MADE EASY

GATE 2025

Civil Engineering
Shift-1

Memory based
Questions & **Solutions**

Exam held on
16/02/2025 (Forenoon Session)

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SECTION - A GENERAL APTITUDE

Q.1 A person goes inside a restaurant and find minute hand and hour hand coincides. He comes out when minute hand and hour hand again coincides. For how long does he remain inside the restaurant?

(a) $65\frac{5}{11}$ (b) $66\frac{4}{11}$

(c) 60 (d) None of these

Ans. (a)

For R.G of 1 minute hand goes $\frac{12}{11}$

For R.G of 60 = $60\times\frac{12}{11}=\frac{720}{11}=65\frac{5}{11}$

End of Solution

Q.2 A thin wire is used to construct all the edge of a cube of 1 m side by bending, cutting to soldering the wire. If the wire is 12 m long what is the minimum number of cuts required to construct the wire frame and form the cube?

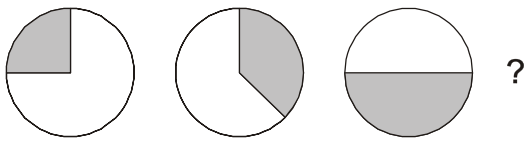
(a) 6 (b) 4

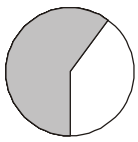
(c) 12 (d) 3

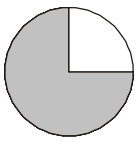
Ans. (d)

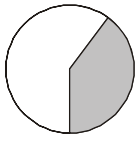
End of Solution

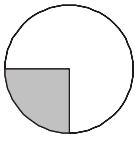
Q.3 Which of the following figure is suitable at?



(a) 

(b) 

(c) 

(d) 

Ans. (a)

End of Solution

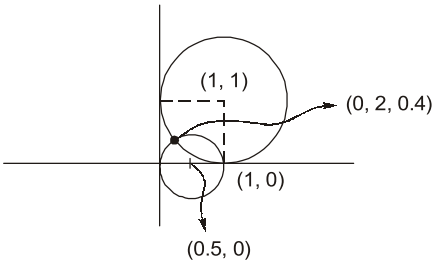
Q.4 Two circle are given as:

1. Center (0.5, 0), $R = 0.5$
2. Center (1, 1), $R = 1$

The points of Intersection of the above circle is

(a) (0.2, 0.4) (b) (1, 2)
(c) (2, 1) (d) (0.5, 1)

Ans. **(a)**



Equation of the circles,

$$(x - 0.5)^2 + y^2 = 0.5 \quad \text{...(i)}$$

$$(x - 1)^2 + (y - 1)^2 = 1 \quad \text{...(ii)}$$

From equation (i) and (ii),

Points of intersection are (0.2, 0.4) and (1, 0).

End of Solution

Q.5 Is there any good show _____ television tonight

(a) In (b) At
(c) On (d) Within

Ans. **(c)**

Is there any good show on television tonight.

End of Solution

■■■■

ANNOUNCING

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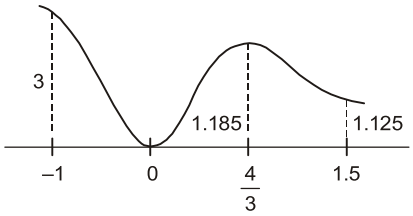
SECTION - B TECHNICAL

Q.6 Maximum value of $f(x) = -x^3 + 2x^2$; $x \in [-1, 1.5]$ is

Ans. (3)

$$f(x) = -x^3 + 2x^2$$
$$f'(x) = -3x^2 + 4x = 0$$
$$x(-3x + 4) = 6$$
$$x = 0, \quad x = \frac{4}{3}$$
$$f''(x) = -6x + 4$$
$$f''(x)\big|_{x=0} = -6 \times 0 + 4 = 4 > 0 \Rightarrow x = 0 \text{ point of minima}$$
$$f''(x)\big|_{x=\frac{4}{3}} = -6\times\frac{4}{3}+4 = -4 < 0 \Rightarrow x = \frac{4}{3} \text{ is point of maxima}$$
$$f(x) = -x^3 + 2x^2$$
$$f(x)\big|_{x=-1} = -(-1)^3 + 2(-1)^2 = 1 + 2 = 3$$
$$f(x)\big|_{x=0} = 0 + 0 = 0$$
$$f(x)\big|_{x=\frac{4}{3}} = -\left(\frac{4}{3}\right)^3 + 2\left(\frac{4}{3}\right)^2 = -\frac{64}{27}+\frac{32}{9}\times\frac{3}{3} = 1.185$$
$$f(x)\big|_{x=1.5} = -(1.5)^3 + 2(1.5)^2 = 1.125$$



So, maximum rate $\Rightarrow$ 3 at $x = -1$

End of Solution

Q.7 The value of $\lim_{n\to\infty}\left(n-\sqrt{n^2+n}\right)$ is

(a) –2 (b) –1
(c) –0.5 (d) 0

Ans. (c)

$$\lim_{n\to\infty}\left(n-\sqrt{n^2+n}\right)\ (\infty-\infty)\text{ form}$$

$$\lim_{n\to\infty}\left(n-\sqrt{n^2+n}\right)\times\frac{\left(n+\sqrt{n^2+n}\right)}{\left(n+\sqrt{n^2+n}\right)}$$

$$\lim_{n\to\infty}\frac{n^2-(n^2+n)}{n+\left(\sqrt{n^2+n}\right)}$$

$$\lim_{n\to\infty}\frac{-n}{n+\sqrt{n^2+n}}$$

$$\lim_{n\to\infty}\frac{-n}{n\left(1+\sqrt{1+\frac{1}{n}}\right)}$$

$$\lim_{n\to\infty}\frac{-1}{1+\sqrt{1+\frac{1}{n}}}=\frac{-1}{1+1}=\frac{-1}{2}=-0.5$$

End of Solution

Q.8 If $y'' + 0.8y' + 0.16y = 0$, $y(0) = 3$, $y'(0) = 4.5$, then $y(1)$ is _____.

Ans. (5.831)

$$y'' + 0.8y' + 0.16y = 0,$$
$$(D^2 + 0.8D + 0.16)Y = 0$$

A.E. $m^2 + 0.8m + 0.16 = 0$

$$(m + 0.4)^2 = 0$$
$$m = -0.4, -0.4 \quad \text{(repeated root)}$$
$$y = (c_1 + c_2 x)e^{-0.4x}$$
$$x = 0,\quad y = 3$$
$$3 = c_1$$
$$y' = (c_1 + c_2x)e^{-0.4x}\times(-0.4) + e^{0.4x}\times c_2$$
$$x = 0,\quad y' = 4.5$$
$$4.5 = -3 \times 0.4 + c_2$$
$$4.5 = -1.2 + c_2$$
$$c_2 = 5.7$$
$$y = (c_1 + c_2x)e^{-0.4x}$$
$$x = 1$$
$$y = (3 + 5.7 \times 1)e^{-0.4 \times 1}$$

$\Rightarrow$ $y = 5.831$

End of Solution

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Q.9 Let λ is an eigen value of A and corresponding eigen vector is x, let x is also eigen vector of $B = A - 2I$, then corresponding eigen value = ?

(a) $\lambda + 1$ (b) $\lambda + 2$
(c) 2λ (d) $\lambda - 2$

Ans. **(d)**

$$Ax = \lambda x$$
$$Bx = \lambda' x \quad \text{(eigen value} = A - 2I\text{)}$$

Since, eigen value of $A = \lambda$
eigen value of $A - 2I = \lambda - 2$
i.e. eigen rate of $B = \lambda - 2$

End of Solution

Q.10 The sum of series $\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+\frac{1}{4!}+----= ?$

(a) $e - 1$ (b) $e + 1$
(c) e (d) π

Ans. **(a)**

Extension of e^x about $a = 0$

$$e^x = 1+\frac{x}{\lfloor 1}+\frac{x^2}{\lfloor 2}+\frac{x^3}{\lfloor 3}+....$$

Put $x = 1$

$$e^1 = 1+\frac{1}{\lfloor 1}+\frac{1}{\lfloor 2}+\frac{1}{\lfloor 3}+....$$

So, $1+\frac{1}{\lfloor 1}+\frac{1}{\lfloor 2}+\frac{1}{\lfloor 3}+.... = e - 1$

$\Rightarrow e - 1$

End of Solution

Q.11 x is a random variable that can take any one of the values 0, 1, 7, 11, 12. The probability mass function for x is

$P(x = 0) = 0.4$; $P(x = 1) = 0.3$; $P(x = 7) = 0.1$; $P(x = 11) = 0.2$;
$P(x = 12) = 0.1$

Then variance of x is

(a) 10.89 (b) 28.40
(c) 31.70 (d) 20.81

Ans. (d)

x	0	1	7	11	12
$P(x)$	0.4	0.3	0.1	0.1	0.1

$$E[x] = \Sigma\, x.p(x)$$
$$= 0 \times 0.4 + 1 \times 0.3 + 7 \times 0.1 + 11 \times 0.1 + 12 \times 0.1$$
$$= 3.3$$
$$E(x^2) = \Sigma\, x^2 p(x)$$
$$= 0^2 \times 0.4 + 1^2 \times 0.3 + 7^2 \times 0.1 + 11^2 \times 0.1 + 12^2 \times 0.1$$
$$= 31.7$$
$$\text{Var}(x) = E(x^2) - (E(x))^2$$
$$= 31.7 - (3.3)^2$$
$$= 20.81$$

End of Solution

Q.12 $A = \begin{bmatrix} 1 & 1 \\ 1 & 3 \\ -2 & -3 \end{bmatrix}$; $b = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$

For $Ax = b$ to be solvable,

(a) $b_1 + b_2 + b_3 = 0$ (b) $b_1 + 3b_2 + b_3 = 2$

(c) $b_1 + b_2 + b_3 = 2$ (d) $3b_1 + b_2 + 2b_3 = 0$

Ans. (d)

$$[A : B] = \begin{bmatrix} 1 & 1 & b_1 \\ 1 & 3 & b_2 \\ -2 & -3 & b_3 \end{bmatrix}$$

$\downarrow$

Convert into echelon form

For solution exist

$\Downarrow$

System should be consistent

$\Downarrow$

$\rho(AB) = \rho(A)$

$$[AB] = \begin{bmatrix} 1 & 1 & b_1 \\ 1 & 3 & b_2 \\ -2 & -3 & b_3 \end{bmatrix} \xrightarrow[R_3 = R_3 + 2R_1]{R_2 = R_2 - R_1}$$

$$\begin{bmatrix} 1 & 1 & b_1 \\ 0 & 2 & b_2 - b_1 \\ 0 & -1 & b_3 + 2b_1 \end{bmatrix} \downarrow R_3 = R_3 + \frac{R_2}{2}$$

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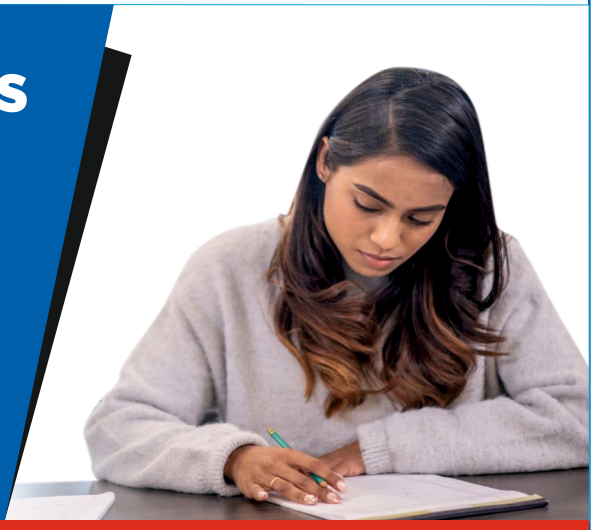

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$$\begin{bmatrix} 1 & 1 & b_1 \\ 0 & 2 & b_2 - b_1 \\ \underbrace{0 \quad 0}_{A} & & 3b_1 + b_2 + 2b_3 \end{bmatrix}$$

$$\rho(A) = 2$$

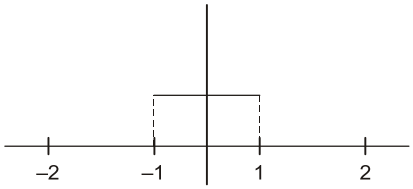
For, $\rho(AB) = 2$

$\Rightarrow \quad 3b_1 + b_2 + 2b_3 = 0$

End of Solution

Q.13 $f(x) = \begin{cases} 0 & \text{for } -2 < x < -1 \\ 2k & \text{for } -1 < x < 1 \\ 0 & \text{for } 1 < x < 2 \end{cases}$; with period = 4, then Fourier series expansion is _____.

Ans. (0.5)



$f(x) \Rightarrow$ even function

so, $b_x = 0$

$$a_0 = \frac{1}{2}\int_{-2}^{2} f(x)\,dx = \frac{1}{2}\int_{-1}^{1} 2k\,dx = \frac{2k}{2}[x]_{-1}^{1} = 2k$$

$$\frac{a_0}{2} = \frac{2k}{2} = k$$

$$a_n = \frac{1}{2}\int_{-2}^{1} f(x)\cos\left(\frac{n\pi x}{2}\right)dx$$

$$= \frac{1}{2}$$

End of Solution

Q.14 A one-way single-lane road has traffic consisting of 30% trucks and 70% cars. The speed of the trucks follows a uniform random variable (U.R.V) over the range (30, 60) kmph, while the speed of the cars follows a U.R.V over the range (40, 80) kmph. If the speed limit of the road is 50 kmph, what percentage of vehicles exceed the speed limit? (Round the final answer to one decimal place)

Ans. (62.5)

x = Truck = 30%

y = Car = 70%

$x \in (30, 60)$

$y \in (40, 80)$

$$x = \text{Uniform R.V } f(x) = \frac{1}{60-30} = \frac{1}{30}$$

$$y = \text{Uniform R.M} = \frac{1}{80-40} = \frac{1}{40}$$

Probability of Truck exceeding the limit

$$P(50 < x < 60) = \int_{50}^{60} f(x)dx = \int_{50}^{60} \frac{1}{30}dx$$

$$= \frac{60-50}{30} = \frac{1}{3}$$

Probability of Car exceeding the limit

$$P(60 < x < 80) = \int_{50}^{80} f(y)dy = \int_{50}^{80} \frac{1}{40}dy$$

$$= \frac{3}{4}$$

$$\% \text{ of vehicle time} = \frac{1}{3}\times 30\% + \frac{3}{4}\times 70\%$$

$$= 10 + 52.5\% = 62.5\%$$

End of Solution

Q.15 Identify the correct statements from the following regarding construction management?

(a) Gantt chart are used to find the critical activities

(b) The free float is amount of time by which an activity can be delayed without affecting the following activity

(c) Dummy activity uses resources and time

(d) PERT network is used in the project time where uncertainties are included

Ans. (b, d)

End of Solution

Q.16 Organic fraction of municipal solid waste (OFMSW) with bulk density of 315 kg/m^3 and water content of 30% is mixed municipal sludge of bulk density 700 kg/m^3 and water content = 70%. Such that mix has a water content of 40%. Calculate the amount of sludge (in kg) to be mixed per kg of MSW (upto 2 decimal places) and bulk density of mix.

(a) Bulk density of mix 450 kg/m^3 (b) Bulk density of mix 365 kg/m^3

(c) 0.33 kg of sludge is to be mixed (d) 0.66 kg of sludge is to be mixed

Ans. (b, c)

Given:

	MSW (X_1)	Sludge (X_2)
Weight	W_1	W_2
Moisture control	MC = 30%	MC = 70%
Density	ρ = 315 kg/m^3	ρ = 700 kg/m^3

Now,

$$0.3W_1 + 0.7W_2 = 0.4\,(W_1 + W_2) \quad \text{(given in question)}$$
$$3W_1 + 7W_2 = 4W_1 + 4W_2$$
$$3W_2 = W_1$$
$$\frac{W_2}{W_1} = \frac{1}{3} = 0.33$$

Bulk density of mix.

$$\rho_{max} = \frac{M_1 + M_2}{\frac{M_1}{\rho_1} + \frac{M_2}{\rho_2}}$$

$$\therefore \frac{W_2}{W_1} = \frac{(\text{Mass})_2}{(\text{Mass})_1} = \frac{M_2}{M_1} = \frac{1}{3}$$

$M_1 = 1,\ M_2 = 0.33$

$$\rho_{bulk} = \frac{1 + 0.33}{\frac{1}{315} + \frac{0.33}{700}} \simeq 365 \text{ kg/m}^3$$

End of Solution

Q.17 Aeration can be employed for which of the following pollutants?

(a) Zinc
(b) Manganese
(c) Iron
(d) Cadamium

Ans. (b, c)

Iron and Manganese are converted to precipitation through aeration and further removed through sedimentation and filtration.

End of Solution

Q.18 Overflow rate of 45 m^3/day/m^2 is given for a liquid medium having organic and inorganic solids. Taking stokes law to be valid. Diameter of inorganic solid (G = 2.65) and organic solid (G =1.20) settleable by stokes law are

Take kinematic viscosity = 10^{-6} m^2/s and g = 9.81.

(a) diameter of settled organic particle is 27 μm
(b) diameter of settled organic particle is 69 μm
(c) diameter of settled inorganic particle is 24 μm
(d) diameter of settled inorganic particle is 30 μm

Ans. (b, c)

Given:

SOR $V_0 = 45\ m^3/m^2/day = \frac{45}{86400} m/sec$

Kinematic viscosity, $\nu = 1 \times 10^{-6}\ m^2/sec$, $g = 9.81\ m/sec^2$

For inorganic solid $G = 2.65$

By stoke's Law settling velocity is given by

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

where, G_S = specific gravity of particle

d = diameter of particle

$$\frac{45}{86400} = \frac{9.81\times(2.65-1)d^2}{18\times1\times10^{-6}}$$

$$d_{\text{inorganic particle}} = 2.40 \times 10^{-5}\ m$$

$$= 24\ \mu m$$

For organic solid ($G = 1.20$)

$$V_s = \frac{g}{180}(G-1)d^2$$

$$\frac{45}{86400} = \frac{9.81}{18\times1\times10^{-6}}(1.2-1)d^2$$

$$d_{\text{organic particle}} = 6.9 \times 10^{-5}\ m = 69\ \mu m$$

End of Solution

Q.19 Which of the following statements are correct regarding facultative ponds

(a) pH is lower during day time than night time

(b) pH is lower during night time than day time

(c) Dissolved oxygen is lower during night time

(d) Dissolved oxygen is lower during day time

Ans. (b, c)

During day time photosynthesis takes place, algae produces oxygen and consumes CO_2, therefore pH will increase and dissolved oxygen will also increase.

End of Solution

Q.20 Initial faecal coliform bacteria conc. 10708 cfu/100 ml in water. After convention water treatment the conc. Is 23 cfu/100 ml. The log inactivation of bacteria is:

(a) 2.67 (b) 3

(c) 4 (d) 0

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Ans. **(a)**

Given, $N_0 = 10708$ cfu/100 ml

$N_t = 23$ cfu/100 ml

Log kill = Log N_0 – log N_t

= Log10708 – Log(23)

= 2.667

End of Solution

Q.21 $MgCl_2$ and $CaSO_4$ salts are added to 1 litre of distilled deionized water and mixed until completely dissolved. TDS concentration is 500 mg/L and total hardness (TH) is 400 mg/L, (as $CaCO_3$). The amounts of salts added are calculated. Which of the following statements is/are true?

Ca(40) Mg (24), S(32) O(16) Cl(35.5 C(12)

(a) $MgCl_2$, added to water is 143 mg/L

(b) $CaSO_4$ added to water is 357 mg/L

(c) $MgCl_2$ added to water is 103 mg/L

(d) $CaSO_4$ added to water is 397 mg/L

Ans. **(c, d)**

Total dissolved solid (TDS) = 500 mg/lt

Total hardness = 400 mg/lt (as $CaCO_3$)

$MgCl_2$ and $CaSO_4$ added in to the water.

$MgCl_2 \rightarrow Mg^{+2} + 2Cl^-$

95 24 71

$CaSO_4 \rightarrow Ca^{+2} + SO_4^{-}2$

136 40 96

Now,Total hardness (as $CaCO_3$) = $\left(\frac{Ca^{+2}}{20}+\frac{Mg^{+2}}{12}\right)\times 50$

400 mg/lt = $\left(\frac{40B}{20}+\frac{24A}{12}\right)\times 50$

$2A + 2B = 8$

$A + B = 4$ ... (i)

Now, Total dissolved solid (TDS) = 500 mg/lt

($MgCl_2$ and $CaSO_4$ completely dissolved in water)

95 part of $MgCl_2$ + 136 part of $CaSO_4$ = 500 mg/lt

$95A + 136B = 500$ ... (ii)

On solving equation (i) and (ii) weight

$A = 1.073$

$B = 2.926$

Now,

$MgCl_2$ added in water = 95A = 95 × 1.073 = 103 mg/lt

$CaSO_4$ added in water = 136B = 136 × 2.926 = 397 mg/lt.

End of Solution

Q.22 A hydro carbon (C_nH_m) is burnt in air (O_2 + 3.78 N_2). The stoichiometric fuel to air mass ratio for this process is
Note: Atomic weight : C(12) H(1)
Effective molecular weight : Air (28.8)
Ignore any conversion of N_2 in air to oxides of nitrogen (NO_x)

(a) $34.42\left(\frac{4n+m}{12n+m}\right)$ (b) $0.0291\left(\frac{12n+m}{4n+m}\right)$

(c) $0.0291\left(\frac{4n+m}{12n+m}\right)$ (d) $34.42\left(\frac{12n+m}{4n+m}\right)$

Ans. **(b)**

$$C_nH_m + aO_2 \rightarrow xCO_2 + yH_2O$$

For carbon c : $n = x \Rightarrow x = n$ ...(1)

For hydrogen H : $m = 2y \Rightarrow y = \frac{m}{2}$ ...(2)

For Oxygen O : $2a = 2x + y \Rightarrow a = \frac{2n+\frac{m}{2}}{2} = \left(n+\frac{m}{4}\right)$ ...(3)

Mass of fuel : $C_nH_m = 12n + m$ (C = 12, H = 1)

Mass of O_2: $32\times\left(n+\frac{m}{4}\right)$ (O = 16)

Mass of air $= 137.84\left(\frac{4n+m}{4}\right)$

Now, $\frac{\text{Fuel}}{\text{Air}} = \frac{12n+m}{\frac{137.84}{4}(4n+m)} = 0.029\left(\frac{12n+m}{4n+m}\right)$

End of Solution

Q.23 Bernoulli's theorem is applicable when
(a) Flow is Steady (b) Flow is Incompressible
(c) Flow is Inviscid (d) Flow is Rotational

Ans. **(a, b, c)**

End of Solution

Q.24 Dimensionless number among the following is

(a) $\frac{L}{v^2g}$ (b) $\frac{v^2}{gL}$

(c) $\frac{vg}{L}$ (d) $\frac{gL^2}{v}$

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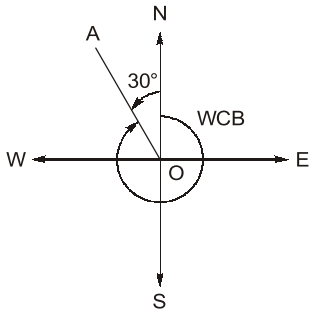
Ans. (b)

$$\frac{v^2}{gl} = \frac{\frac{m^2}{\sec^2}}{\frac{m}{\sec^2} \times m} \quad \text{(Dimensionless)}$$

End of Solution

Q.25 If quadrantal bearing of a line is N30°W, then its whole circle bearing is _____.

Ans. (330°)



WCB of line OA = 360° – 30°
= 330°

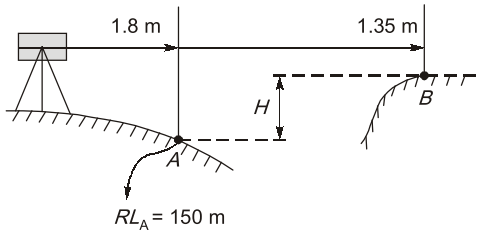
End of Solution

Q.26

	Reading	
Level	*A*	*B*
A	1.8 m	1.35 m
B	1.45 m	0.95 m

RL_A = 150 m
RL_B = ?

Ans. (150.475)



Here, $H_{avg} = \frac{(1.8-1.35)+(1.45-0.95)}{2} = 0.475$ m

$\therefore$ *R.L* of *B* = *R.L* of *A* + H_{avg}
= 150 + 0.475 = 150.475 m

End of Solution

Q.27 If horizontal distance between staff point and point of observation is d, error due to curvature of earth is proportional is?

(a) $\frac{1}{d^2}$ (b) d

(c) $d^{1/2}$ (d) d^2

Ans. **(d)**

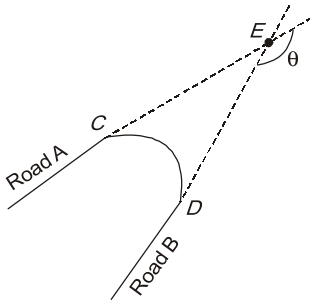
We know, error due to curvature

$$E = +0.0785d^2$$

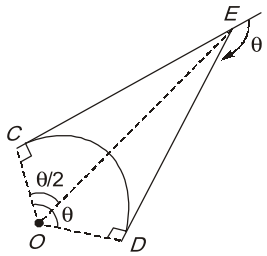
$$\Rightarrow \quad E \propto d^2$$

End of Solution

Q.28 Road A and B are joined by a circular horizontal curve of Radius 200 m. Road A and B are tangential to curve at point C and D respectively, had the curve not been in there, straight roads A and B would had met at point E. The distance from C to E = 92 m. The value of θ is _____. (Round off to two decimal place)



Ans. **(49.40°)**



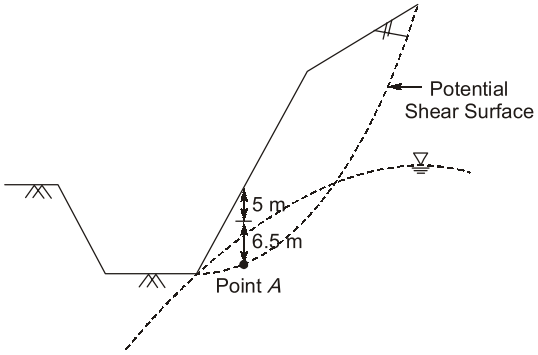
Tangent length, $CE = R\frac{\tan\theta}{2}$

$$92 = 200 + \tan\frac{\theta}{2}$$

$$\theta = 2\tan^{-1}\left[\frac{92}{200}\right] = 49.40°$$

End of Solution

Q.29 For the construction of a highway, a cut is to be made as shown in the figure.



The soil exhibits $c' = 15$ kPA, $\phi' = 15°$, and the undrained shear strength = 60 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 19 and 20 kN/m^3, respectively. If the shear stress at point A is 60 kPa, the factors of safety against the shear failure at this point, in long term is

Ans. (0.97)

For long term, effective shear parameters will be used,

$$FOS = \frac{C' + \bar{\sigma}_n \tan\phi'}{\tau}$$

$$\bar{\sigma}_n = (5\gamma_B + 6.5\gamma_{sat}) - 6.5\gamma_w$$
$$= 5 \times 19 + 6.5 \times 20 - 6.5 \times 9.81$$
$$= 161.235 \text{ kN/m}^2$$

$$FOS = \frac{15 + 161.235\tan 15°}{60}$$
$$= 0.97$$

End of Solution

Q.30 If the vertical pressure in an oedometer increases from 100 kPa to 150 kPa, assuming the soil is fully saturated and initially has zero excess pore water pressure, find the effective stress and pore water pressure?

(a) 100 kN/m^2 and 50 kN/m^2 (b) 100 kN/m^2 and 150 kN/m^2
(c) 150 kN/m^2 and 50 kN/m^2 (d) 50 kN/m^2 and 100 kN/m^2

Ans. (a)

Initial effective stress, $\bar{\sigma}_1 = 100$ kPa

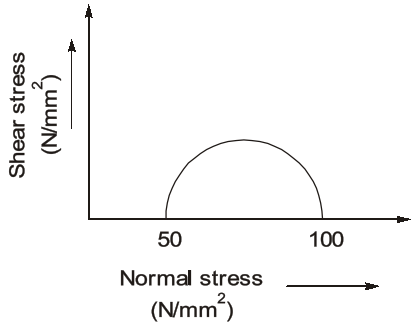
After immediate increment in vertical pressure,

Excess PWP, $u_i = 50$ kPa

$\therefore$ $\bar{\sigma} = 100$ kPa and $u_i = 50$ kPa

End of Solution

Q.31 The results of a consolidated drained triaxial shear stress test on a normally consolidated clay are shown in the figure below. The angle of internal friction is



(a) $\sin^{-1}\left(\frac{3}{4}\right)$ (b) $\sin^{-1}\left(\frac{1}{2}\right)$

(c) $\sin^{-1}\left(\frac{2}{3}\right)$ (d) $\sin^{-1}\left(\frac{1}{3}\right)$

Ans. **(d)**

For CD test, $C = 0$

$$\sigma_1 = \sigma_3 \tan^2\left(45 + \frac{\phi}{2}\right)$$

$$100 = 50 \times \left[\frac{1+\sin\phi}{1-\sin\phi}\right]$$

$$\sin\phi = \frac{1}{3}$$

$$\Rightarrow \quad \phi = \sin^{-1}\left(\frac{1}{3}\right)$$

End of Solution

Q.32 A single pile with 450 mm diameter is driven into homogeneous clay layer is with C_u = 20 kPa, γ = 18 kN/m^3. GWT is found at surface. If α = 0.95, N_c = 9, Pile support column load of 144 kN, FOS = 3.0 against ultimate axial pile capacity in compression, the required embedment depth of pile in m is _____.

Ans. **(15.01)**

Here,

Ultimate load capacity of pile,

$$Q_{up} = 9CA_b + \alpha\bar{C}A_s$$

$$= 9 \times 20 \times \frac{\pi}{4} \times 0.45^2 + 0.95 \times 20 \times (\pi \times 0.45 \times L)$$

$$Q_{safe} = \frac{Q_{up}}{FOS}$$

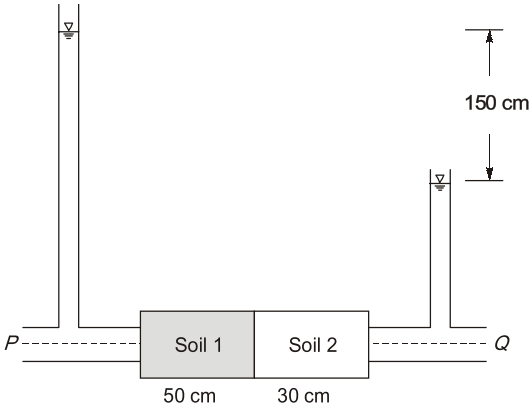
$$Q_{up} = 144 \times 3$$

$$432 = 28.627 + 26.861\ L$$

$$L = 15.01\ m$$

End of Solution

Q.33 Water flows from *P* to *Q* through two soil samples, Soil 1 and Soil 2, having cross sectional area of 60 cm^2 as shown in the figure. The flow conditions can be assumed to be steady state. If the coefficient of permeability of Soil 1 is 0.055 cm/s, the coefficient of permeability of Soil 2 is 0.035 cm/s, then discharge through the soil is _____.



Ans. (5.09)

For series arrangement of soil 1 and soil 2,

Discharge, $q = k_{eq}.i.A.$

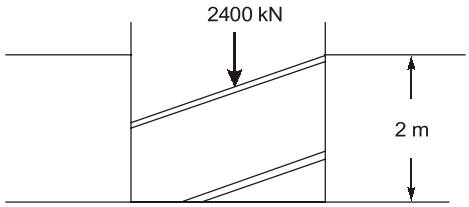
$$= \frac{\Sigma z_i}{\Sigma \frac{z_i}{k_i}} \times \left(\frac{H_L}{\text{Length}} \right) \times A$$

$$= \frac{50+30}{\frac{50}{0.055} + \frac{30}{0.035}} \times \frac{150}{80} \times 60 = 5.09\ cm^3/s$$

End of Solution

Q.34 A square footing with base of footing at 2 m depth and size 6 m × 6 m and 2 m thick of (concrete 24 kN/m^3) has a point load of 2400kN acting on it. Find FOS with respect to soil bearing capacity? Given data $N_C = 5.7$, $N_q = 1$, $N_y = 0$, C = 30 kN/m^2. Unit wt of soil 19 kN/m^3, ground water depth is beyond influence depth. Using Terzaghi bearing capacity.

Ans. (2.90)



$$Q_{safe} = \frac{Q_u - \bar{\sigma}}{FOS} + \bar{\sigma}$$

$$= \frac{Q_u - \gamma D_f}{FOS} + \gamma D_f$$

Here, Applied load $= \frac{2400}{6 \times 6} + \gamma_c \times 2$

$= 66.67 + 24 \times 2 = 114.67$ kN/m^2

For square footing, $Q_u = 1.3\, CN_c + \gamma D_f N_q + 0.4 B \gamma N_r$

$= 1.3 \times 30 \times 5.7 + 19 \times 2 \times 1 + 0$

$= 222.3 + 38$

$= 260.3$

$\Rightarrow \quad Q_{safe} = \frac{260.3 - 38}{FOS} + 38$

$$114.67 = \frac{222.3}{FOS} + 38$$

$$FOS = 2.90$$

End of Solution

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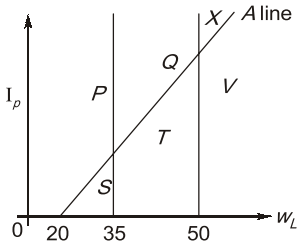
Q.35



Classify the soil X ?

(a) Highly compressible clay soil
(b) Low compressible clay soil
(c) Highly compressible silt soil
(d) Low compressible silt soil

Ans. (a)

Soil X can be classified as high compressible clay [CH].

End of Solution

Q.36 If initial water content of a soil is 18%, degree of saturation is 65%, specific gravity of soil solids is 2.74 then find the water content (in %) of soil when degree of saturation will be 82%. Assume there is no change in volume of soil.

Ans. (22.71)

For initial condition,

$$w_1 = 18\%$$
$$S_1 = 65\%$$
$$G = 2.74$$
$$e = \frac{w_1 G}{S_1} = \frac{18 \times 2.74}{65} = 0.7587$$

For e same and saturation 82%,

$$w = \frac{eS}{G} = \frac{0.7587 \times 82}{2.74}\% = 22.71\%$$

Q.37 To derive the total flood hydrograph at a catchment outlet from an isolated storm, the order in which the following methods are applied, from the Ist method to the last method is,

P. Obtaining the hyetograph
Q. Addition of base flow
R. Estimation of initial and infiltration losses
S. Application of unit hydrograph

Ans. (PRSQ)

To obtain the flood hydrograph, the methods would be arranged as PRSQ.

P. Obtaining the hyetograph
R. Estimation of initial and infiltration losses
S. Application of unit hydrograph
Q. Addition of base flow

End of Solution

Q.38 A trapezoidal canal of length of canal 10 km
Base width of the canal 10 m
Side slope = 1 H : 1 V
Average evaporation Rate in the class A pan is 2 cm/day in the month of April.
What is the volume of evaporation water from the canal in month of April is _____ $\times 10^3$ m^3.

Ans. (72)

In the month of April,

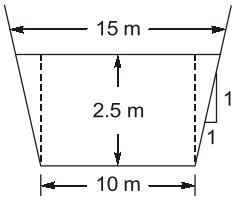
Total volume of water due to evaporation less

$= C_P \cdot$ (PAN Evaporation)

$= 0.8 \times 2$ cm/d $\times 30d$

$= 0.48$ m

For trapezoidal canal of length 10 km,



Evaporation loss volume = L × B × 0.48

$= 72 \times 10^3$ m^3

End of Solution

Q.39 A hydraulic structure is having a design life of 25 years and risk allowed is 5% then recurrence interval, T of the flood for which structure is designed is

Ans. (488)

Given, $n = 25$ years

Risk = 5%

T = ?

We know,

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

$$0.05 = 1-\left(1-\frac{1}{T}\right)^{25}$$

$\Rightarrow$ $T = 488$ day

End of Solution

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Q.40 Which of the following statement(s) is correct?

Stations	P	Q	R	S
Weighted factor	0.25	0.5	0.1	0.15
Precipitation (mm)	100	110	100	125

P, Q, R are inside the catchment while S is outside the catchment.

(a) Thiessen polygon method is not applied for raingauge stations outside the catchment.

(b) Average precipitation calculated using Thiessen polygon method is greater than arithmetic mean method.

(c) Average precipitation calculated using Thiessen polygon method is less than arithmetic mean method.

(d) Average precipitation calculated using Thiessen polygon method is equal to arithmetic mean method.

Ans. **(b)**

By Arithmetic mean method.

$$(\bar{P})_A = \frac{P_A + P_Q + P_R}{3} = \frac{100 + 110 + 100}{3} = 103.33 \text{ mm}$$

By Thiessen polygon method,

$$(\bar{P})_T = \frac{\sum P_i x_i}{\sum x_i}$$

$$= \frac{100 \times 0.25 + 110 \times 0.5 + 100 \times 0.1 + 125 \times 0.15}{1} = 108.75 \text{ mm}$$

$$\Rightarrow \quad (\bar{P})_T > (\bar{P})_A$$

End of Solution

Q.41 A hydraulic jump is formed in a rectangular open channel of width 5 m carries discharge in channel is 15 m^3/sec and the pre-jump depth is 0.5 m, calculate power dissipated (in kW) through jump is _____. (Take g = 9.81 m/s^2, ρ_w = 1000 kg/m^3, α = 1.0)

Ans. **(72.10)**

Given: rectangular channel.

width B = 5 m

Discharge Q = 15 m3/sec

Prejump depth y_1 = 0.5 m

Power dissipated = ?

$$\Delta P = \rho g Q \Delta E \qquad ...(1)$$

$$\Delta E = \frac{(y_2 - y_1)^3}{4 y_1 y_2} \qquad ...(2)$$

For Froude number at upstream

$$Fr_1^2 = \frac{V_1^2}{g y_1} = \frac{q^2}{g y_1^3}$$

$$= \frac{3^2}{9.81\times 0.5^3}$$

$$Fr_1^2 = 7.34$$

Now, $$\frac{y_2}{y_1} = \frac{-1+\sqrt{1+8Fr_1^2}}{2}$$

$$\frac{y_2}{0.5} = \frac{-1+\sqrt{1+8\times 7.34}}{2}$$

$$y_2 = 1.68 \text{ m}$$

Now, $$\Delta E = \frac{(1.68-0.5)^3}{4\times 1.68\times 0.5} = 0.49\text{m}$$

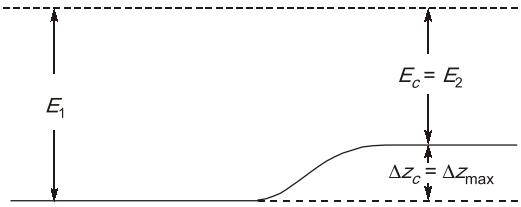
From equation (1)

$$\Delta P = 10^3 \times 9.81 \times 15 \times 0.49$$
$$= 72.10 \text{ k Watt}$$

End of Solution

Q.42 A rectangular open channel has a width of 5 m carries discharge of 10 m^3/sec under uniform flow conditions width a depth of 1.5 m. To produce critical flow conditions without effecting the upstream conditions the channel bottom elevation should be raised (in m) by _____ (upto two decimals).
Assume there is no loss of head at the raise Kinematic energy factor $\alpha = 1$, acceleration due to gravity, g = 9,81 m/sec^2.

Ans. **(0.48)**



Given, $B = 5$ m

$Q = 10$ m^3/sec

$y8_1 = 1.5$ m

$$v_1 = \frac{Q}{By_1} = \frac{10}{5\times 1.5} = 1.33 \text{ m/sec}$$

$$y_c = \left(\frac{q^2}{g}\right)^{1/3}$$

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{2^2}{9.81}\right)^{1/3} = 0.74\text{m}$$

For maximum height of hump $\Delta z = \Delta z_c$ and $E_2 = E_C = \frac{3}{2}y_c$

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$$E_1 = E_2 + \Delta z_c$$

$$y_1 + \frac{v_1^2}{2g} = \frac{3}{2}y_c + \Delta z$$

$$1.5 + \frac{1.33^2}{2\times 9.81} = \frac{3}{2}\times 0.74 + \Delta z$$

$$\Delta z = 0.48 \text{ m}$$

End of Solution

Q.43 In railways, maximum degree of curve in mountainous region is _____.

(a) 10 (b) 30

(c) 20 (d) 50

Ans. **(a)**

For BG track, maximum degree of curve in mountainous region is 10°.

End of Solution

Q.44 Which of the following statement is false?

(a) Compressive strength depends upon water to binder ratio w/c

(b) Compressive strength depends upon the curing condition i.e. temperature and humidity

(c) Air dried and saturated specimen shows same compressive strength.

(d) Compressive strength varies with shape and size of the specimen.

Ans. **(c)**

End of Solution

Q.45 Following data represents percentage of weight retained in sieve analysis:

2.36mm	30%
1.18 mm	35%
600 μ	25%
300 μ	10%

The value of fineness modulus is _____.

Ans. **(2.85)**

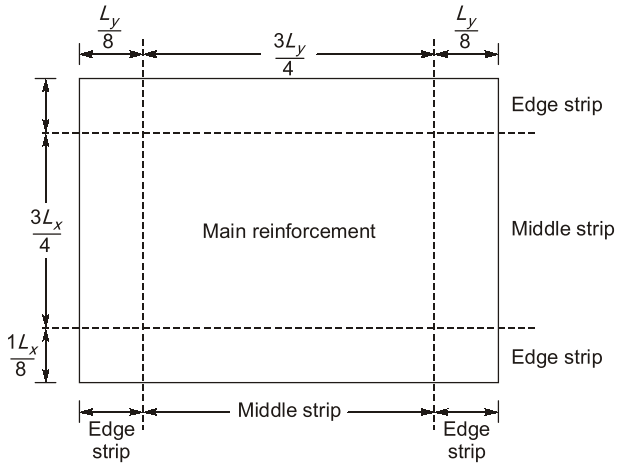
Sieve size	Weight retained	Cumulative weight retained
2.36mm	30%	30%
1.18mm	35%	65%
600μ	25%	90%
300μ	10%	100%
		285

$$\text{Fineness modulus} = \frac{285}{100} = 2.85$$

End of Solution

Q.46 As per IS : 456-2000 → 2 way slab, continuous edge, the longitudinal steel reinforcement to be provided in edge strip,

Ans. (Sol.)



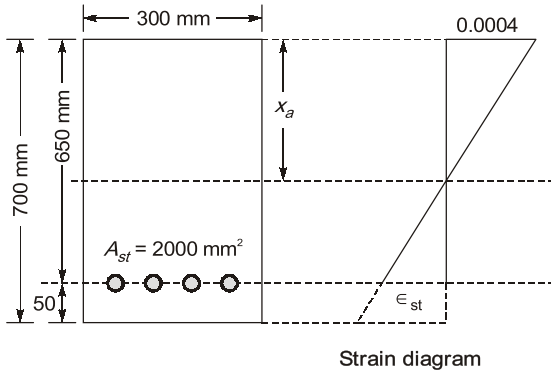
As per IS 456 : 2000
In edge strip minimum reinforcement are provided.
0.15% of BD for Fe250
0.12% of BD for HYSD

End of Solution

Q.47 RCC beam of width 300 mm and depth 700 mm reinforced A_{st} = 2000 mm^2 in tension zone, modular ratio = 12, if maximum compressive strain is 0.0004 then the value of stress in steel. Take E_s = 200 GPa and effective cover 50 mm.

(a) 120 MPa (b) 126 MPa
(c) 135 MPa (d) 140 MPa

Ans. (b)



Modular ration, m = 12 and E_s = 200 GPa
Actual depth of NA

$$\frac{Bx_a^2}{2} = mA_{st}(d - x_a)$$

$$\frac{300x_a^2}{2} = 12 \times 200\,(650 - x_a)$$

$$150x_a^2 + 12 \times 2000x_a - 12 \times 2000 \times 650 = 0$$

$$x_a = 252.26 \text{ mm}$$

Now from strain diagram. (Let $\in_{st}$ strain in steel)

$$\frac{0.0004}{x_a} = \frac{\in_{st}}{d - x_a}$$

$$\in_{st} = \frac{0.0004(650 - 252.26)}{252.26} = 6.306 \times 10^{-4}$$

Stress in steel, $\sigma_{st} = \in_{st} \times E_s = 6.306 \times 10^{-4} \times 2 \times 10^5$

$$\sigma_{st} = 126.136 \text{ N/mm}^2 \text{ or MPa}$$

End of Solution

Q.48 Which of the following statement is/are incorrect?

(a) Compressive strength depends upon water to binder ratio.

(b) Compressive strength depends upon the curing condition i.e. temperature and humidity.

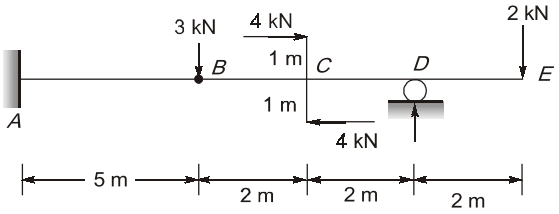
(c) Air dried and saturated specimen shows same compressive strength.

(d) Compressive strength varies with shape and size of the specimen.

Ans. **(a, b, d)**

End of Solution

Q.49



(a) there will be sudden change in BMD at *D*.

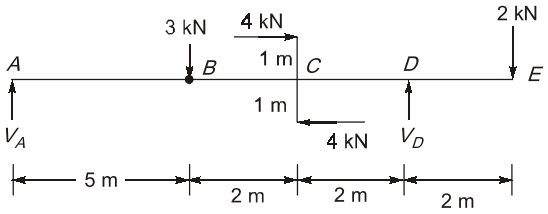
(b) there will be sudden jump in SFD at *C*.

(c) there will be zero BM between *C* and *D*.

(d) there will be zero BM between *A* and *B*.

Ans. **(c, d)**

Let V_A and V_D be the vertical reactions at *A* and *D* respectively.



From right side,

$$\Sigma M_B = 0$$

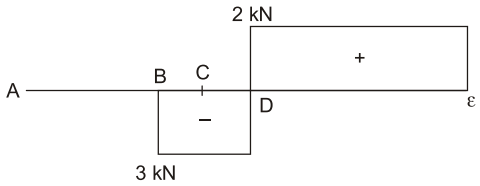
$$-V_D(4) + 4(2) + 2(6) = 0$$

$$\Rightarrow \quad V_D = 5 \text{ kN}$$

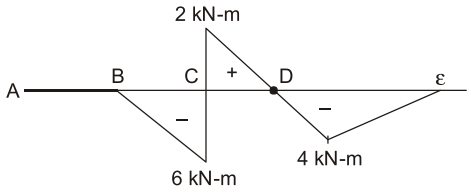
Also, $V_A + V_D = 5$

$$V_A = 0,\ M_A = 0$$

SFD:



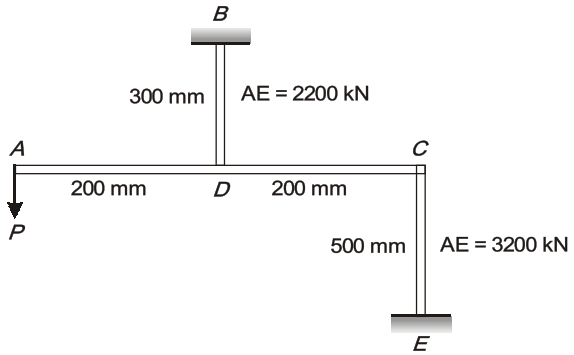
BMD:



BM is zero in span AB and in between C and D.
Correct answer will be (c) and (d).

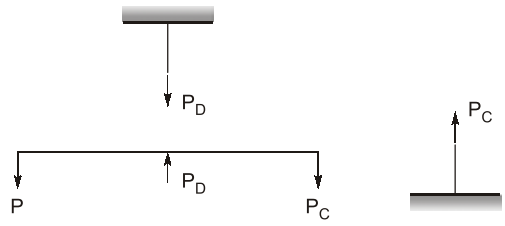
End of Solution

Q.50 If CE member gets elongated by 5 mm then deflection at point A will be _____ mm, ADC is a rigid member.



Ans. (22.453)

FBD :



From equilibrium,

$$P_D = 2P \text{ and } P_C = P$$

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Basics of Computers and Applications	10	10	
Basics of Environment and Pollution Control	10	10	
Technical Abilities (CE/ME/EE/EC)	**100**	**100**	
Total	**150**	**150**	

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Test No.	Activate Date	Total Marks	Total Questions	Total Time
1	11th Feb 2025	150 Marks	150 Qs	2 Hours
2	14th Feb 2025	150 Marks	150 Qs	2 Hours
3	18th Feb 2025	150 Marks	150 Qs	2 Hours
4	21st Feb 2025	150 Marks	150 Qs	2 Hours
5	25th Feb 2025	150 Marks	150 Qs	2 Hours
6	28th Feb 2025	150 Marks	150 Qs	2 Hours
7	4th Mar 2025	150 Marks	150 Qs	2 Hours
8	7th Mar 2025	150 Marks	150 Qs	2 Hours
9	11th Mar 2025	150 Marks	150 Qs	2 Hours
10	14th Mar 2025	150 Marks	150 Qs	2 Hours

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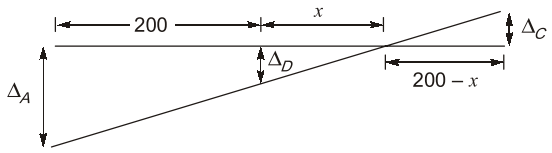
Given, $\Delta_C = 5 \text{ mm} = \dfrac{P_C \cdot L_{CE}}{(AE)_{CE}}$

$= \dfrac{P \times 500}{3200}$

$P = 32 \text{ kN}$

$\Delta_D = \dfrac{P_D \cdot L_{DB}}{(AE)_{DB}} = \dfrac{P_D \cdot 300}{2200} = 8.727 \text{ mm}$

Deformed profile :



From similar D's,

$\dfrac{\Delta_D}{\Delta_C} = \dfrac{x}{200 - x}$

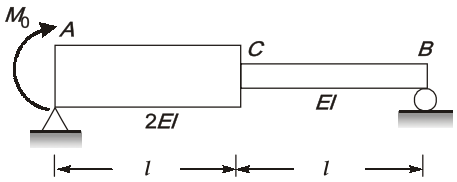
$x = 127.148 \text{ mm}$

$\dfrac{\Delta_A}{\Delta_D} = \dfrac{200 + x}{x} = \dfrac{200 + 127.148}{127.148}$

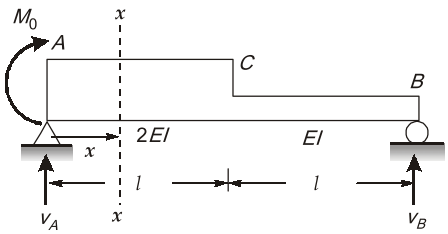
$\Delta_A = 22.453 \text{ mm}$

End of Solution

Q.51 If double derivative of deflection profile at midspan of AC is $\dfrac{\alpha M_0}{8EI}$ Find α.



Ans. (3)



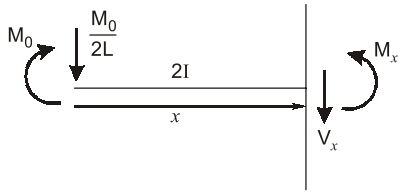
Let V_A and V_B be the vertical reactions at A and B respectively.

$\Sigma M_A = 0$

$(-V_B \times 2L) + M = 0$

$$V_B = \frac{M_0}{2L} \text{ and } V_A = \frac{-M_0}{2L}$$

By double integration method,
At section x-x,



$$M_0 - \frac{M_0}{2L}x + [-M_x] = 0$$

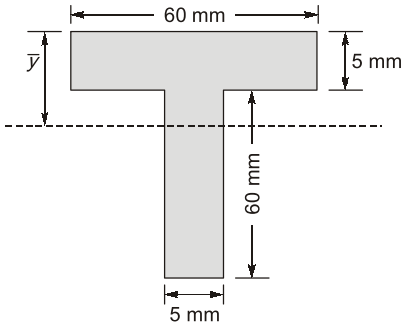
At $x = \frac{L}{2}$ $\quad M_0 - \frac{M_0}{2L}\cdot\frac{L}{2} = (2EI)\frac{d^2y}{dx^2}$

$$\frac{d^2y}{dx^2} = \frac{3M_0}{8EI}$$

$\Rightarrow \quad \alpha = 3$

End of Solution

Q.52

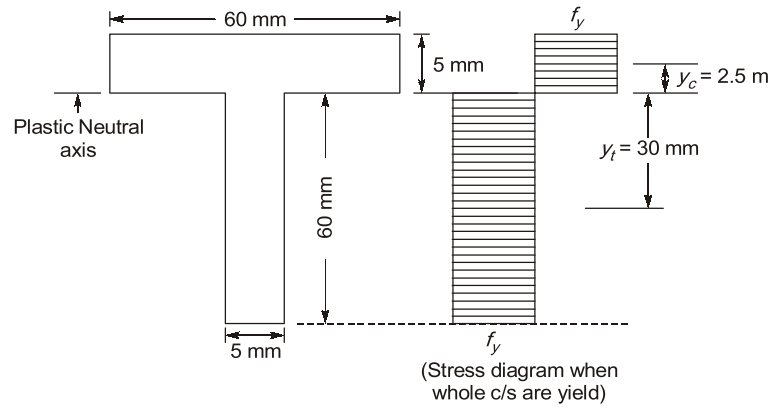


At $\bar{y} = 18.75$ mm top and bottom fiber are yield.

At $\bar{y} = 5$ mm complete section yield. Find shape factor = ?

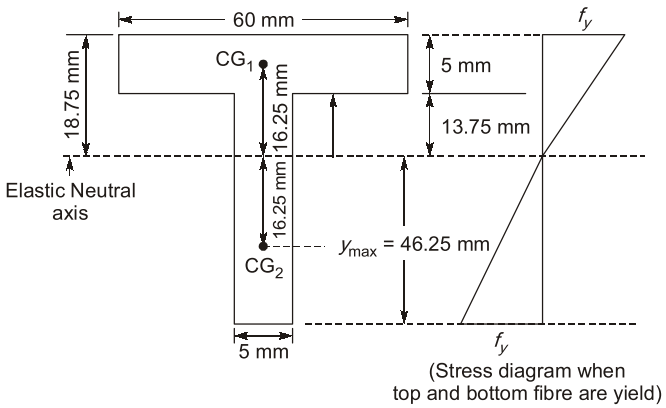
Ans. (1.77)

For plastic section modulus $(Z_p) = \frac{A}{2}(y_c + y_t)$



$$Z_p = \frac{A}{2}(y_c + y_t)$$
$$= \frac{2\times 60\times 5}{2}(2.5+30)$$
$$Z_p = 9750\ \text{mm}^3$$

For elastic section modulus $(Z_e) = \frac{I_{NA}}{y_{max}}$



(Stress diagram when top and bottom fibre are yield)

Area moment of inertia about NA

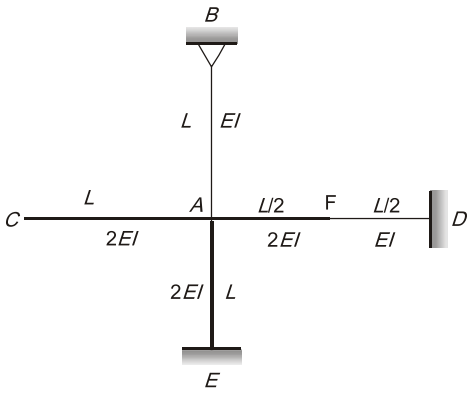
$$I_{NA} = \left[\frac{60\times 5^3}{12} + 60\times 5(16.25)^2\right] + \left[\frac{5\times 60^3}{12} + 5\times 60\times (16.25)^2\right]$$
$$I_{NA} = 249062.5\ \text{mm}^4$$
$$y_{max} = 46.25\ \text{mm}$$
$$Z_e = \frac{I_{NA}}{y_{max}} = \frac{249062.5\text{mm}^4}{46.25\text{mm}}$$
$$Z_e = 5385.135\ \text{mm}^3$$

Now, shape factor $S = \frac{M_P}{M_y} = \frac{f_y Z_p}{f_y Z_e}$

$$= \frac{9570\text{mm}^3}{5385.135\text{mm}^3}$$
$$S = 1.77$$

End of Solution

Q.53 Consider the frame shown below:



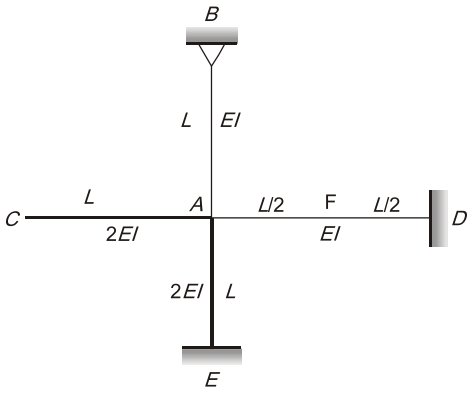
Distribution factor for member AD is _____?

(a) 0.267 (b) 0.398

(c) 0.421 (d) 0.254

Ans. **(b)**

Assume flexure rigidity of member AD is 'EI'



Joint	member	stiffness	Total stiffness	DF
A	AC	0	$\frac{15EI}{L}$	0
	AB	$\frac{3(EI)}{L}$		3/15
	AD	$\frac{4(EI)}{L}$		4/15
	AE	$\frac{4(2EI)}{L}$		8/15

$$(DF)_{AD\ (\text{when } I_{AD} = I)} = \frac{4}{15} = 0.267$$

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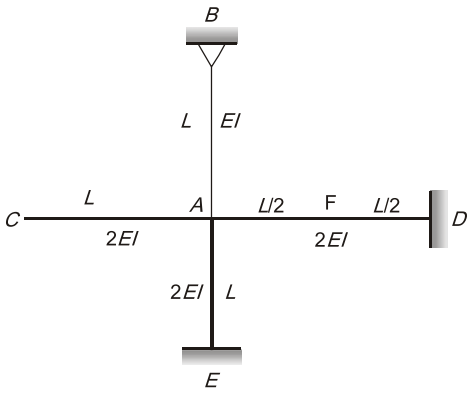
Assume flexural rigidity of number AD is '2EI'



Joint	member	stiffness	Total stiffness	DF
A	AC	0	$\frac{19EI}{L}$	0
	AB	$\frac{3(EI)}{L}$		3/19
	AD	$\frac{2(EI)}{L}$		8/19
	AE	$\frac{4(2EI)}{L}$		8/19

$$(DF)_{AD\ (\text{when } I_{AD} = 2I)} = \frac{8}{19} = 0.421$$

If, $I_{AF} = 2I$ and $I_{FD} = I$.

then $(DF)_{AD}$ should lies between (0.267) and (0.421)

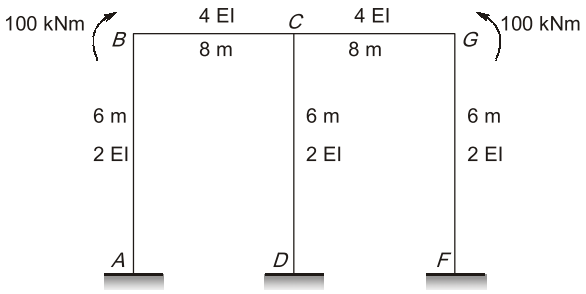
only option (b) lies in this range

So,

$$(DF)_{AD \text{ for given frame}} = 0.398$$

End of Solution

Q.54



Which of the following option(s) regarding given from is/are correct.

(a) No rotation at joint C

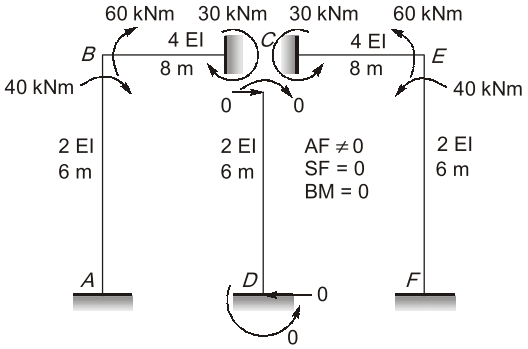
(b) Zero shear force in CD

(c) Bending moment developed in BC at C is more than 50 kNm

(d) Axial force is zero in CD

Ans. (a, b)

Joint	member	stiffness	T.S.	DF
B	BA	$\frac{4E(2I)}{6} = \frac{4}{3}EI$	$\frac{10}{3}EI$	2/5
	BC	$\frac{4E(4I)}{8} = 2EI$		3/5



Bending moment transfer in member BA.

$$M_{BA} = DF_{BA} \times M$$

$$= \frac{2}{5} \times 100 = 40 \text{ kN.}m$$

Bending moment Transfer in member BC

$$M_{BC} = DF_{BC} \times M$$

$$= \frac{3}{5} \times 100 = 60 \text{ kN.}m$$

It is clear that

- No rotation at joint 'C'
- Shear force in CD member = 0
- Axial force in CD member ≠ 0
- Bending moment developed in BC at joint C = 30 kN-m

Which is less than 50 kN-m

End of Solution

Q.55 All the vehicles that come during a particular peak hour come in 10 minute interval. The value of the 15 minute peak hour factor is

(a) 0.167 (b) 0.75

(c) 0.25 (d) 1

Ans. (c)

Peak hour factor for 15 minutes = $\frac{q}{4 \times q_{15}}$

Here, all the vehicle are passing in 10 minute interval,

$\therefore \quad q = q_{15}$

$\Rightarrow \quad \text{PHF} = \frac{1}{4} = 0.25$

End of Solution

Q.56 Which of the following is incorrect related to testing of bitumen?

(a) The penetration is measured in terms of $\frac{1}{10}^{th}$ of mm.

(b) Ductility is measured in unit of length.

(c) Softening point is measured by ring ball apparatus.

(d) Softening point is measured in units of time.

Ans. **(d)**

Softening is measured in units of temperature.

End of Solution

Q.57 During determination of bulk specific gravity of compacted bituminous specimen, the mass in air of the specimen is 1260 g and volume is 525 cc. The density of water is 1 g/cc. The theoretical maximum specific gravity of mix = 2.510. The percentage air voids in bituminous mix is____.

Ans. **(4.38)**

Given,

Mass of specimen, $W = 1260$ gm,

Volume = 525 cm^3

Density of water, $\rho_w = 1$ gm/cm^3

Theoretical maximum specific gravity, $G_t = 2.51$

Percentage of air voids in bituminous mix $V_a\% = ?$

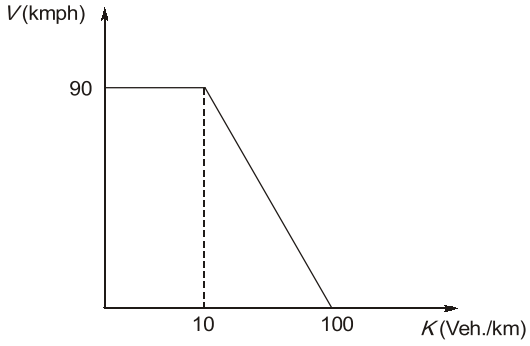
Mass specific gravity $G_m = \frac{\gamma_m}{\gamma_w} = \frac{w}{V \times 1} = \frac{1260}{525} = 2.4$

Percentage of air voids, $V\% = \left(\frac{G_t - G_m}{G_t}\right) \times 100 = \left(\frac{2.51 - 2.4}{2.51}\right) \times 100$

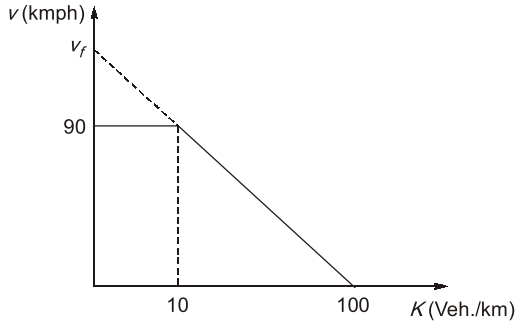
$= 4.38\%$

End of Solution

Q.58 For the given speed density relationship given below find the maximum traffic flow in vehicle per hour.



Ans. (2500)



$$\frac{90}{100-10} = \frac{v_f}{100}$$

$$v_f = 100$$

$$q_{max} = \left(\frac{k_j}{2}\right)\left(\frac{v_f}{2}\right) = \left(\frac{100}{2}\right)\left(\frac{100}{2}\right) = 2500 \text{ veh/ hr}$$

End of Solution

■■■■