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# GATE 2025

Memory based

**QUESTION & SOLUTION**

# CIVIL ENGINEERING

**PAPER-II**

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## 23 STUDENTS SCORED UNDER AIR 20

# GATE 2024 RESULTS

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RANK 2 — Branch XE — PARAJ R. CHHATWANI

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*And Still Counting...*

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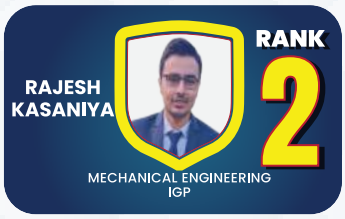




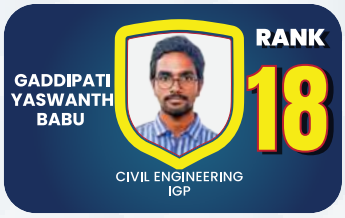














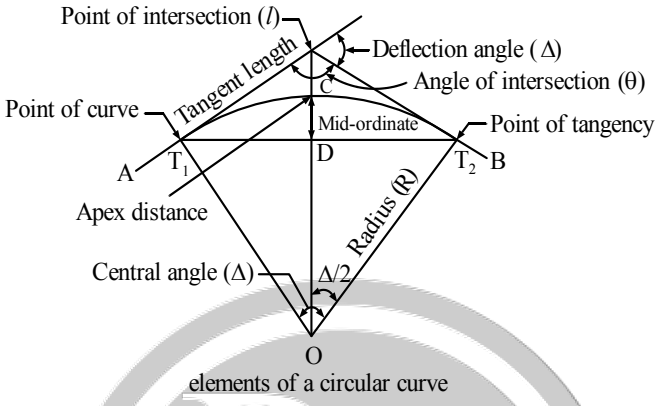
*And Still Counting...*

## QUESTION-1 — MCQ

The point where the road alignment changes from a tangent to a curve is known as _____ .

(a) Point of deflection
(b) Point of intersection
(c) Point of curve
(d) Point of tangency

**SOLUTION: (c)**



elements of a circular curve

1. The point $T_1$ where the circular curve begins is known as point of curve (P.C.).
2. The point $T_2$ is known as point of tangency (P.T.) where it leaves the circular curve.

## QUESTION-2 — MCQ

Which of the following statements is/are **INCORRECT**?

(a) The purity of bitumen can be determined using solubility.
(b) Bitumen having lower softening point is preferred for warm climate regions.
(c) The air voids in the range of 3% - 5% are required to arrive at the optimum bitumen content.
(d) The viscosity of bitumen influences the mixing and compaction of bituminous mix.

**SOLUTION: (b)**

The purity of bitumen can be determined using solubility.

Bitumen having higher softening point is preferred for warm climate regions.

The air voids in the range of 3% - 5% are required to arrive at the optimum bitumen content.

The viscosity of bitumen influences the mixing and compaction of bituminous mix.

## QUESTION-3 — MCQ

After applying the correction for elevation and temperature, the runway length was found to be 700m. The corrected runway length (in meters) for an effective gradient of 1.5% is _____ **(rounded off to the nearest integer).**

(a) 840
(b) 720
(c) 740
(d) 700

**SOLUTION: (a)**

Gradient correction = 20% for 1% effective gradient.

So, runway length = 1.2 × 700 = 840 m.

**QUESTION-4 — MCQ**

Which of the following statements is/are Incorrect?

(a) The effective stress in a liquified soil is almost zero.

(b) As the depth of the groundwater table from the ground surface increases, the effective stress in the soil decreases.

(c) The earth pressure at any point in the soil under all conditions is always smaller than the vertical effective stress at that point.

(d) The bulking of moist sand is due to the capillary action in the sand.

**SOLUTION: (b & c)**

(a) is correct because during liquification process, effective stress under undrained condition in saturated loose sands becomes zero due to the development of excess PWP(equals to total stress) when subjected to dynamic loading.

(b) is incorrect because by lowering water table, both total stress & PWP reduces but effective stress increases.

(c) is false, because passive earth pressure is greater than vertical effective stress

**QUESTION-5 — MCQ**

The recommended minimum traffic growth rate and design period considered for structural design of flexible pavements in national highways in India as per IRC is: 37 : 2018 is _____ percentage and ___ years, respectively.

(a) 5, 30 (b) 7, 20

(c) 5, 20 (d) 7, 30

**SOLUTION: (c)**

The recommended minimum traffic growth rate and design period considered for structural design of flexible pavements in national highways in India as per IRC is: 37 : 2018 is 5% and 20 years, respectively.

**QUESTION-6 — MCQ**

| Column I | | Column II | |
|---|---|---|---|
| (1) | Vehicle Damage Factor | (a) | Stability of subgrade soil |
| (2) | Passenger car unit | (b) | Capacity of a roadway |
| (3) | Perception Reaction Time | (c) | Design rigid pavement |
| (4) | California Bearing Ratio | (d) | Design flexible pavement |
| | | (e) | Stopping Sight Distance |

(a) (1) – (D) ; (2) – (B); (3) – (E); (4) – (A) (b) (1) – (C) ; (2) – (B); (3) – (D); (4) – (A)

(c) (1) – (D) ; (2) – (B); (3) – (E); (4) – (E) (d) (1) – (D) ; (2) – (E); (3) – (B); (4) – (A)

**SOLUTION: (a)**

Vehicle Damage Factor → Design flexible pavement

Passenger car unit → Capacity of a roadway

Perception Reaction Time → Stopping Sight Distance

California Bearing Ratio → Stability of subgrade soil

**QUESTION-7 — MCQ**

For a partially saturated soil deposit at a construction site, the water content (w) is 15%, the degree of saturation (S) is 60%, the void ratio (e) is 0.8, and the specific gravity of the soil ($G_s$) is 2.69. Consider the unit weight of water as 9.81 kN/m³.

The required weight of water to fully saturate 5 m³ of this soil (rounded off to the nearest integer) in kN will be:

(a) 7 (b) 8

(c) 6 (d) 5

**SOLUTION: (C)**

Given

W = 15%

S = 0.67

e = 0.60

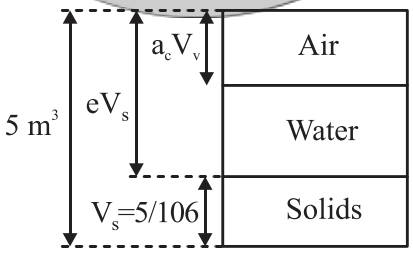
$G_s = 2.67$

$y_w = 9.81\ kN/m^3$

$V = 5\ m^3$

Initially soil is partially Saturated

$W_w$ = weight of water required to saturated the soil = ?




As, $V_s = \frac{V}{1+e}$

$V_s \frac{5}{1+0.60} = \frac{5}{1.6}$

So,

$e = \frac{V_v}{V_s}$

$$\boxed{V_v = 0.6 \times \frac{5}{1.6}\ m^3}$$

Also,

$V_a = a_c\ V_v$

$$V_a = (1 - 0.67) \times \frac{0.6 \times 5}{1.6}$$

$\boxed{V_a = 0.61875\ m^3}$

So,

Weight of water required for saturation ($W_w$) = $V_a\ \gamma_w$

$W_w = 0.61875 \times 9.81$

$\boxed{W_w = 6.07\ kN}$

**QUESTION-8 — MSQ**

The free flow speed of a highway is 100 km/h & its capacity is 4000 veh/h. Assume speed-density relation is linear. For a traffic volume of 2000 veh/h. Choose all possible speed in km/h.

(a) 65.20 (b) 14.64

(a) 7.22 (d) 85.36

**SOLUTION: (b, d)**

$$V_f = 100 \frac{Km}{hr}$$

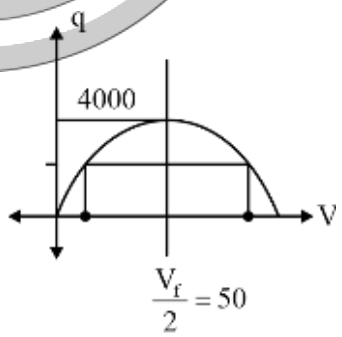
$$q_{max} = 4000 \frac{veh}{hr} = \frac{V_f K_j}{4}$$

$$K_j = 160 \frac{veh}{Km}$$

$$V = V_f \left(1 - \frac{K}{K_j}\right)$$

$$\frac{V}{V_f} = 1 - \frac{K}{K_j}$$

$$\left(1 - \frac{V}{V_f}\right) = \frac{K}{K_j} \Rightarrow K = K_j \left(1 - \frac{V}{V_f}\right)$$




$$q = KV = K_j \left(V - \frac{V^2}{V_f}\right)$$

$$2000 = 160 \left(V - \frac{V^2}{100}\right)$$

$0.01V^2 - V + 12.5 = 0$

V = 14.64 km/h and 85.36 km/h.

**QUESTION-9 — MCQ**

On a two-lane highway, a horizontal curve of R = 300m is provided. The design speed is 80 km/hr. If the longest wheelbase of the vehicle expected on this highway is 7m, then the extra widening required in m is _____ .

**SOLUTION: (0.65)**

Number of lane road = 2

R = 300 m

V = 80 km/hr

l = 7 m.

$$W_e = \frac{nl^2}{2R} + \frac{V}{9.5\sqrt{R}} = 0.65 \text{ m}$$

**QUESTION-10 — MCQ**

A surveyor measured the distance between two points on a plan drawn to a scale of 1 cm = 40 m, and the result was 468 cm. If it was discovered that the used scale was 1 cm = 20 m, the true distance between the points (in m) is ____ (1m).

**SOLUTION: (936)**

$$\text{Correct length} = \frac{\text{Wrong Scale}}{\text{Correct Scale}} \times \text{Measured Length}$$

$$\text{Correct length} = \frac{\left[\frac{1}{20}\right]}{\left[\frac{1}{40}\right]} \times 468\text{m} = 936\text{m}$$

**QUESTION-11 — MCQ**

Consider flow having a long and very wide rectangular open channel. Width of the channel can be considered infinitely compared to the depth of flow. Uniform flow depth is 1.0 m, bed slope of the channel is 0.0001, and the value of Manning's n is 0.02. The critical depth (in m) corresponding to the above conditions is _____. (Note: use g = 9.81 m/s²).

**SOLUTION: (0.3 m)**

For wide rectangular (B >> y), depth of flow, y = 1 m

$S_b = 0.0001$, n = 0.02, g = 9.81 m/s²

$y_c$ = ?

For wide rectangular channel R is nearly equal to y

$$Q = \frac{1}{n}(By)(y)^{2/3} S_b^{1/2}$$

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$$\frac{Q}{B}=\frac{1}{0.02}1^{5/3}(0.0001)^{1/2}$$

$$q=0.5\ m^2/sec$$

$$y_c=\left(\frac{0.5^2}{9.81}\right)^{1/3}=0.294\ m$$

**QUESTION-12 — MCQ**

Consider a RCC Beam section 350 mm width & 600 mm depth. The beam is reformed with tension steel of 800 $mm^2$ area. Take effective cover of 40 mm. M20, Fe 415 used, Let the stress block considered for concrete replaced by equivalent rectangular stress block. Assumed following parameter are not changed.

(a) Area of stress block

(b) Design strain of 0.0035

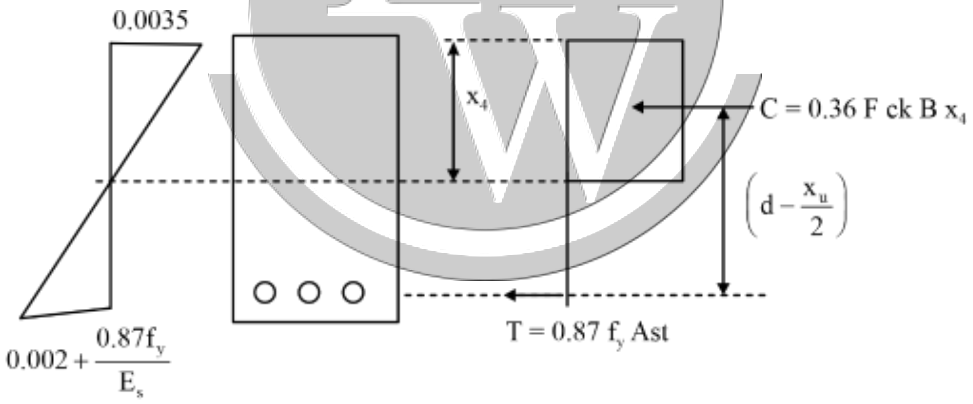
(c) Location of NA at Flexural collapse

Find moment of resistance (in kNm).

(a) 145.2 kNm (b) 56.2 kNm

(c) 156 kNm (d) 62 kNm

**SOLUTION: (a)**




d = 600 – 40 = 560 mm

$$x_4=\frac{0.87\times415\times800}{0.36\times20\times350}=114.62mm$$

$$M_4=0.36\times20\times350\times114.62\times\left(500-\frac{114.62}{2}\right)$$

= 145.2 kNm

**QUESTION-13 — MCQ**

Consider statement

(P) Fly Ash & GGBS can be used as mineral admixture in concrete.

(Q) As per IS 456 : 2000 mm moist curing period be Higher when admixture is added in concrete

(a) Statement – P is true while statement – Q is false

(b) Statement – P is false while statement – Q is false

(c) Both statement -P and statement – Q are True.

(d) Both statement -P and statement – Q are True.

**SOLUTION: (c)**

(1) Mineral admixtures that can be used in concrete are:

(i) Pozzolanas,

(ii) Fly ash (pulverized fuel ash),

(iii) Silica fume,

(iv) Rice husk ash,

(v) Metakaolin,

(vi) Ground Granulated Blast Furnace Slag (GGBS), etc.

(2) As per IS 456:2000, Cl: 13.5.1,

**Moist curing:**

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar materials and kept constantly wet for at least. seven days from the date of placing concrete in case of ordinary Portland Cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

**QUESTION-14 — NAT**

A RCC Beam has supposed section width 30mm & effective depth of 500 mm. The support section reinforced with 3 bar of 20 mm diameter at tension side. Two leg vertical strips 10mm diameter & Fe 415 steel at spacing of 100 mm. Provided as shear reinforcement Assum that there is no possibility of diagonal compress failure find maximum shear force (kN) resist by vertical stirrups.

**SOLUTION: (283.56)**

$$\text{Spacing} = S_v = \frac{A_{sv} \times 0.87 f_y d}{V_{us}}$$

$$V_{us} = \frac{2 \times \frac{\pi}{4} \times 10^2 \times 0.87 \times 415 \times 500}{100} = 283.56 \times 10^3 \text{ N} = 283.56 \text{ kN}$$

## QUESTION-15 — NAT

A 6 m thick clay stratum drained both top & bottom is 50% consolidated in 2 years

$m_v = 1.51 \times 10^{-3}$ m²/kN

$\gamma_w = 9.81$ kN/m³

Co-efficient of permeability_____ (in m/year)

**SOLUTION: (0.013)**

Given,

Double drainage condition

$d = 6$ m , $H = \frac{d}{2} = \frac{6}{2}$ m

$m_v = 1.81 \times 10^{-3}$ m²/kN

$\gamma_w = 9.81$ kN/m³

$t_{50} = 2$ years

Using

$$T_v = \frac{C_V t}{H^2}$$

$$\frac{\pi}{y}(0.5)^2 = \frac{C_v \times 2}{\left(\frac{6}{2}\right)^2}$$

$C_V = 0.8836$ m²/yr

Using

$K = M_v C_v \gamma_\omega$

$K = (1.51 \times 10^{-3}) \times 0.8836 \times 9.81$

$K = 0.013$ m/yr

## QUESTION-16 — MSQ

The details of Flow net diagram is given below:

Head difference b/w U/s and D/s = 9 m

Number of equi-potential drop = 10

Length of the flow field nearest to the toe in the D/S is side is 1 m

$\gamma_{sat} = 21$ kN/m³

$\gamma_w = 9.81$ kN/m³

Factor of safety against quick sand condition is _____.

**SOLUTION: (1.267)**

**Given:**

$H = 9$ m

$N_D = 10$

$\ell_e$ = length of flow field near the toe of dam

$\ell_e = 1$ m

$\gamma_{sat} = 21$ kN/m$^3$

$\gamma_\omega = 9.81$ kN/m$^3$

As, $$i_e = \frac{\Delta h}{\ell_e} = \frac{\text{head loss}}{\text{length of last flow field}}$$

$$i_e = \frac{\left(\frac{9}{10}\right)}{1} = 0.9$$

Now,

$$i_{cr} = \frac{\gamma_{sub}}{\gamma_\omega} = \frac{(21 - 9.81)}{9.81} = 1.14$$

So,

$$\text{FOS against quick sand condition (FOS)} = \frac{i_{cr}}{i_e}$$

$$\text{FOS} = \frac{1.14}{0.9}$$

$\boxed{\text{FOS} = 1.267}$

## QUESTION-17 — NAT

A circular plate of diameter 1 m placed on the surface of a dry sand having unit weight of sand = 16.66 kN/m$^3$. Failure of plate occurs at 1500 kPa.

Considering Terzaghi's bearing capacity theory, the bearing capacity factor $N_\gamma$ is _____.

**SOLUTION: (300.12)**

Shape of plate = Circular

diameter (d) = 1 m

$\gamma = 16.66$ kN/m$^3$

$Q_u = 1500$ kPa

$N_\gamma = ?$

For circular plate on ground surface

$Q_u = 0.3\ B\ \gamma\ N_\gamma$

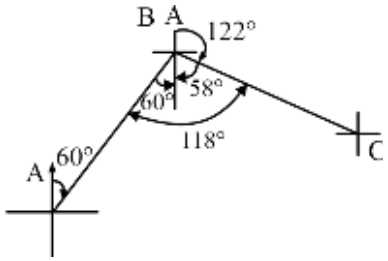
$1500 = 0.3 \times 1 \times 16.66\ N_\gamma$

$\boxed{N_\gamma = 300.12}$

## QUESTION-18 — NAT

If FB of the AB & BC are 60° & 122° then interior angle ∠ABC = _____

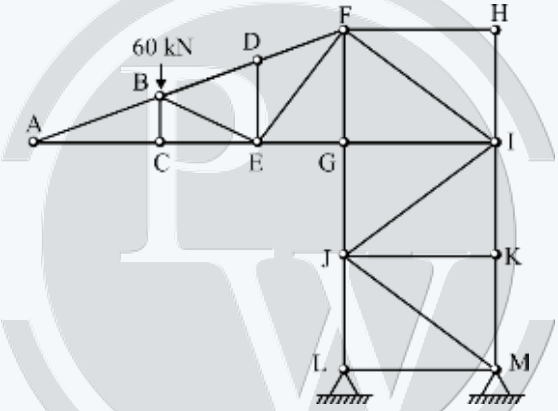
**SOLUTION: (118°)**




∴ Interior angle ∠ABC = 60°+ 58°= 118°

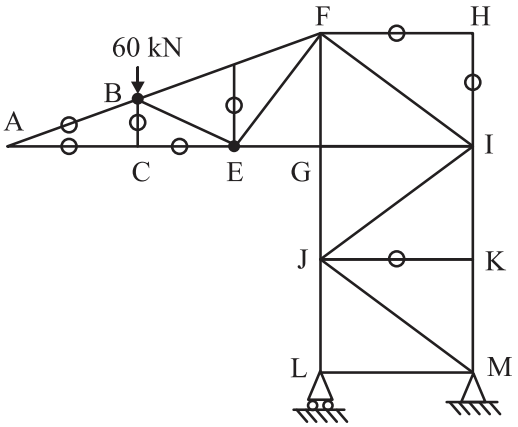
## QUESTION-19 — MSQ

In Pin jointed Truss shows below carry zero force are in




(a) BC
(b) GE
(c) JK
(d) FI

**SOLUTION: (a & c)**



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## QUESTION-20 —MCQ

For $A=\begin{bmatrix}6 & 8\\ 4 & 2\end{bmatrix}$ one of the Eigen Value is _____

(a) 4 (b) –10

(c) 10 (d) 2

**SOLUTION: (c)**

Equation of A is $|A - \lambda I| = 0$

$\Rightarrow \lambda^2 - Tr(A)\,\lambda + |A| = 0$

$\lambda^2 - 8\lambda - 20 = 0 \Rightarrow (\lambda - 10)\ (\lambda + 2) = 0$

$\lambda = 10$ & $-2$

## QUESTION-21 —MSQ

For the velocity Vector $\bar{v}$ in (x, y, z) coordinate given below

Pick one or more correct statements for $v = ux + vy$

(a) z component of curl of velocity i.e. $\vec{\nabla}\times\vec{v} = \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)\vec{z}$

(b) z component of curl of velocity i.e. $\vec{\nabla}\times\vec{v} = \left(\frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}\right)\vec{z}$

(c) Divergence of velocity i.e. $\vec{\nabla}\cdot\vec{v} = \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right)$

(d) Divergence of velocity i.e. $\vec{\nabla}\cdot\vec{v} = \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)$

**SOLUTION: (a, c)**

$v = ux + vy + oz \approx u\hat{i} + v\hat{j} + D\hat{k}$

$$\text{Div } v = \nabla.v = \frac{\partial}{\partial x}(u) + \frac{\partial}{\partial y}(v) + \frac{\partial}{\partial z}(0) = \frac{\partial v}{\partial x} + \frac{\partial v}{\partial y}$$

$$\text{Curl } v = \nabla\times v = \begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ \partial/\partial x & \partial/\partial y & \partial/\partial z\\ u & v & 0\end{vmatrix} = 0\hat{i} + 0\hat{j} + \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)\hat{k}$$

**QUESTION-22 —MCQ**

For the function $f(x)=x^3-\frac{15}{2}x^2+18x+20$. Choose correct option

(a) f(x) has local maximum at x = 2

(b) f(x) has local minimum at x = 3

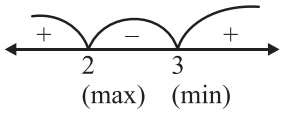
(c) f(x) has local maximum at x = 3

(d) f(x) has local maximum at x = 2

**SOLUTION: (a, b)**

$f'(x) = 3x^2 - 15x + 18 = 3(x^2 - 5x + 6) = 3(x - 2)(x - 3)$

turning points are x = 2 & 3




x = 2 is point of maxima & x = 3 is point of minima.

**QUESTION-23 —NAT**

The order of $y'''+(y'')^6+(y')^4+y=0$ is _____?

**SOLUTION: (3)**

The highest order derivative occurring in the equation is called it's order so order of the equation = 3.

**QUESTION-24 —MCQ**

For the Equation $\frac{dy}{dx}=e^{x-y}$ the correct option?

(a) $\ln y = \ln e^x + \text{constant}$

(b) $\ln y = x + \text{constant}$

(c) $y = \ln (e^x + \text{constant})$

(d) $y = x + \text{constant}$

**SOLUTION: (c)**

$$\frac{dy}{dx}=e^{x-y}=e^x.e^{-y}$$

$$e^y\,dy = e^x\,dx$$

$$\int e^y\,dy=\int e^x\,dx+C$$

$$e^y = e^x + C$$

$$y = \ln (e^x + C)$$

**QUESTION-25 — MSQ**

$\int \ln x \, dx = ?$

(a) $x \log x - x + C$ (b) $x \log x + x + C$

(c) $\log x - x + C$ (d) $\log x + x + C$

**SOLUTION: (a)**

$\because \int uv \, dx = u\int v \, dx - \int\left(\frac{dy}{dx}\int v \, dx\right)dx + C$

$\int \log x.1. \, dx = \log x(x) - \int \frac{1}{x}(x) \, dx = x \log x - x + C$

**QUESTION-26 — MSQ**

Choose the correct options:

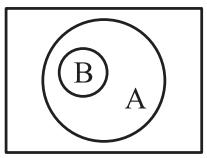
(a) $P(A/B) = 1$ if $B \subset A$

(b) $P(A \cap B) = 0$ if A & B Independent

(c) $P(A \cup B) = P(A) + P(B)$ if A & B are mutually exclusive

(d) $P(A \cap B) = P(A).P(B)$ if A & B are mutually exclusive.

**SOLUTION: (a, c)**

If $B \subset A$ i.e. 

$P\left(\frac{A}{B}\right) = \frac{(A \cap B)}{P(B)} = \frac{P(B)}{P(B)} = 1$ i.e (a)

For mutually exclusive events $A \cap B = \phi$

$\rightarrow P(A \cap B) = P(\phi) = 0$ i.e (d)

Now by addition theorem, $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

or $P(A \cup B) = P(A) + P(B) = 0$

So, (c) is also true.

**QUESTION-27 — MCQ**

If matrix $A=\begin{bmatrix}2 & 3 & 4\\ 1 & 4 & 5\\ 4 & 3 & 2\end{bmatrix}_{3\times3}$ then transpose of A is

(a) $A^T=\begin{bmatrix}2 & 1 & 4\\ 3 & 4 & 3\\ 4 & 5 & 2\end{bmatrix}$

(b) $A^T=\begin{bmatrix}2 & 3 & 4\\ 1 & 4 & 5\\ 4 & 3 & 2\end{bmatrix}$

(c) $A^T=\begin{bmatrix}1 & 2 & 4\\ 4 & 3 & 3\\ 5 & 4 & 2\end{bmatrix}$

(d) $A^T=\begin{bmatrix}2 & 4 & 1\\ 3 & 3 & 4\\ 4 & 2 & 5\end{bmatrix}$

**SOLUTION: (a)**

$$A^T=\begin{bmatrix}2 & 1 & 4\\ 3 & 4 & 3\\ 4 & 5 & 2\end{bmatrix}$$

**QUESTION-28 — MSQ**

The most suitable test for measuring the permeability of clayey soils in the laboratory is

(a) Falling head test

(b) Hydrometer test

(c) Constant head test

(d) Pumping head test

**SOLUTION: (a)**

**QUESTION-29 — MCQ**

$Ca^{2+}$ = 150 mg/l as $CaCO_3$

$Mg^{2+}$ = 40 mg/l as $CaCO_3$

$Fe^{2+}$ = 10 mg/l as $CaCO_3$

$HCO_3^-$ = 50 mg/l as $CaCO_3$

$CO_3^{-2}$ = 100 mg/l as $CaCO_3$

Find non carbonate hardness for this sample?

(a) 50

(b) 100

(c) 150

(d) 200

**SOLUTION: (a)**

$Ca^{2+}$ = 150 mg/l as $CaCO_3$

$Mg^{2+}$ = 40 mg/l as $CaCO_3$

$Fe^{2+}$ = 10 mg/l as $CaCO_3$

$HCO_3^-$ = 50 mg/l as $CaCO_3$

$CO_3^{-2}$ = 100 mg/l as $CaCO_3$

TA = 150 mg/l

TH = 200 mg/l

CH = 150 mg/l

NCH = 50 mg/l as $CaCO_3$

**QUESTION-30 — MCQ**

Which of the following bacteria cause crown corrosion in sewer line?

(a) Sulphate reducing bacteria
(b) Methano organic bacteria
(c) Pseudomonas bacteria
(d) Denitrifying bacteria

**SOLUTION: (a)**

Sulphate reducing bacteria

**QUESTION-31 — MSQ**

Higher biodegradable organic matter is not treated by

(a) Composting
(b) Bio Hydrogenation
(c) Anaerobic digester
(d) Open dumping

**SOLUTION: (b, d)**

Higher biodegradable organic matter is not treated by

1. Bio Hydrogenation
2. Open Dumping

**QUESTION-32 — MCQ**

Free resident $Cl_2$ = 2 mg/l as $Cl_2$, pH = 8.5, K = $10^{-7.5}$ mol/lt

Find HOCl concentration (in μmol/L ) in this sample?

(a) 2.56
(b) 5.8
(c) 7.26
(d) 4.5

**SOLUTION: (a)**

Free resident $Cl_2$ = 2 mg/l as $Cl_2 = \frac{2}{71\times1000}$ mol/lt

$HOCl \rightleftharpoons H^+ + OCl^-$

pH = 8.5, K = $10^{-7.5}$ mol/lt

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$$K = \frac{[H^+][OCl^-]}{[HOCl]}$$

$$\frac{K}{[H^+]} = \frac{[OCl^-]}{[HOCl]}$$

$$\frac{[OCl^-]}{[HOCl]} = \frac{10^{-7.5}}{10^{-8.5}} \Rightarrow \boxed{OCl^- = 10HOCl}$$

$$OCl^- + HOCl = \frac{2}{71\times1000}\text{ mol / lt}$$

$$10HOCl + HOCl = \frac{2}{71\times1000}\text{ mol / lt}$$

$$HOCl = \frac{2}{71\times1000\times11} = 2.56\times10^{-6}$$

**QUESTION-33 — MCQ**

Hydraulic jump is formed for break in grade from

(a) mild to steep
(b) steep to steeper
(c) mild to zero slope
(d) steep to mild

**SOLUTION: (d)**

Hydraulic jump is formed for break in trade from super critical ($Fr_1 > 1$) to sub critical ($Fr_2 < 1$)

**QUESTION-34 — MCQ** **1 Mark**

Even though I had planned to go skiing with my friends , I had to _____at the last moment because of an injury.

(a) back up
(b) back out
(c) back on
(d) back of

**SOLUTION: (b)**

Back out means to withdraw.

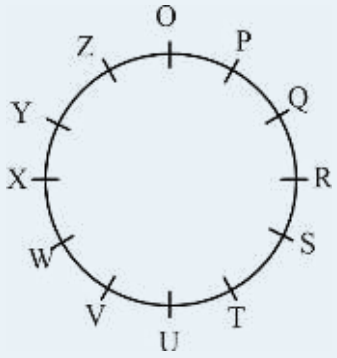
**QUESTION-35 — MCQ** **2 Marks**

For the clock shown in the figure, if

O* = OQSZPRT

X* = XZPWYOQ

Then which one among the given attains is most appropriate for P*




(a) PTVQSUW (b) PRTOQSU

(c) PSUPRTV (d) PVWRTVX

**SOLUTION: (b)**

O* → + 2, +2, – 5, +2, +2, +2 (Clockwise)

X* → + 2, +2, – 5, +2, +2, +2 (Clockwise)

P* → P , P + 2 = R, R + 2 = T, T – 5 = O, O + 2 = Q, Q + 2 = S, S + 2 = U ( PRTOQSU)

**QUESTION-36 — NAT** **1 Mark**

P & Q mix in certain ratio and sold at ₹192 Per/kg. The cost of P is ₹ 800 for 5 kg & the cost of Q is ₹ 800 for 4 kg. The person gets 8% Profit. The ratio of P : Q (by weight) is.

(a) 3 : 2 (b) 1 : 1

(c) 5 : 4 (d) 3 : 4

**SOLUTION: (c)**

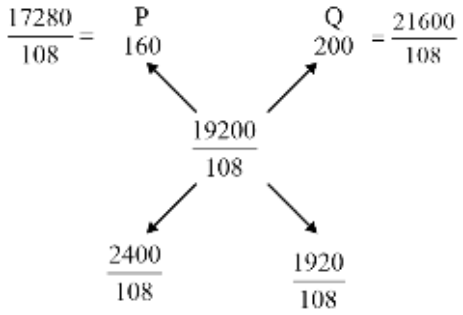
S.P = 192 kg ; Profit 8% ; $\frac{\text{S.P.}}{\text{C.P.}} = 1.08$

$\frac{192}{1.08} = \frac{19200}{108}$

C.P. of P = $\frac{800}{5} = 160 / \text{kg}$

C.P. of Q = $\frac{800}{4} = 200 / \text{kg}$

By mixture Rule




P:O = 2400 : 1920 = 5 : 4

**QUESTION-37 — MCQ** **1 Mark**

The president, along with the council of minister, _____to visit India Next week

(a) is wishing (b) Wish

(c) wishes (d) Will wish

**SOLUTION: (c)**

When the noun (The President) is singular the verb (wishes) goes plural.

**QUESTION-38 — MCQ** **1 Mark**

Consider a five digit number PQRST that has distinct digits P, Q, R, S and T and satisfies the following conditions:

P < Q

S > P > T

R < T

If integers 1 through 5 are used to construct such a number, the value of P is _____ .

(a) 1 (b) 2

(c) 3 (d) 4

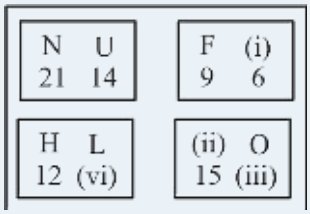
**SOLUTION: (c)**

Arranging according to given conditions in decreasing order of the values of P, Q, R, S, T.

Q or S, P, T, R stands for 1 or 2, 3, 4, 5 respectively. i.e., P = 3.

**QUESTION-39 — MCQ** **2 Marks**

In the context of the given figure which are of the following options represents the entities in the blocks labelled (i), (ii), (iii) and (iv) respectively?




(a) Q, M, 12 and 8 (b) L, K, 12 and 8

(c) K, L, 10 and 14 (d) I, J, 10 and 8

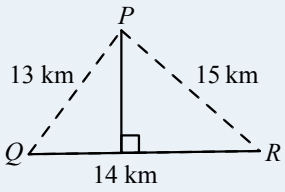
**SOLUTION: (d)**

The diagonal blocks represents the position of alphabets as given below:

| | | | |
|---|---|---|---|
| N | U | F | (i) |
| 21 | 14 | 9 | 6 |
| H | L | (ii) | O |
| 12 | (iv) | 15 | (iii) |

In alphabetical order N placed 14th Rank and U placed that 21st rank So similarly option 'd' is correct as per given logic.

**QUESTION-40 — MCQ** **2 Marks**

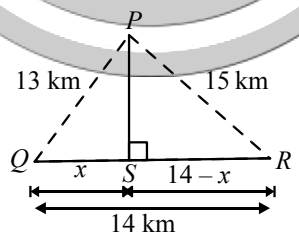



Three villages P, Q and R are located in such a way that the distance PQ = 13 km. QR = 14 km and RP = 15 km as shown in the figure. A straight road joins Q and R. It is proposed to connect P to this road QR by constructing another road. What is minimum possible length (km) of this connecting road? (**Note :** Figure shown is representative)

(a) 10.5 (b) 12.0

(c) 12.5 (d) 11.0

**SOLUTION: (b)**




In ΔPSR,

$$PS = \sqrt{15^2-(14-x)^2} = \sqrt{15^2-(14^2-28x+x^2)}$$

In ΔPSQ,

$$PS = \sqrt{13^2-x^2}$$

$$\Rightarrow \sqrt{15^2-14^2+28x-x^2} = \sqrt{13^2-x^2}$$

$$\Rightarrow 15^2-14^2+28x = 13^2$$

$\Rightarrow \quad 28x = 169 + 196 - 225$

$\Rightarrow \quad x = \frac{140}{28} = 5$

Now, In $\Delta PQS$,

$13^2 - 5^2 = PS^2$

i.e., $PS = 12$

**QUESTION-41 — NAT**

A Flood hydrograph of 3-hr laving peak flow is 180 $m^3$/sec. Base flow is 30 $m^3$/sec. Total precipitation during this 3-hrs is 6.6 cm and average infraction is 0.2 cm/hr. Find the peak of 3-hr U.H.

**SOLUTION: (25)**

Peak of FH = 180 $m^3/s$

B.F = 30$m^3/s$, $\phi$-index = 0.2 cm/hr

P = 6.6 cm $\rightarrow$ t = 3 hrs.

Peak of 3-hrVH = ?

$R = P - \phi t = 6.6 - (0.2 \times 3) = 6$ cm

Peak of 3-hr UH = $\frac{(\text{Peak of FH} - \text{B.F})}{\text{Rcm}} \times 1\text{cm}$

$= \frac{(180 - 30)}{6\text{cm}} \times 1\text{cm}$

= 25 $m^3/s$

**QUESTION-42 — MSQ**

Pick correct statement in the contest of upstream and down stream cut off provided below the concrete apron of weirs/barrages constructed (in)

(a) Bottom level of cut offs mainly depend on scour depth

(b) cut off are provided to ensure occurrence of hydraulic jump with the stilling basin

(c) cut off are provided to increase the seepage length to prevent failure due to piping

(d) cu off are provided to increase the rate of flow over the weir/barrage

**SOLUTION: (a, c)**

Bottom level of cut offs mainly depend on scour depth

cut off are provided to increase the seepage length to prevent failure due to piping

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## QUESTION-43 — MCQ

A circular tube of thickness 10 mm and diameter 250 mm is welded to a flat plate using 5 mm fillet weld all along circumference Assume Fe410 steel and shop welding

As per IS 800:2007, the torque in kN-m that can be applied.

(a) 65.1 (b) 78.1

(c) 156.2 (d) 130.2

**SOLUTION: (a)**

Given,

weld size (s) = 5 mm

$f_{wd}$ = 410 MPa

thickness of tube = 10 mm

diameter = 250 mm

$t_T = k \times s = 0.7 \times 5$

$= 3.5$ mm

Toque (T) that can be applied = $(f_{wd} \times l_w \times t_T) \times d/2$

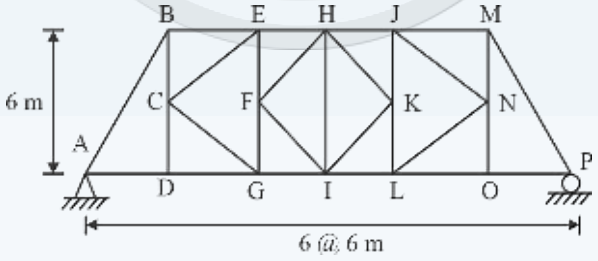
$$= \frac{410}{\sqrt{3} \times 1.25} \times \frac{\pi d^2 t_T}{2}$$

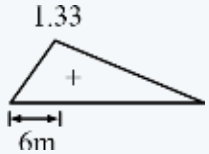
$$= \frac{410}{\sqrt{3} \times 1.25} \times \frac{\pi (250)^2 \times 3.5}{2} \times 10^{-6} \text{ kN-m}$$

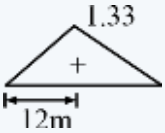
$= 65.07$ kN-m

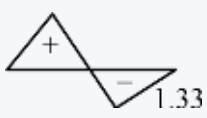
## QUESTION-44 — MCQ

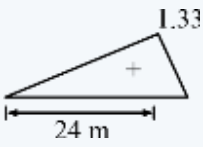
Consider the frame shown in the figure. The correct ILD for member GI will be



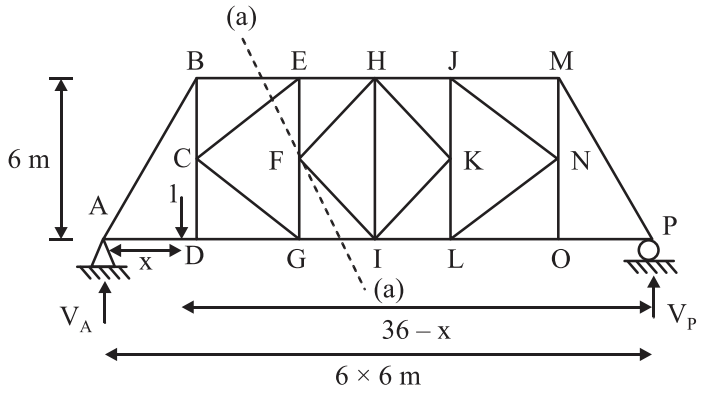

(a) 


(b) 


(c) 


(d) 

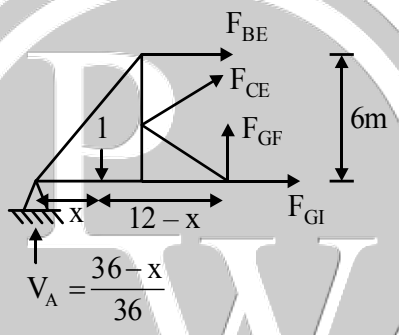
**SOLUTION: (b)**




$\Sigma M_P = 0 \quad V_A \times 36 - 1(36 - x) = 0$

$$\boxed{V_A = \frac{36-x}{36}}$$

When unit load is left of (a) – (a)




$\Sigma M_E = 0$

$V_A \times 12 - 1(12 - x) - F_{GI} \times 6 = 0$

$$\left(\frac{36-x}{36}\right)\times 12 - (12-x) = 6\,F_{GI}$$

$$\frac{36-x-36+3x}{3} = 6\,F_{GI}$$

$$\boxed{F_{GI} = \frac{2x}{18} = \frac{x}{9}}$$

$0 \le x \le 12$ m

$x = 0 \qquad F_{GI} = 0$

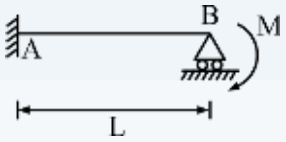
$x = 6$ m $\qquad F_{GI} = \frac{6}{9} = \frac{2}{3}$

$\boxed{x = 12} \qquad F_{GI} = \frac{12}{9} = \frac{4}{3} = 1.33$

Hence option d is correct.

**QUESTION-45 — MCQ**

The figure shows propped cantilever with uniform flexural rigidity EI (in N.m$^2$) and subjected to a moment in (in N-m). Consider forces and displacement in the upward direction as positive.




Find the upward reaction of the propped support B (in N) when this support settles by (–Δ) given in metres.

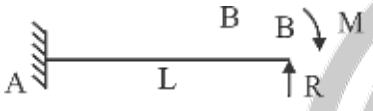
(a) $\frac{8M}{3L}-\frac{2EI\Delta}{L^3}$

(b) $\frac{3M}{2L}-\frac{3EI\Delta}{L^3}$

(c) $\frac{3M}{2L}-\frac{6EI\Delta}{L^3}$

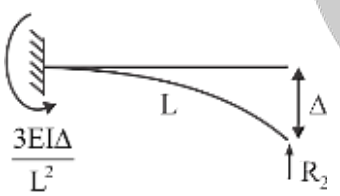
(d) $\frac{M}{L}-\frac{8EI\Delta}{L^3}$

**SOLUTION: (b)**




$\Delta_B = 0$

$$\frac{RL^3}{3EI}-\frac{ML^2}{2EI}=0$$




$$R_2\times L+\frac{3EI\Delta}{L^2}=0$$

$$\boxed{R_2=-\frac{3EI\Delta}{L^3}}$$

$\Rightarrow R = R_1 - R_2$

$$\Rightarrow R=\frac{3M}{2L}-\frac{3EI\Delta}{L^3}$$

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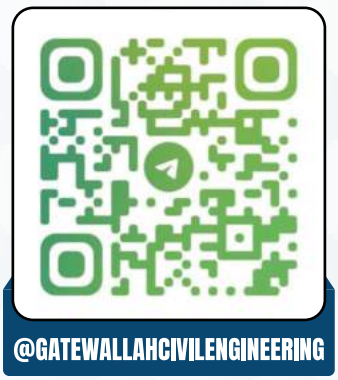

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