GATE WALLAH

CIVIL ENGINEERING

EXAM HELD ON

4th FEBRUARY 2024

MORNING SESSION

DETAILED SOLUTION BY TEAM

Civil Engineering

[NAT]

Q.1. An embankment is constructed with soil by maintaining the degree of saturation as 75% during compaction. The specific gravity of soil is 2.68 and the moisture content is 17% during compaction. Consider the unit weight of water as 10 kN/m^3. The dry unit weight (in kN/m^3) of the compacted soil is ________ (rounded off to 2 decimal places).

Sol. **(16.67)**

S.e = w.G

or $e = \frac{w.G}{S} = \frac{0.17 \times 2.68}{0.75} = 0.6075$

$\gamma_d = \frac{G.\,r_w}{1+e} = \frac{2.68 \times 10}{1+0.6075}$

= 16.67 kN/m^3

[MCQ]

Q.2. A car is travelling at a speed of 60 km/hr on a section of a National Highway having downward gradient of 2%. The driver of the car suddenly observes a stopped vehicle on the car path at a distance 130m ahead, and applies brake. If the brake efficiency is 60%, coefficient of friction is 0.7, driver's reaction time is 2.5 s and acceleration due to gravity is 9.81 m/s^2, the distance (in meters) required by the driver to bring the car to a safe stop lies in the range.

(a) 75 to 79
(b) 33 to 37
(c) 126 to 130
(d) 41 to 45

Sol. **(a)**

$f = 0.6 \times 0.7 = 0.42$

$\text{SSD} = 0.278\,V.\,t_R + \frac{V^2}{254(f - s\%)}$

$= 0.278 \times 60 \times 2.5 + \frac{(60)^2}{254(0.42 - 0.02)}$

= 77.133 m

[MCQ]

Q.3. The number of degrees of freedom for a natural open channel flow with a mobile bed is

(a) 2
(b) 5
(c) 3
(d) 4

Sol. **(d)**

For Rigid Boundary Channel, D.O.F = 1
For Mobile Boundary Channel, D.O.F = 4
(Bed width, Bed Slope, Depth and Layout can be independently changed)

Civil Engineering

[MCQ]

Q.4. Among the following statements relating the fundamental lines of transit theodolite, which one is CORRECT?

(a) The axis of altitude level must be perpendicular to the line of collimation.
(b) The line of collimation must be perpendicular to the horizontal axis at its intersection with the vertical axis.
(c) The axis of plate level must lie in a plane parallel to the vertical axis.
(d) The Vernier of vertical circle must read zero when the line of collimation is vertical.

Sol. **(b)**

The line of collimation must be perpendicular to the horizontal axis at its intersection with the vertical axis.

[MSQ]

Q.5. The elements that DO NOT increase the strength of structural steel are

(a) Manganese (b) Carbon
(c) Chlorine (d) Sulphur

Sol. **(c, d)**

Manganese and Carbon increases the strength of structural steel.

[MSQ]

Q.6. Consider a balanced doubly-reinforced concrete section. If the material and other sectional properties remain unchanged, for which of the following cases will the section becomes under-reinforced?

(a) Increase the area of compression reinforcement
(b) Decrease the area of tension reinforcement
(c) Decrease the area of compression reinforcement
(d) Increase the area of tension reinforcement

Sol. **(a, b)**

From the relation:

$0.36\, f_{ck}\, x_u\, b + (f_{sc} - 0.45\, f_{ck})\, A_{sc} = 0.87\, f_y\, A_{st}$

$$x_u = \frac{0.87\, f_y A_{st} - \left(f_{sc} - 0.45\, f_{ck}\right) A_{sc}}{0.36\, f_{ck} b}$$

[MCQ]

Q.7. If the number of sides resulting in a closed traverse is increased from three to four, the sum of the interior angles increases by

(a) 180° (b) 360°
(c) 90° (d) 270°

Sol. **(a)**

Sum of interior angles = (2n – 4) × 90

For 3 sides → Sum of interior angle = (2 × 3 – 4) × 90 = 180°

For 4 sides → Sum of interior angle = (2 × 4 – 4) × 90 = 360°

∴ Change in interior angle = 360° – 180°

= 180°

[NAT]

Q.8. A 30 cm diameter well fully penetrates an unconfined aquifer of saturated thickness 20 m with hydraulic conductivity of 10 m/day. Under the steady pumping rate for a long time, the drawdowns in two observations wells located at 10 m and 100 m from the pumping well are 5 m and 1 m respectively. The corresponding pumping rate (in m^3/day) from the well is _______ .

Sol. **(1855.217)**

$$Q = \frac{\pi K\left(h_2^2 - h_1^2\right)}{2.303\log_{10}\left(\frac{r_2}{r_1}\right)} = \frac{\pi \times 10\left(19^2 - 15^2\right)}{2.303\log_{10}\left(\frac{100}{10}\right)}$$

∴ Q = 1855.217 m^3/day

[NAT]

Q.9. Consider the data of f(x) given in the table.

i	0	1	2
x_i	1	2	3
$f(x_i)$	0	0.3010	0.4771

The value of f(1.5) estimated using second-order Newton's interpolation formula is __________ (rounded off to 2 decimal places.

Sol. **(0.17)**

i	0	1	2
x_i	1	2	3
$f(x_i)$	0	0.3010	0.4771

Newton's 2nd order Interpolation f (1.5) = ?

$$f(x) = f(x_1) + \frac{f(x_2) - f(x_1)}{x_2 - x_1}(x - x_1)$$

$$\frac{f(x_3) - f(x_2)}{x_3 - x_2} - \frac{f(x_2) - f(x_1)}{x_3 - x_1} \times (x - x_1)(x - x_2)$$

$$f(1.5) = 0.3010(0.5) + \frac{0.4771 - 2(0.3010)}{2} \times (0.5)(-0.5)$$

$$\Rightarrow f(1.5) = 0.166 \approx 0.17$$

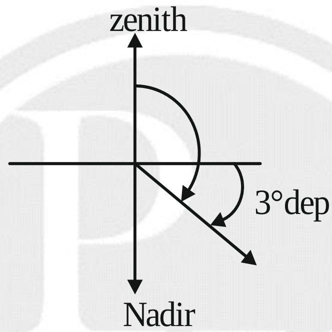
[MCQ]

Q.10. A surveyor observes a zenith angle of 93°00'00" during a theodolite survey. The corresponding vertical angle is

(a) – 03°00'00"
(b) + 03°00'00"
(c) + 87°00'00"
(d) – 87°00'00"

Sol. **(a)**

Zenith ∠ = 93°0'0"
Vertical ∠ = _______



[NAT]

Q.11. An infinite slope is made up of cohesionless soil with seepage parallel to and up to the sloping surface. The angle of slope is 30 degrees with respect to horizontal ground surface. The unit weight of the saturated soil and water are 20 kN/m^3 and 10 kN/m^3, respectively.
The minimum angle of shearing resistance of the soil (in degrees) for the critically stable condition of the slope is ___________ (rounded off to the nearest integer).

Sol. (49)

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

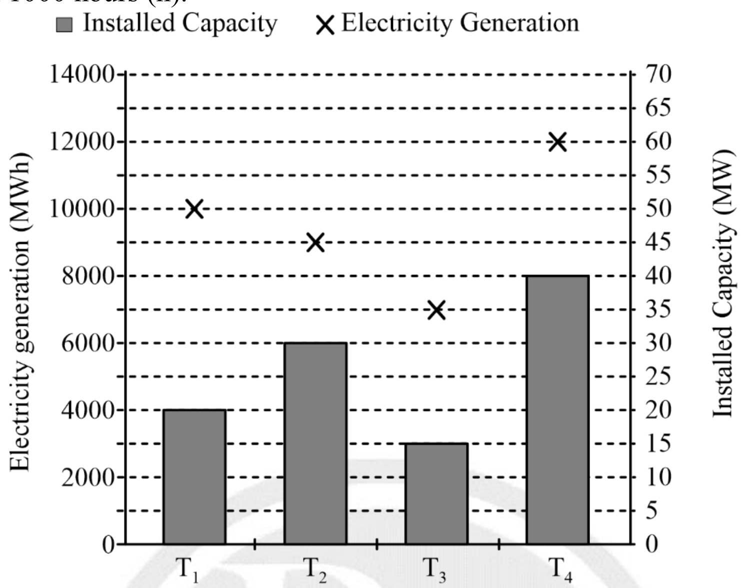
$$\therefore \gamma' = \gamma_{sat} - \gamma_w = 20 - 10 = 10 \text{ kN/m}^3$$

$$= \frac{10}{20} \times \frac{\tan\phi}{\tan 30} \geq 1$$

Solving, we get:
$\phi \geq 49.10°$

[MCQ]

Q.12. The chart given below compares the Installed Capacity (MW) of four power generation technologies. T_1. T_2.T_3 and T_4 and their Electricity Generation (MWh) in a time of 1000 hours (h).



The Capacity Factor of a power generation technology is:

$$\text{CapacityFactor} = \frac{\text{Electricity Generation (MWh)}}{\text{Installed Capacity (MW)} \times 100\text{(h)}}$$

Which one of the given technologies has highest Capacity Factor?

(a) T_2 (b) T_4

(c) T_1 (d) T_3

Sol. **(c)**

For T_1, Capacity Factor $= \frac{10,000}{20 \times 100} = 5$

For T_2, Capacity Factor $= \frac{9,000}{30 \times 100} = 3$

For T_3, Capacity Factor $= \frac{7,000}{15 \times 100} = 4.67$

For T_4, Capacity Factor $= \frac{12,000}{40 \times 100} = 3$

$\therefore$ Technology T_1 has highest capacity factor

[MCQ]

Q.13. On a given day how many times will the second hand the minute hand of a clock cross each other during the clock time 12:05:00 hours to 12:55:00 hours

(a) 51 (b) 49

(c) 55 (d) 50

Sol. **(b)**

Civil Engineering

[MCQ]

Q.14. For positive integers P and q with $\frac{P}{q} \neq 1. \left(\frac{p}{q}\right)^{\frac{p}{q}} = p^{\left(\frac{p}{q}-1\right)}$ Then.

(a) $q^p = p^{2q}$ (b) $q^p = p^q$

(c) $\sqrt{q} = \sqrt{p}$ (d) $\sqrt[p]{q} = \sqrt[q]{p}$

Sol. **(b)**

$$\frac{(p)^{p/q}}{(q)^{p/q}} = p^{(p/q)}P^{-1}$$

$$p = (q)^{p/q}$$

$$p^q = q^p$$

[MCQ]

Q.15. In a locality the houses are numbered in the following way

The hours number on one side of a road are consecutive odd integers starting from 301 while the hours numbers on the side of the road are consecutive even numbers starting from 302. The total number of houses is the same on both sides of the road.

If the difference of the sum of the hours numbers between the two sides of road is 27, then the number of houses on each of the road is

(a) 52 (b) 27

(c) 26 (d) 54

Sol. **(b)**

$S_1 = 302 + 304 + 306 \ldots.. + n$

$$Sn_1 = \frac{n}{2}\left[2a + (n-1)d\right]$$

$$= \frac{n}{2}\left[2 \times 302 + (n-1) \times 2\right]$$

$S_2 = 301 + 303 + 305 \ldots.. + n$

$$Sn_2 = \frac{n}{2}\left[2a + (n-1)d\right]$$

$$= \frac{n}{2}\left[2 \times 301 + (n-1) \times 2\right]$$

$Sn_1 = Sn_2 = 27$

$$\frac{n}{2}\left[2 \times 302 + (n-1) \times 2\right] - \frac{n}{2}\left[2 \times 301 + (n-1) \times 2\right] = 27$$

$n = 27$

[MCQ]

Q.16. Which one of the given options is a possible value of x in the following sequence?
3,7,15,x,63,127,255

(a) 31 (b) 45
(c) 35 (d) 40

Sol. **(a)**

3, 7, 15, x, 63, 127, 255
4 8 x–15 63–x 64 128

$x - 15 = 16$

$x = 31$

[MCQ]

Q.17. Three distinct sets of indistinguishable twins are to be seated at a circular table that has 8 identical chairs Unique seating arrangements are defined by the relative positions of the people.
How many unique seating arrangements are possible such that each person is sitting next to their twin?

(a) 14 (b) 12
(c) 28 (d) 10

Sol. **(b)**

[MCQ]

Q.18. The smallest positive root of the equation
$x^5 - 5x^4 - 10x^3 + 50x^2 + 9x - 45 = 0$
Lies in the range

(a) $2 > x \le 4$ (b) $0 > x \le$
(c) $10 \le x \le 100$ (d) $0 < x \le 2$

Sol. **(d)**

Smallest positive root of

$x^5 - 5x^4 - 10x^3 + 50x^2 + 9x - 45 = 0 \rightarrow a < x < b$

$f(a) \cdot f(b) < 0$

$f(0) < 0$

$f(2) = 32 - 80 - 80 + 200 + 18$

$= 45 > 0$

$\therefore$ Smallest root in $0 < x \le 2$

[NAT]

Q.19. The initial cost of an equipment is Rs. 10000. Its salvage value at the end of accounting life of 5 years is Rs. 10000. The difference in depreciation (in)s computed using double declining balance method and straight-line method of depreciation is years- 2 is_________.

Sol. **(6000)**

Double declining rate $= \frac{2}{n} = \frac{2}{5} = 0.4\ (40\%)$

$D_1 = 100000 \times 0.4 = 40000$

$B_1 = 100000 - 40000 = 60000$

$D_2 = 60000 \times 0.4 = 24000$

Line mtd = $D = \frac{C_i - C_s}{n} = \frac{100000 - 10000}{5}$ = ₹ 18000/year

Difference = 24000 – 18000 = 6000

[MCQ]

Q.20. A flow velocity field $\vec{V} : \vec{V}(x, y)$ for a fluid is represented by

$\vec{V} = 3i + (5x)j$

In the context of the fluid and the flow. Which one of the following statements is CORRECT?

(a) The fluid is compressible and the flow is rotational
(b) The fluid is compressible and the flow is irrotational
(c) The flow is incompressible and the flow is irrotational
(d) The flow is incompressible and the flow is rotational

Sol. **(d)**

$\vec{V} = \underset{u}{3\hat{i}} + \underset{v}{(5x)\hat{j}}$

$\nabla \cdot \vec{V} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$

$\Rightarrow$ Incompressible

$\nabla \cdot \vec{V}\Big|_{\text{for two variable}} = \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)\hat{k} = 5\hat{k} \neq \vec{0}$

$\Rightarrow$ Flow is rotational.

Civil Engineering

[NAT]

Q.21. The total primary consolidation settlement (S_c) of a building constructed on a 10 m thick saturated clay layer is estimated to be 50 mm. After 300 days of the construction of the building primary consolidation settlement was reported as 10 mm. The additional time (in days) required to achieve 50% of S_C will be ____________ (rounded off the nearest integer)

Sol. **(1575)**

H = 10 m

$\Delta h_1 = 10$ mm, $t_1 = 300$ day

$\Delta H = 50$ mm

Additional time required for 50% settlement

$$U_1 = \frac{\Delta h_1}{\Delta H} \times 100 = 20\%$$

$U_1, U_2 < 60\%$

$$T_r = \frac{C_v t}{H^2} = \pi/4\, U^2$$

$$\frac{t_2}{t_1} = \frac{U_2^2}{U_1^2}$$

$$\Rightarrow t_2 = \left(\frac{0.5}{0.2}\right)^2 \times 300$$

= 1875 days

Additional time (t) = t = $t_2 - t_1$ = 1785 – 300

= 1575 day

[NAT]

Q.22. The return period of a large earthquake for a given region is 200 years. Assuming that earthquake occurrence follows Poisson's distribution the probability that it will be exceeded at least once is 50 years is __________.
(rounded off to the two decimal places)

Sol. **(0.22)**

T = 200 years

$$P = \frac{1}{T} = \frac{1}{200}$$

Mean (λ) = np = $50 \times \frac{1}{200} = 0.25$

P (x ≥ 1) = 1 – P (x = 0)

Civil Engineering

$$= 1 - \frac{\lambda^r e^{-\lambda}}{0!}$$

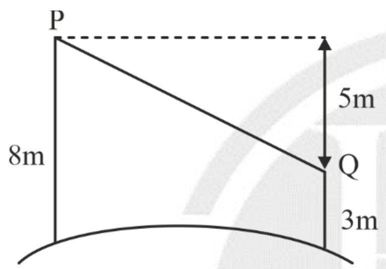
$$= 1 - \frac{0.25^0 \times e^{-\lambda}}{0!}$$

$$= 1 - e^{-0.25} = 0.22$$

[NAT]

Q.23. A bird is resting on a point P at a height of 8 m above the Menn Sen Level (MSL). Upon hearing a load noise. The bird flies parallel to the ground surface and reaches a point Q which is located at a height of 3 above MSL. The ground surface has a falling gradient of 1 in 2 Ignoring the effects of curvature and refraction. The horizontal distance (in meters) between points P and Q is ___________ (in integer)

Sol. **(10)**



Given,
1 in 2
5 vertical = 10 m horizontal

[MCQ]

Q.24. A vertical smooth rigid retaining wall is supporting horizontal ground with dry cohesionless back having a friction angle of 30°, The inclinations of failure planes with respect to the major principal plane for Rankine's active and passive earth pressure conditions, respectively are

(a) 30° and 30°
(b) 30° and 60°
(c) 60° and 60°
(d) 60° and 30°

Sol. **(d)**

For active pressure,

$\theta_c = 45° + \theta/2 = 45° + 30°/2 = 60°$

For passive pressure,

$\theta_c = 45° - \theta/2 = 45° - 30°/2 = 30°$

[MCQ]

Q.25. Which of the following statements (s) is /are CORRECT?

(a) In electrical resistivity tomography the depth of current penetration is half of the spacing between the electrodes.

(b) Both loose and dense sands with different initial void ratios can attain similar void ratio at large strain during shearing

(c) Swell potential of soil decreases with an increase in the shrinkage limit

(d) Among the several corrections to be applied to the SPT-N value the dilatancy

Sol. **(b)**

Both loose and dense sands with different initial void ratios can attain similar void ratio at large strain during shearing

[MCQ]

Q.26. For assessing the compliance with the emissions standards of incineration plants a correction needs to be applied to the measured concentrations of air pollutants. The emission standard (based on 11% Oxygen) for HCI is 50 mg/Nm^3 and the measured concentrations of HCI and Oxygen in the flue gas are 42 mg/Nm^3 and 13% respectively. Assuming 21% Oxygen in air the CORRECT statement is:

(a) No compliance as the corrected HCI emission is greater than the emission standard

(b) Compliance is the as there is no need to apply the correction since Oxygen is greater than 11% and HCI emission is less than the emission standard.

(c) No compliance as the Oxygen is greater than 11% in the flue gas

(d) Compliance is there as the corrected HCI emission is lesser than the emission standard

Sol. **(b)**

Compliance is the as there is no need to apply the correction since Oxygen is greater than 11% and HCI emission is less than the emission standard.

[NAT]

Q.27. A water treatment plant treats 35 MLD water with a natural alkalinity of 4.0 mg/L (as $CaCO_3$)

It is estimated that during coagulation of this water. 400 kg/day of calcium bicarbonate ($Ca(HCO_3)_2$) is required based on the alum dosage.

Consider the atomic weights as : Ca – 40, H – 1, C – 12, O – 16

The quantity of pure quick lime, CaO (in kg) required for this process per day is __________(rounded off to 2 decimal places)

Sol. **(82.27)**

Molecular weight of $Ca(HCO_3)_2$ is

$40 + 2\ (1 + 12 + 48)$

$40 + 2\ (61) = 162$

Amount of coagulant in terms of $CaCO_3$ is given as

$$\frac{\frac{400}{162}}{2}\times 50$$

$= 246.91$ kg/d

$$=\frac{56}{100}\times (\text{Alk})_{\text{defines}}$$

$$=\frac{56}{100}\times(246.91-100)$$

$= 82.27$ kg/d

[NAT]

Q.28. Activated carbon is used to remove a pollutant from wastewater in a mixed reactor, which follows first order reaction kinetics
At a reaction rate of 0.38 / day the time (in day) required to remove the by 95% is ___________ (rounded off to 1 decimal place)

Sol. **(50)**

CMFR

$$C_0=\frac{C}{1+kt}$$

$$\frac{1}{1+kt}=\frac{C_0}{C}$$

$$\eta=\frac{C_0-C}{C_0}\times 100$$

$$\eta=\frac{1-C}{C_0}\times 100$$

$$0.95=1-\frac{C}{C_0}$$

$$\frac{C}{C_0}=1-0.95=0.05$$

$$\frac{1}{1+kt}=0.05$$

$$\frac{1}{1+0.38\times t}=0.05$$

t = 50 days

Civil Engineering

[NAT]

Q.29. A slab panel with an effective depth of 250 mm is reinforced with 0.2% main reinforcement using 8mm diameter steel bars. The uniform center to center spacing (in mm) at which the 8 mm diameter bars are placed in the slab panel is ____________ (rounded off to the nearest integer)

Sol. **(100)**

Slab $\rightarrow$ d = 250 mm $\simeq$ D

ϕ = 8 mm

$$\text{Ast} = 0.2\% = \frac{0.2 \times 250 \times 1000}{100} = 500 \text{ mm}^2$$

$$S \le \text{leser of} \begin{cases} \frac{1000}{\text{Ast}} \times \frac{\pi}{4}\phi^2 \\ 3d \\ 300 \text{ mm} \end{cases}$$

= 100.53 mm

Round off to nearest integer so answer is 100 mm.

[NAT]

Q.30. A soil sample was consolidated at a cell pressure of 20 kPa and a back pressure of 10 kPa for 24 hours during a consolidated undrained (CU) triaxial test. The cell pressure was increased to 30 kPa on the next day and it resulted in the development of pore water pressure of 1 kPa. The soil sample failed when the axial stress was gradually increased to 50 kPa. The pore water pressure at failure was recorded as 21 kPa. The value of Skempton's pore pressure parameter B for The soil sample is __________ (rounded off 2 decimal places)

Sol. **(0.10)**

Initial cell pressure $\sigma_3^i = 20$ kPa

Backpressure = 10 kPa

Final cell pressure $\sigma_3^f = 30$ kPa

$\Delta U_c = 1$ kPa

Skempton's pore pressure parameter $B = \frac{\Delta U_c}{\Delta \sigma_3} = \frac{1}{10} = 0.10$

Civil Engineering

[MCQ]

Q.31. What are the eigenvalues of the matrix $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 4 & 1 \\ 1 & 1 & 2 \end{bmatrix}$?

(a) 1,3,4 (b) – 5, - 1, 2

(c) 1,2,5 (d) 1,3,5

Sol. **(c)**

$|A - \lambda I| = 0$

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 4 & 1 \\ 1 & 1 & 2 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

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

$\lambda = 1, 2, 5$

[MCQ]

Q.32. A map is prepared with a scale of 1: 1000 and a contour interval of 1 m. If the distance between two adjacent contour on the map is 10 mm. the slope of the ground between the adjacent contours is

(a) 35% (b) 30 %

(c) 10% (d) 40%

Sol. **(c)**

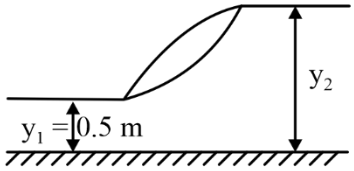
1: 1000
C.I = 1 m
H2 = 10 mm
1 : 1000
↓ ↓
1 mm 1 m
Plan G
10 m Horizontal distance
1 Vertical distance
G = 1/100 × 1000 = 10%

[NAT]

Q.33. A spillway has unit discharge of $7.5 m^3/s/m$. The flow depth at the downstream horizontal apron is m. The tail water depth (in meters) required to from a hydraulic jump is __________(rounded off to 2 decimal places)

Sol. **(4.55)**

$$F_{r1} = \frac{V_1}{\sqrt{gy_1}} \Rightarrow V_1 = g / y_1$$



$q = 7.5\ m^2/s/m$

$$\frac{y_2}{y_1} = \frac{1}{2}\left[-1 + \sqrt{8F_{r1}^2 + 1}\right]$$

= 7.5/05 = 15

$$F_{r1} = \frac{V_1}{\sqrt{gy_1}}$$

$$= \frac{15}{\sqrt{9.81 \times 0.5}}$$

= 6.77

$$\frac{y_2}{0.5} = \frac{1}{2}\left[-1 + \sqrt{8 \times 6.77 + 1}\right] \Rightarrow y_2 = 4.55\text{m}$$

[NAT]

Q.34. The following data is obtained from an axle load survey at a site:
Average rear axle load = 12000 kg
Number of commercial vehicles = 800 per day
The pavement at the site would be reconstructed over a period of 5 years from the date of survey, The design life of the reconstructed pavement is 15 year. Use the standard axle load as 8160 kg and the annual average vehicle growth rate as 4.0% Assume that Equivalent Wheel Load Factor (EWLF) and Vehicle Damage Factor (VDF) are equal. The cumulative standard axle (in msa) for the pavement design is _________ (rounded off to 2 decimal places)

Sol. **(32.02)**

Axel load = 12000 kg

P = 800 CVPD

$X = 5$ years

n = 15 years

Standard Axel (L_S) $= 8160 \nless g$

r = 4%

EALF = VDF

N(MSA)

As per IRC : 37

$$N = \frac{365 \times A\left[\left(1+\frac{r}{100}\right)^n - 1\right] \times VDF \times LDF \times FOS}{100}$$

$$A = P\left[1+\frac{r}{100}\right]^x$$

$$A = 800\left[1+\frac{4}{100}\right]^5 = 935.886 \text{ CPVD}$$

$$N = \frac{365 \times 935.866\left[\left(1+\frac{4}{100}\right)^{15} - 1\right] \times 1}{0.04 \times 10^6} \times \left(\frac{12000}{8160}\right)^4$$

$N = 32.02$

[MCQ]

Q.35. Concrete of characteristic strength 30 MPa is required. If 40 specimens of concrete cubes are to be tested, the minimum number of specimens having at least 30 MPa strength should be:

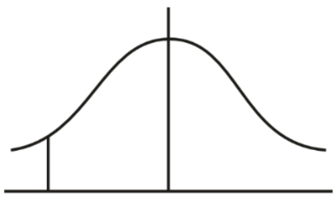
(a) 38 (b) 39

(c) 35 (d) 37

Sol. **(a)**

$F_{ck} = 30$ MPa
n = 40 specimens

→ How many specimens are the at least having strength of 30 MPa?



$f > f_{ck} \Rightarrow$
95%
$\Rightarrow$ 95% of 40
= 38 Specimens

[NAT]

Q.36. The ordinates of 1 hr UH are:

Time (hr)	0	1	2	3	4	5	6	7	8	9	10	11
Ordinates (m^3/s)	0	13	50	60	95	85	55	35	15	10	3	0

These ordinates are used to derive 3-hr UH. The peak discharge in (m^3/s). For the derived 3-hr UH is ________. (Round off to the nearest integer).

Sol. **(87)**

t	Q			DRH	Peak 3-hr UH
0	0				
1	13	0			
2	50	13	0		
3	80	50	13		
4	94	80	50		
5	85	95	80	260	$260/3 = 86.66 \approx 87$
6	55	85	95		
7	35	55	85		
8	15	35	55		
9	10	15	35		
10	3	10	15		
11	0	3	10		
		0	3		
			0		

[MCQ]

Q.37. $$\sigma = \begin{bmatrix} 10 & 0 & 0 \\ 0 & 40 & 0 \\ 0 & 0 & 0 \end{bmatrix} \text{MPa}$$

Maximum shear stress at the point is ______ MPa.

(a) 15
(b) 5
(c) 20
(d) 30

Sol. **(c)**

$$\begin{bmatrix} 10 & 0 & 0 \\ 0 & 40 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\tau_{max} = \frac{40}{2}, \frac{10}{2}, \frac{40-10}{2}$$

$$\tau_{max} = 20$$

Civil Engineering

[MCQ]

Q.38. The free mean speed is 60 km/hr on a given road. The average space headway at jam density on the road is 8 m. For a linear speed density relationship the maximum flow (in veh/hr/lane) expected on the road is

(a) 1875 (b) 1038
(c) 938 (d) 2075

Sol. **(a)**

Traffic question

Space headway at jam density = 8m

V_{st} = 60 kmph

Q_{max} = ?

$$K_j = \frac{1000}{5} = \frac{100}{8} = 125$$

Greenshield's

$$q_{max} = \frac{V_{st} \cdot K_j}{4}$$

$$= \frac{60 \times 125}{4}$$

$$q_{max} = 1875 \frac{veh}{hr}$$

[MCQ]

Q.39. Runway length of airport increases by x% for every increase in height of y m. The values of x and y are respectively

(a) x is 10% and y is 200 m (b) x is 7% and y is 300 m
(c) x is 20% and y is 400 m (d) x is 10% and y is 200 m

Sol. **(b)**

Runway length of airport increases by 7% for every increase in height of 200 m from Mean Sea Level

[MCQ]

Q.40. For second order partial differential equation

$$\frac{\partial^2 u}{\partial x^2} = 2$$

(a) $u = x^2 + f(y) + yg(x)$ (b) $u = x^2 + f(y) + g(x)$
(c) $u = x^2 + xf(y) + g(x)$ (d) $u = x^2 + xf(y) + h(y)$

Sol. **(d)**

$$\int \frac{\partial^2 u}{\partial x^2} = 2$$

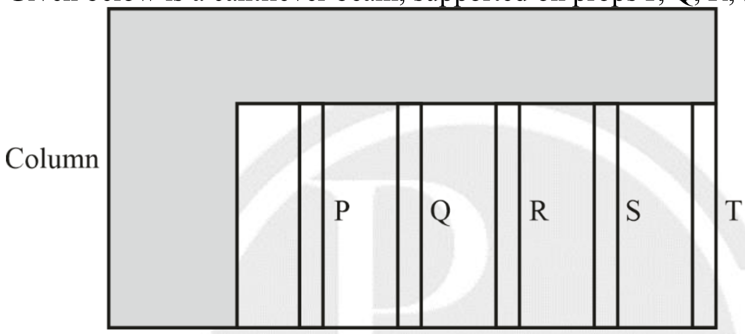
$$\frac{\partial u}{\partial x} = 2\int 1dx + f(y)$$

$$\frac{\partial u}{\partial x} = 2x + f(y)$$

$$u = x^2 + xf(y) + h(y)$$

[MCQ]

Q.41. Given below is a cantilever beam, supported on props P, Q, R, S, T during casting



The order in which props PQRST will be removed

(a) T-S-R-Q-P (b) P-Q-R-S-T

(c) P-S-R-Q-T (d) R-Q-T-P-S

Sol. **(a)**

[MCQ]

Q.42. A 2m wide strip footing is founded at a depth of 1.5 m below the ground level in a homogeneous pure clay bad. The clay bed has unit cohesion of 40 kPa. Due to seasonal fluctuations of water table from peak summer to peak monsoon period. The net ultimate bearing capacity of the footing as per Terzaghi's theory will

(a) remain the same (b) become zero

(c) decreases (d) increases]

Sol. **(a)**

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

$$q_u = 5.7C + \gamma D_f$$

$$q_{nu} = 5.7C$$

Water table, $q_{nu} = 5.7C'$

$C = C'$

PW GATE WALLAH SOLDIERS

THANK YOU