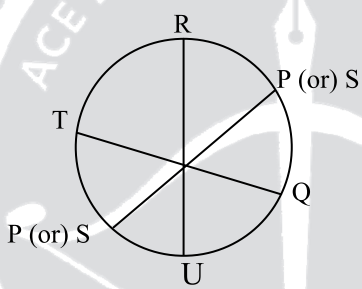
Sol: From the given data, all are seated around a circular table as follows

P Q – R

S is opposite to U



P and U are switch seated means, they are interchange their places



In option (C), before interchange T is immediately to the left of P and After interchange P is immediately to the right of Q

∴ Option 'C' is correct

07. 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

07. Ans: (D)

Sol:

$$19 \text{ km} \rightarrow 2 \text{ hrs} \begin{cases} \text{Cycling} \Rightarrow \dfrac{1}{4}\text{th} = 2\times\dfrac{1}{4} = \dfrac{1}{2} \\ \text{Walking} \Rightarrow \dfrac{3}{4}\text{th} = 2\times\dfrac{3}{4} = \dfrac{3}{2} \end{cases}$$

Let cycling speed = C

Walking speed = W

$\frac{C}{2} + \frac{3W}{2} = 19$ ....(i)

$$26 \text{ km} \rightarrow 2 \text{ hrs} \begin{cases} \text{Cycling} \Rightarrow \dfrac{1}{2}\text{th} = 2\times\dfrac{1}{2} = 1 \\ \text{Walking} \Rightarrow \dfrac{1}{2}\text{th} = 2\times\dfrac{1}{2} = 1 \end{cases}$$

C +W = 26………..(ii)

By solving equation no (i) and (ii)

W = 6 km/hr

$\therefore$ The speed at which Budhan walks = 6 kmph

08. A map shows the elevation 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 than Kalimpong

ii. Kalimpong is at a lower elevation than Darjeeling

iii. Kalimpong is at a higher elevation than Siliguri

iv. Siliguri is at lower elevation than Gangtok

(A) Only ii (B) Only ii and iii (C) Only ii and iv (D) Only iii and iv

08. Ans: (C)

09. 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 arbitarary 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.

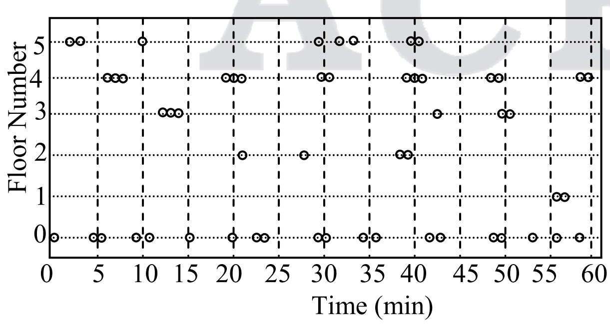
(D) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

09. Ans: (A)

Sol: The key sentence is "the order that they went in"

10. 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

10. Ans: (D)

Sol: (i) is in correct as it has move directly

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