CE : CIVIL ENGINEERING

Duration: Three Hours *Maximum Marks*: 100

Read the following instructions carefully.

1. Write your name and registration number in the space provided at the bottom of this page.
2. Take out the **O**ptical **R**esponse **S**heet (**ORS**) from this Question Booklet **without breaking the seal**.
3. Do not open the seal of the Question Booklet until you are asked to do so by the invigilator.
4. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **ORS**. Also, using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your test paper code (CE).
5. This Question Booklet contains **20** pages including blank pages for rough work. After opening the seal at the specified time, please check all pages and report discrepancy, if any.
6. There are a total of 65 questions carrying 100 marks. All these questions are of objective type. Questions must be answered on the left hand side of the **ORS** by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number. **For each question darken the bubble of the correct answer**. In case you wish to change an answer, erase the old answer completely. More than one answer bubbled against a question will be treated as an incorrect response.
7. Questions Q.1 – Q.25 carry 1-mark each, and questions Q.26 – Q.55 carry 2-marks each.
8. Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated.
9. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 carry 1-mark each, and questions Q.61 – Q.65 carry 2-marks each. The GA questions begin on a fresh page starting from page **13**.
10. Unattempted questions will result in zero mark and wrong answers will result in **NEGATIVE** marks. For Q.1 – Q.25 and Q.56 – Q.60, ⅓ mark will be deducted for each wrong answer. For Q.26 – Q.51 and Q.61 – Q.65, ⅔ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair, i.e. for Q.52 and Q.54, ⅔ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.
11. Calculator is allowed whereas charts, graph sheets or tables are **NOT** allowed in the examination hall.
12. Rough work can be done on the question paper itself. Additionally, blank pages are provided at the end of the question paper for rough work.

Name								
Registration Number	**CE**							

Q. 1 – Q. 25 carry one mark each.

Q.1 [A] is a square matrix which is neither symmetric nor skew-symmetric and $[A]^T$ is its transpose. The sum and difference of these matrices are defined as $[S] = [A] + [A]^T$ and $[D] = [A] - [A]^T$, respectively. Which of the following statements is **TRUE**?

(A) Both [S] and [D] are symmetric
(B) Both [S] and [D] are skew-symmetric
(C) [S] is skew-symmetric and [D] is symmetric
(D) [S] is symmetric and [D] is skew-symmetric

Q.2 The square root of a number N is to be obtained by applying the Newton Raphson iterations to the equation $x^2 - N = 0$. If i denotes the iteration index, the correct iterative scheme will be

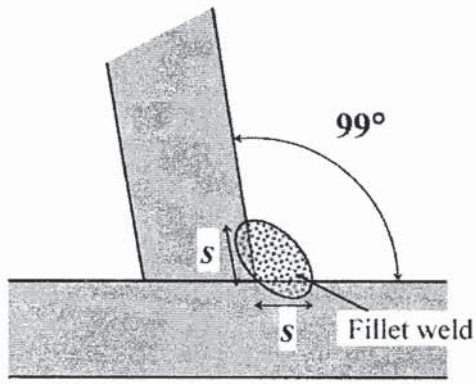
(A) $x_{i+1} = \frac{1}{2}\left(x_i + \frac{N}{x_i}\right)$ (B) $x_{i+1} = \frac{1}{2}\left(x_i^2 + \frac{N}{x_i^2}\right)$

(C) $x_{i+1} = \frac{1}{2}\left(x_i + \frac{N^2}{x_i}\right)$ (D) $x_{i+1} = \frac{1}{2}\left(x_i - \frac{N}{x_i}\right)$

Q.3 There are two containers, with one containing 4 Red and 3 Green balls and the other containing 3 Blue and 4 Green balls. One ball is drawn at random from each container. The probability that one of the balls is Red and the other is Blue will be

(A) 1/7 (B) 9/49 (C) 12/49 (D) 3/7

Q.4 For the fillet weld of size 's' shown in the adjoining figure the effective throat thickness is



(A) 0.61 s (B) 0.65 s (C) 0.70 s (D) 0.75 s

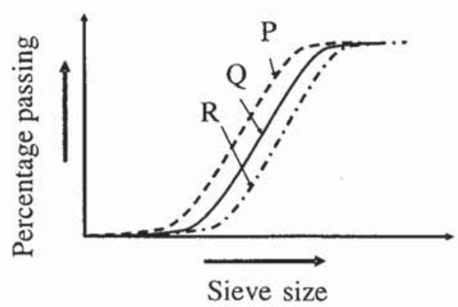
Q.5 A 16 mm thick plate measuring 650 mm × 420 mm is used as a base plate for an ISHB 300 column subjected to a factored axial compressive load of 2000 kN. As per IS 456-2000, the minimum grade of concrete that should be used below the base plate for safely carrying the load is

(A) M15 (B) M20 (C) M30 (D) M40

Q.6 Consider a reinforcing bar embedded in concrete. In a marine environment this bar un uniform corrosion, which leads to the deposition of corrosion products on its surface a increase in the apparent volume of the bar. This subjects the surrounding concrete to expansi pressure. As a result, corrosion induced cracks appear at the surface of concrete. Which of the following statements is **TRUE**?

(A) Corrosion causes circumferential tensile stresses in concrete and the cracks will be parallel to the corroded reinforcing bar.
(B) Corrosion causes radial tensile stresses in concrete and the cracks will be parallel to the corroded reinforcing bar.
(C) Corrosion causes circumferential tensile stresses in concrete and the cracks will be perpendicular to the direction of the corroded reinforcing bar.
(D) Corrosion causes radial tensile stresses in concrete and the cracks will be perpendicular to the direction of the corroded reinforcing bar.

Q.7 The results for sieve analysis carried out for three types of sand, P, Q and R, are given in the adjoining figure. If the fineness modulus values of the three sands are given as FM_P, FM_Q and FM_R, it can be stated that

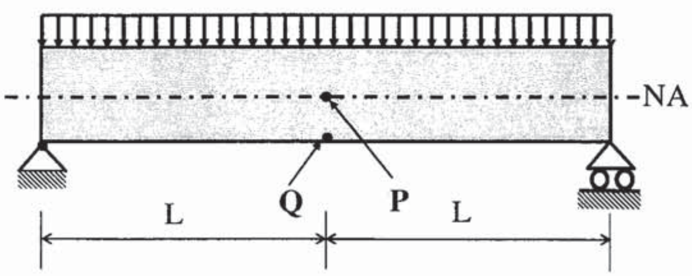


(A) $FM_Q = \sqrt{FM_P \times FM_R}$
(B) $FM_Q = 0.5\,(FM_P + FM_R)$
(C) $FM_P > FM_Q > FM_R$
(D) $FM_P < FM_Q < FM_R$

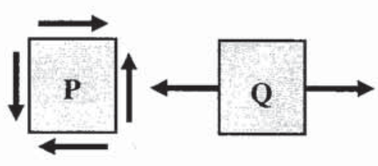
Q.8 The cross-section of a thermo-mechanically treated (TMT) reinforcing bar has

(A) soft ferrite-pearlite throughout.
(B) hard martensite throughout.
(C) a soft ferrite-pearlite core with a hard martensitic rim.
(D) a hard martensitic core with a soft pearlite-bainitic rim.

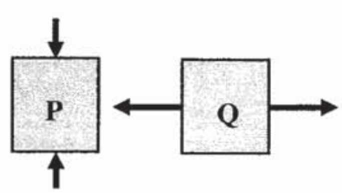
Q.9 Consider a simply supported beam with a uniformly distributed load having a neutral axis (NA) as shown. For points P (on the neutral axis) and Q (at the bottom of the beam) the state of stress is best represented by which of the following pairs?



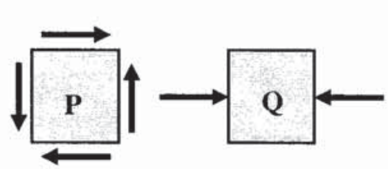
(A)



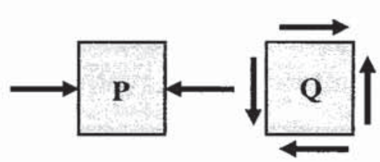
(B)



(C)



(D)



Q.10 For a saturated sand deposit, the void ratio and the specific gravity of solids are 0.70 respectively. The critical (upward) hydraulic gradient for the deposit would be

(A) 0.54 (B) 0.98 (C) 1.02 (D) 1.87

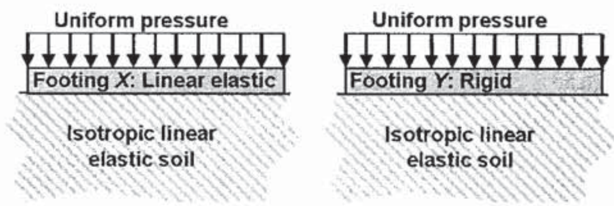
Q.11 Likelihood of general shear failure for an isolated footing in sand decreases with

(A) decreasing footing depth
(B) decreasing inter-granular packing of the sand
(C) increasing footing width
(D) decreasing soil grain compressibility

Q.12 For a sample of dry, cohesionless soil with friction angle, ϕ, the failure plane will be inclined to the major principal plane by an angle equal to

(A) ϕ (B) 45° (C) $45° - \phi/2$ (D) $45° + \phi/2$

Q.13 Two geometrically identical isolated footings, X (linear elastic) and Y (rigid), are loaded identically (shown alongside). The soil reactions will



(A) be uniformly distributed for Y but not for X
(B) be uniformly distributed for X but not for Y
(C) be uniformly distributed for both X and Y
(D) not be uniformly distributed for both X and Y

Q.14 A soil is composed of solid spherical grains of identical specific gravity and diameter between 0.075 mm and 0.0075 mm. If the terminal velocity of the largest particle falling through water without flocculation is 0.5 mm/s, that for the smallest particle would be

(A) 0.005 mm/s (B) 0.05 mm/s (C) 5 mm/s (D) 50 mm/s

Q.15 A watershed got transformed from rural to urban over a period of time. The effect of urbanization on storm runoff hydrograph from the watershed is to

(A) decrease the volume of runoff
(B) increase the time to peak discharge
(C) decrease the time base
(D) decrease the peak discharge

Q.16 For a given discharge, the critical flow depth in an open channel depends on

(A) channel geometry only
(B) channel geometry and bed slope
(C) channel geometry, bed slope and roughness
(D) channel geometry, bed slope, roughness and Reynolds number

Q.17 For a body completely submerged in a fluid, the centre of gravity (G) and centre of Buoyancy (O) are known. The body is considered to be in stable equilibrium if

(A) O does not coincide with the centre of mass of the displaced fluid
(B) G coincides with the centre of mass of the displaced fluid
(C) O lies below G
(D) O lies above G

Q.18 The flow in a horizontal, frictionless rectangular open channel is supercritical. A smooth [hump is] built on the channel floor. As the height of hump is increased, choked condition is attained [. With] further increase in the height of the hump, the water surface will

(A) rise at a section upstream of the hump
(B) drop at a section upstream of the hump
(C) drop at the hump
(D) rise at the hump

Q.19 Consider the following unit processes commonly used in water treatment; rapid mixing (RM), flocculation (F), primary sedimentation (PS), secondary sedimentation (SS), chlorination (C) and rapid sand filtration (RSF). The order of these unit processes (first to last) in a conventional water treatment plant is

(A) PS$\rightarrow$RSF$\rightarrow$F$\rightarrow$RM$\rightarrow$SS$\rightarrow$C
(B) PS$\rightarrow$F$\rightarrow$RM$\rightarrow$RSF$\rightarrow$SS$\rightarrow$C
(C) PS$\rightarrow$F$\rightarrow$SS$\rightarrow$RSF$\rightarrow$RM$\rightarrow$C
(D) PS$\rightarrow$RM$\rightarrow$F$\rightarrow$SS$\rightarrow$RSF$\rightarrow$C

Q.20 Anaerobically treated effluent has MPN of total coliform as 10^6 / 100 mL. After chlorination, the MPN value declines to 10^2 / 100 mL. The percent removal (%R) and log removal (log R) of total coliform MPN is

(A) %R = 99.90; log R = 4
(B) %R = 99.90; log R = 2
(C) %R = 99.99; log R = 4
(D) %R = 99.99; log R = 2

Q.21 Consider four common air pollutants found in urban environments, NO, SO_2, Soot and O_3. Among these which one is the secondary air pollutant?

(A) O_3
(B) NO
(C) SO_2
(D) Soot

Q.22 The probability that k number of vehicles arrive (i.e. cross a predefined line) in time t is given as $(\lambda t)^k e^{-\lambda t}/k!$, where λ is the average vehicle arrival rate. What is the probability that the time headway is greater than or equal to time t_1?

(A) $\lambda e^{\lambda t_1}$
(B) λe^{-t_1}
(C) $e^{\lambda t_1}$
(D) $e^{-\lambda t_1}$

Q.23 A vehicle negotiates a transition curve with uniform speed v. If the radius of the horizontal curve and the allowable jerk are R and J, respectively, the minimum length of the transition curve is

(A) $R^3/(vJ)$
(B) $J^3/(Rv)$
(C) v^2R/J
(D) $v^3/(RJ)$

Q.24 In Marshall testing of bituminous mixes, as the bitumen content increases the *flow* value

(A) remains constant
(B) decreases first and then increases
(C) increases monotonically
(D) increases first and then decreases

Q.25 Curvature correction to a staff reading in a differential leveling survey is

(A) always subtractive
(B) always zero
(C) always additive
(D) dependent on latitude

Q. 26 to Q. 55 carry two marks each.

Q.26 For an analytic function, $f(x+iy)=u(x,y)+i\,v(x,y)$, u is given by $u=3x^2-3y^2$. expression for v, considering K to be a constant is

(A) $3y^2-3x^2+K$ (B) $6x-6y+K$ (C) $6y-6x+K$ (D) $6xy+K$

Q.27 What should be the value of λ such that the function defined below is continuous at $x=\pi/2$?

$$f(x)=\begin{cases}\dfrac{\lambda\cos x}{\dfrac{\pi}{2}-x} & \text{if } x\neq \pi/2\\[2ex] 1 & \text{if } x=\pi/2\end{cases}$$

(A) 0 (B) $2/\pi$ (C) 1 (D) $\pi/2$

Q.28 What is the value of the definite integral, $\displaystyle\int_0^a \frac{\sqrt{x}}{\sqrt{x}+\sqrt{a-x}}\,dx$?

(A) 0 (B) a/2 (C) a (D) 2a

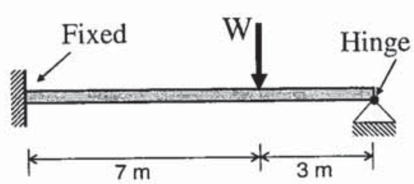
Q.29 If $\vec{a}$ and $\vec{b}$ are two arbitrary vectors with magnitudes a and b, respectively, $\left|\vec{a}\times\vec{b}\right|^2$ will be equal to

(A) $a^2b^2-\left(\vec{a}\cdot\vec{b}\right)^2$ (B) $ab-\vec{a}\cdot\vec{b}$ (C) $a^2b^2+\left(\vec{a}\cdot\vec{b}\right)^2$ (D) $ab+\vec{a}\cdot\vec{b}$

Q.30 The solution of the differential equation $\dfrac{dy}{dx}+\dfrac{y}{x}=x$, with the condition that $y=1$ at $x=1$, is

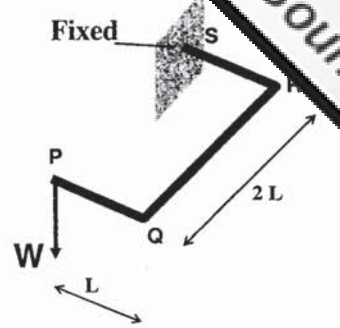
(A) $y=\dfrac{2}{3x^2}+\dfrac{x}{3}$ (B) $y=\dfrac{x}{2}+\dfrac{1}{2x}$ (C) $y=\dfrac{2}{3}+\dfrac{x}{3}$ (D) $y=\dfrac{2}{3x}+\dfrac{x^2}{3}$

Q.31 The value of W that results in the collapse of the beam shown in the adjoining figure and having a plastic moment capacity of $\boldsymbol{M_p}$ is



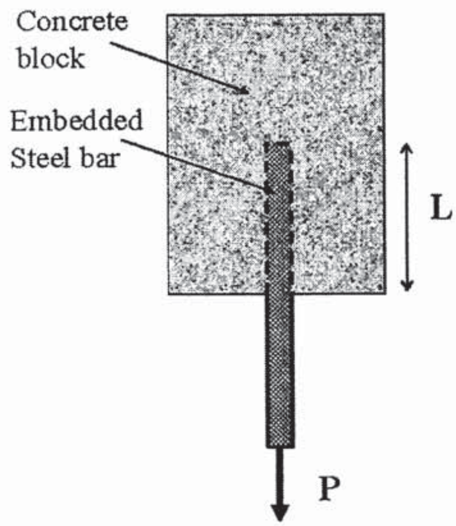
(A) $(4/21)\,\boldsymbol{M_p}$ (B) $(3/10)\,\boldsymbol{M_p}$ (C) $(7/21)\,\boldsymbol{M_p}$ (D) $(13/21)\,\boldsymbol{M_p}$

Q.32 For the cantilever bracket, PQRS, loaded as shown in the adjoining figure (PQ = RS = L, and, QR = 2L), which of the following statements is **FALSE**?



(A) The portion RS has a constant twisting moment with a value of 2WL.
(B) The portion QR has a varying twisting moment with a maximum value of WL.
(C) The portion PQ has a varying bending moment with a maximum value of WL.
(D) The portion PQ has no twisting moment.

Q.33 Consider a bar of diameter 'D' embedded in a large concrete block as shown in the adjoining figure, with a pull out force P being applied. Let σ_b and σ_{st} be the bond strength (between the bar and concrete) and the tensile strength of the bar, respectively. If the block is held in position and it is assumed that the material of the block does not fail, which of the following options represents the maximum value of P?



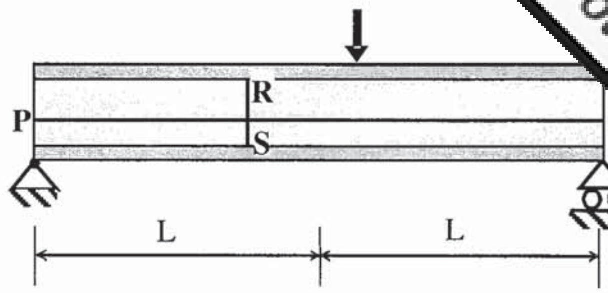
(A) Maximum of $\left(\frac{\pi}{4}D^2\sigma_b\right)$ and $(\pi DL\sigma_{st})$ (B) Maximum of $\left(\frac{\pi}{4}D^2\sigma_{st}\right)$ and $(\pi DL\sigma_b)$

(C) Minimum of $\left(\frac{\pi}{4}D^2\sigma_{st}\right)$ and $(\pi DL\sigma_b)$ (D) Minimum of $\left(\frac{\pi}{4}D^2\sigma_b\right)$ and $(\pi DL\sigma_{st})$

Q.34 Consider two RCC beams, P and Q, each having the section 400 mm × 750 mm (effective depth, d = 750 mm) made with concrete having a τ_{cmax} = 2.1 N/mm^2. For the reinforcement provided and the grade of concrete used, it may be assumed that the τ_c = 0.75 N/mm^2. The design shear in beam P is 400 kN and in beam Q is 750 kN. Considering the provisions of IS 456 – 2000, which of the following statements is **TRUE**?

(A) Shear reinforcement should be designed for 175 kN for beam P and the section for beam Q should be revised.
(B) Nominal shear reinforcement is required for beam P and the shear reinforcement should be designed for 120 kN for beam Q.
(C) Shear reinforcement should be designed for 175 kN for beam P and the shear reinforcement should be designed for 525 kN for beam Q.
(D) The sections for both beams P and Q need to be revised.

Q.35 The adjoining figure shows a schematic representation of a steel plate girder to be used as a simply supported beam with a concentrated load. For stiffeners, PQ (running along the beam axis) and RS (running between the top and bottom flanges) which of the following pairs of statements will be **TRUE**?



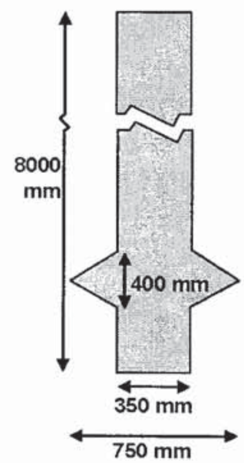
(A) (i) RS should be provided under the concentrated load only.
(ii) PQ should be placed in the tension side of the flange.

(B) (i) RS helps to prevent local buckling of the web.
(ii) PQ should be placed in the compression side of the flange.

(C) (i) RS should be provided at supports.
(ii) PQ should be placed along the neutral axis.

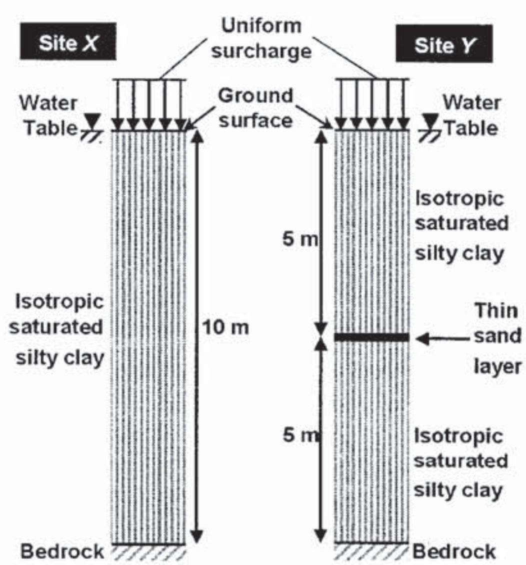
(D) (i) RS should be provided away from points of action of concentrated loads.
(ii) PQ should be provided on the compression side of the flange.

Q.36 A singly under-reamed, 8-m long, RCC pile (shown in the adjoining figure) weighing 20 kN with 350 mm shaft diameter and 750 mm under-ream diameter is installed within stiff, saturated silty clay (undrained shear strength is 50 kPa, adhesion factor is 0.3, and the applicable bearing capacity factor is 9) to counteract the impact of soil swelling on a structure constructed above. Neglecting suction and the contribution of the under-ream to the adhesive shaft capacity, what would be the estimated ultimate tensile capacity (rounded off to the nearest integer value of kN) of the pile?



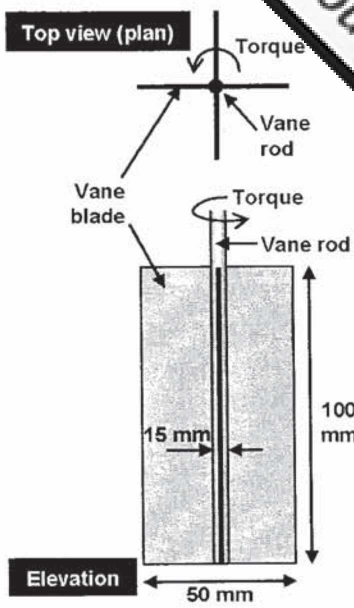
(A) 132 kN (B) 156 kN (C) 287 kN (D) 301 kN

Q.37 Identical surcharges are placed at ground surface at sites X and Y, with soil conditions shown alongside and water table at ground surface. The silty clay layers at X and Y are identical. The thin sand layer at Y is continuous and free-draining with a very large discharge capacity. If primary consolidation at X is estimated to complete in 36 months, what would be the corresponding time for completion of primary consolidation at Y?



(A) 2.25 months (B) 4.5 months (C) 9 months (D) 36 months

Q.38 A field vane shear testing instrument (shown alongside) was inserted completely into a deposit of soft, saturated silty clay with the vane rod vertical such that the top of the blades were 500 mm below the ground surface. Upon application of a rapidly increasing torque about the vane rod, the soil was found to fail when the torque reached 4.6 Nm. Assuming mobilization of undrained shear strength on all failure surfaces to be uniform and the resistance mobilized on the surface of the vane rod to be negligible, what would be the peak undrained shear strength (rounded off to the nearest integer value of kPa) of the soil?



(A) 5 kPa (B) 10 kPa (C) 15 kPa (D) 20 kPa

Q.39 A single pipe of length 1500 m and diameter 60 cm connects two reservoirs having a difference of 20 m in their water levels. The pipe is to be replaced by two pipes of the same length and equal diameter d to convey 25% more discharge under the same head loss. If the friction factor is assumed to be the same for all the pipes, the value of d is approximately equal to which of the following options?

(A) 37.5 cm (B) 40.0 cm (C) 45.0 cm (D) 50.0 cm

Q.40 A spillway discharges flood flow at a rate of 9 m^3/s per metre width. If the depth of flow on the horizontal apron at the toe of the spillway is 46 cm, the tail water depth needed to form a hydraulic jump is approximately given by which of the following options?

(A) 2.54 m (B) 4.90 m (C) 5.77 m (D) 6.23 m

Q.41 In an aquifer extending over 150 hectare, the water table was 20 m below ground level. Over a period of time the water table dropped to 23 m below the ground level. If the porosity of aquifer is 0.40 and the specific retention is 0.15, what is the change in ground water storage of the aquifer?

(A) 67.5 ha-m (B) 112.5 ha-m (C) 180.0 ha-m (D) 450.0 ha-m

Q.42 Total suspended particulate matter (TSP) concentration in ambient air is to be measured using a high volume sampler. The filter used for this purpose had an initial dry weight of 9.787 g. The filter was mounted in the sampler and the initial air flow rate through the filter was set at 1.5 m^3/min. Sampling continued for 24 hours. The airflow after 24 hours was measured to be 1.4 m^3/min. The dry weight of the filter paper after 24 hour sampling was 10.283 g. Assuming a linear decline in the air flow rate during sampling, what is the 24 hour average TSP concentration in the ambient air?

(A) 59.2 $\mu g/m^3$ (B) 118.6 $\mu g/m^3$ (C) 237.5 $\mu g/m^3$ (D) 574.4 $\mu g/m^3$

Q.43 Chlorine gas (8 mg/L as Cl_2) was added to a drinking water sample. If the free chlorin and pH was measured to be 2 mg/L (as Cl_2) and 7.5, respectively, what is the concentra residual OCl^- ions in the water? Assume that the chlorine gas added to the water is comple converted to HOCl and OCl^-. Atomic Weight of Cl: 35.5

Given: $OCl^- + H^+ \xrightleftharpoons{K} HOCl$, $\quad K = 10^{7.5}$

(A) 1.408×10^{-5} moles/L (B) 2.817×10^{-5} moles/L
(C) 5.634×10^{-5} moles/L (D) 1.127×10^{-4} moles/L

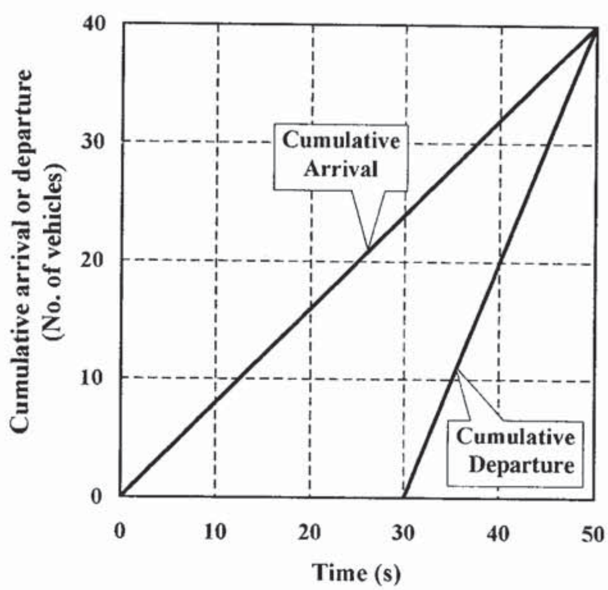
Q.44 If the *jam density* is given as k_j and the *free flow speed* is given as u_f, the maximum flow for a linear traffic speed-density model is given by which of the following options?

(A) $\frac{1}{4}k_j \times u_f$ (B) $\frac{1}{3}k_j \times u_f$ (C) $\frac{3}{5}k_j \times u_f$ (D) $\frac{2}{3}k_j \times u_f$

Q.45 If v is the initial speed of a vehicle, g is the gravitational acceleration, G is the upward longitudinal slope of the road and f_r is the coefficient of rolling friction during braking, the braking distance (measured horizontally) for the vehicle to stop is

(A) $\frac{v^2}{g(G+f_r)}$ (B) $\frac{v^2}{2g(G+f_r)}$ (C) $\frac{vg}{(G+f_r)}$ (D) $\frac{vf_r}{(G+g)}$

Q.46 The cumulative arrival and departure curve of one cycle of an approach lane of a signalized intersection is shown in the adjoining figure. The cycle time is 50 s and the effective red time is 30 s and the effective green time is 20 s. What is the average delay?



(A) 15 s (B) 25 s (C) 35 s (D) 45 s

Q.47 The observations from a closed loop traverse around an obstacle are

Segment	Observation from station	Length (m)	Azimuth (clockwise from magnetic north)
PQ	*P*	Missing	33.7500°
QR	*Q*	300.000	86.3847°
RS	*R*	354.524	169.3819°
ST	*S*	450.000	243.9003°
TP	*T*	268.000	317.5000°

What is the value of the missing measurement (rounded off to the nearest 10 mm)?

(A) 396.86 m (B) 396.79 m (C) 396.05 m (D) 396.94 m

Common Data Questions

Common Data for Questions 48 and 49:

A sand layer found at sea floor under 20 m water depth is characterized with relative density = 40 %, maximum void ratio = 1.0, minimum void ratio = 0.5, and specific gravity of soil solids = 2.67. Assume the specific gravity of sea water to be 1.03 and the unit weight of fresh water to be 9.81 kN/m^3.

Q.48 What would be the effective stress (rounded off to the nearest integer value of kPa) at 30 m depth into the sand layer?

(A) 77 kPa (B) 273 kPa (C) 268 kPa (D) 281 kPa

Q.49 What would be the change in the effective stress (rounded off to the nearest integer value of kPa) at 30 m depth into the sand layer if the sea water level permanently rises by 2 m?

(A) 19 kPa (B) 0 kPa (C) 21 kPa (D) 22 kPa

Common Data for Questions 50 and 51:

The ordinates of a 2-h unit hydrograph at 1 hour intervals starting from time t = 0, are 0, 3, 8, 6, 3, 2 and 0 m^3/s. Use trapezoidal rule for numerical integration, if required.

Q.50 What is the catchment area represented by the unit hydrograph?

(A) 1.00 km^2 (B) 2.00 km^2 (C) 7.92 km^2 (D) 8.64 km^2

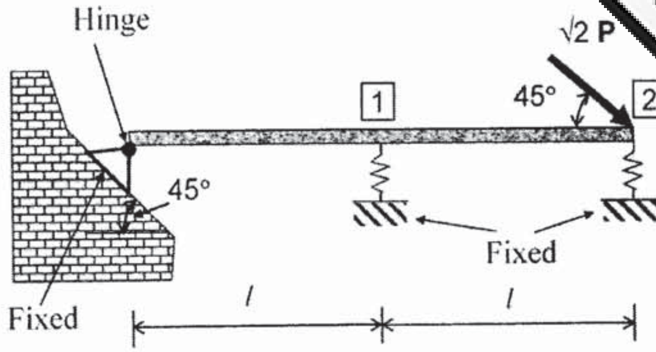
Q.51 A storm of 6.6 cm occurs uniformly over the catchment in 3 hours. If ϕ-index is equal to 2 mm/h and base flow is 5 m^3/s, what is the peak flow due to the storm?

(A) 41.0 m^3/s (B) 43.4 m^3/s (C) 53.0 m^3/s (D) 56.2 m^3/s

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

A rigid beam is hinged at one end and supported on linear elastic springs (both having a stiffness of 'k') at points '1' and '2', and an inclined load acts at '2', as shown.



Q.52 Which of the following options represents the deflections δ_1 and δ_2 at points '1' and '2'?

(A) $\delta_1 = \frac{2}{5}\left(\frac{2P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{2P}{k}\right)$
(B) $\delta_1 = \frac{2}{5}\left(\frac{P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{P}{k}\right)$
(C) $\delta_1 = \frac{2}{5}\left(\frac{P}{\sqrt{2}k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{P}{\sqrt{2}k}\right)$
(D) $\delta_1 = \frac{2}{5}\left(\frac{\sqrt{2}P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{\sqrt{2}P}{k}\right)$

Q.53 If the load P equals 100 kN, which of the following options represents forces R_1 and R_2 in the springs at points '1' and '2'?

(A) R_1 = 20 kN and R_2 = 40 kN
(B) R_1 = 50 kN and R_2 = 50 kN
(C) R_1 = 30 kN and R_2 = 60 kN
(D) R_1 = 40 kN and R_2 = 80 kN

Statement for Linked Answer Questions 54 and 55:

The sludge from the aeration tank of the activated sludge process (ASP) has solids content (by weight) of 2%. This sludge is put in a sludge thickener, where sludge volume is reduced to half. Assume that the amount of solids in the supernatant from the thickener is negligible, the specific gravity of sludge solids is 2.2 and the density of water is 1000 kg/ m^3.

Q.54 What is the density of the sludge removed from the aeration tank?

(A) 990 kg/m^3 (B) 1000 kg/m^3 (C) 1011 kg/m^3 (D) 1022 kg/m^3

Q.55 What is the solids content (by weight) of the thickened sludge?

(A) 3.96% (B) 4.00% (C) 4.04% (D) 4.10%

General Aptitude (GA) Questions

Q. 56 – Q. 60 carry one mark each.

Q.56 If Log (P) = (1/2)Log (Q) = (1/3) Log (R), then which of the following options is **TRUE**?

(A) $P^2 = Q^3R^2$ (B) $Q^2 = PR$ (C) $Q^2 = R^3P$ (D) $R = P^2Q^2$

Q.57 Which of the following options is the closest in the meaning to the word below:
Inexplicable

(A) Incomprehensible
(B) Indelible
(C) Inextricable
(D) Infallible

Q.58 Choose the word from the options given below that is most nearly opposite in meaning to the given word:
Amalgamate

(A) merge
(B) split
(C) collect
(D) separate

Q.59 Choose the most appropriate word from the options given below to complete the following sentence.
If you are trying to make a strong impression on your audience, you cannot do so by being understated, tentative or ______________.

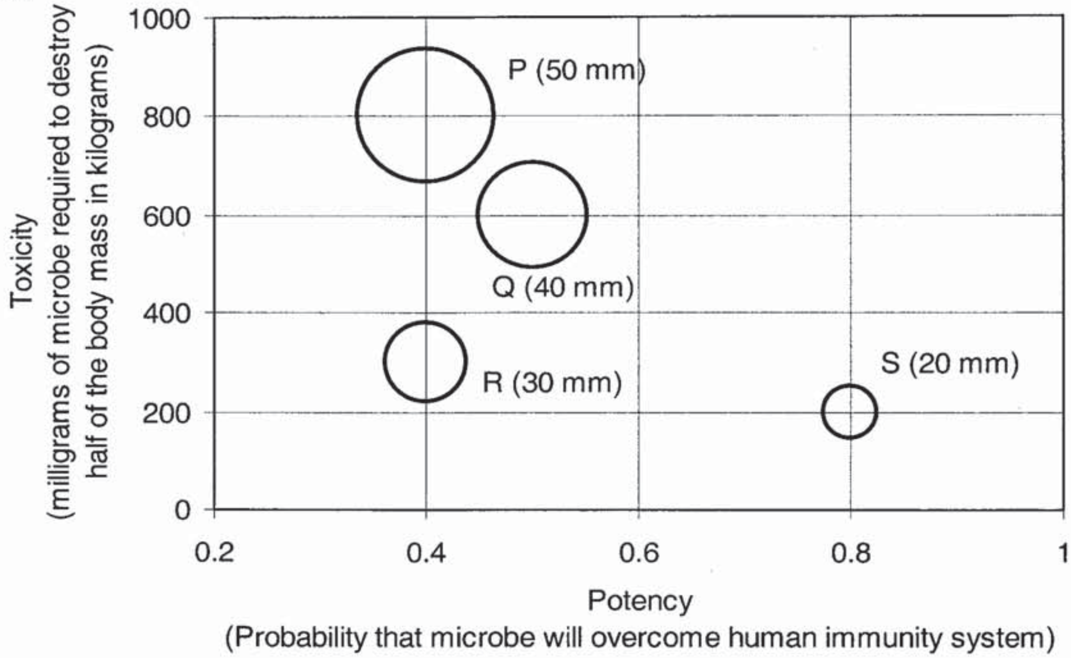
(A) hyperbolic
(B) restrained
(C) argumentative
(D) indifferent

Q.60 Choose the most appropriate word(s) from the options given below to complete the following sentence.
I contemplated ___________ Singapore for my vacation but decided against it.

(A) to visit
(B) having to visit
(C) visiting
(D) for a visit

Q. 61 to Q. 65 carry two marks each.

Q.61 P, Q, R and S are four types of dangerous microbes recently found in a human habitat. The area of each circle with its diameter printed in brackets represents the growth of a single microbe surviving human immunity system within 24 hours of entering the body. The danger to human beings varies proportionately with the toxicity, potency and growth attributed to a microbe shown in the figure below:



A pharmaceutical company is contemplating the development of a vaccine against the most dangerous microbe. Which microbe should the company target in its first attempt?

(A) P (B) Q (C) R (D) S

Q.62 **Few school curricula include a unit on how to deal with bereavement and grief, and yet all students at some point in their lives suffer from losses through death and parting.**

Based on the above passage which topic would not be included in a unit on bereavement?

(A) how to write a letter of condolence
(B) what emotional stages are passed through in the healing process
(C) what the leading causes of death are
(D) how to give support to a grieving friend

Q.63 A container originally contains 10 litres of pure spirit. From this container 1 litre of spirit is replaced with 1 litre of water. Subsequently, 1 litre of the mixture is again replaced with 1 litre of water and this process is repeated one more time. How much spirit is now left in the container?

(A) 7.58 litres (B) 7.84 litres (C) 7 litres (D) 7.29 litres

Q.64 A transporter receives the same number of orders each day. Currently, he has some pending orders (backlog) to be shipped. If he uses 7 trucks, then at the end of the 4th day he can clear all the orders. Alternatively, if he uses only 3 trucks, then all the orders are cleared at the end of the 10th day. What is the minimum number of trucks required so that there will be no pending order at the end of the 5th day?

(A) 4 (B) 5 (C) 6 (D) 7

Q.65 The variable cost (V) of manufacturing a product varies according to the equation V= 4q, where q is the quantity produced. The fixed cost (F) of production of same product reduces with q according to the equation F = 100/q. How many units should be produced to minimize the total cost (V+F)?

(A) 5 (B) 4 (C) 7 (D) 6

END OF THE QUESTION PAPER

GATE 2011 - Answer Key - Paper : CE

Paper	Question no.	Key
CE	1	D
CE	2	A
CE	3	C
CE	4	B
CE	5	B
CE	6	A
CE	7	D
CE	8	C
CE	9	MarkstoAll
CE	10	B
CE	11	B
CE	12	D
CE	13	B/D
CE	14	A
CE	15	C
CE	16	A
CE	17	D
CE	18	B
CE	19	D
CE	20	C
CE	21	A
CE	22	D
CE	23	D
CE	24	C
CE	25	A
CE	26	D
CE	27	C
CE	28	B
CE	29	A
CE	30	D
CE	31	D
CE	32	B
CE	33	C
CE	34	A
CE	35	B

Paper	Question no.	Key
CE	36	D
CE	37	C
CE	38	B
CE	39	D
CE	40	C
CE	41	B
CE	42	C
CE	43	A
CE	44	A
CE	45	B
CE	46	A
CE	47	B
CE	48	C
CE	49	B
CE	50	C
CE	51	A
CE	52	B
CE	53	D
CE	54	C
CE	55	A
CE	56	B
CE	57	A
CE	58	D
CE	59	B
CE	60	C
CE	61	D
CE	62	C
CE	63	D
CE	64	C
CE	65	A