SESSION - 1

CE1: Civil Engineering

GA - General Aptitude

Q1 - Q5 carry one mark each.

Q.No. 1 It is a common criticism that most of the academicians live in their_____, so, they are not aware of the real life challenges.

(A) homes
(B) ivory towers
(C) glass palaces
(D) big flats

Q.No. 2 His hunger for reading is insatiable. He reads indiscriminately. He is most certainly a/an_____reader.

(A) all-round
(B) precocious
(C) voracious
(D) wise

Q.No. 3 Select the word that fits the analogy:

Fuse : Fusion :: Use : _____

(A) Usage
(B) User
(C) Uses
(D) Usion

Q.No. 4 If 0, 1, 2, …,7, 8, 9 are coded as O, P, Q, …, V, W, X, then 45 will be coded as_____.

(A) TS
(B) ST
(C) SS
(D) SU

Q.No. 5 The sum of two positive numbers is 100. After subtracting 5 from each number, the product of the resulting numbers is 0. One of the original numbers is_____.

(A) 80
(B) 85
(C) 90
(D) 95

Q6 - Q10 carry two marks each.

Q.No. 6 The American psychologist Howard Gardner expounds that human intelligence can be sub-categorised into multiple kinds, in such a way that individuals differ with respect to their relative competence in each kind. Based on this theory, modern educationists insist on prescribing multi-dimensional curriculum and evaluation parameters that enable development and assessment of multiple intelligences.

Which of the following statements can be inferred from the given text?

(A)

Howard Gardner insists that the teaching curriculum and evaluation needs to be multi-dimensional.

(B) Howard Gardner wants to develop and assess the theory of multiple intelligences.

(C) Modern educationists want to develop and assess the theory of multiple intelligences.

(D) Modern educationists insist that the teaching curriculum and evaluation needs to be multi-dimensional.

Q.No. 7 Five friends P, Q, R, S and T went camping. At night, they had to sleep in a row inside the tent. P, Q and T refused to sleep next to R since he snored loudly. P and S wanted to avoid Q as he usually hugged people in sleep.

Assuming everyone was satisfied with the sleeping arrangements, what is the order in which they slept?

(A) RSPTQ

(B) SPRTQ

(C) QRSPT

(D) QTSPR

Q.No. 8 Insert seven numbers between 2 and 34, such that the resulting sequence including 2 and 34 is an arithmetic progression. The sum of these inserted seven numbers is_____.

(A) 120

(B) 124

(C) 126

(D) 130

Q.No. 9 The unit's place in 26591749^{110016} is _____.

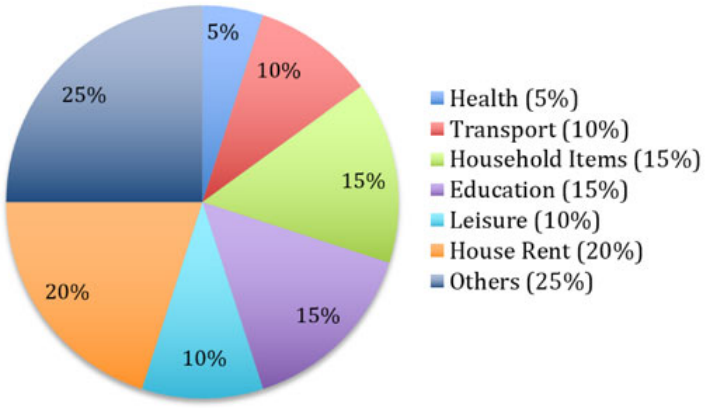
(A) 1

(B) 3

(C) 6

(D) 9

Q.No. 10 The total expenditure of a family, on different activities in a month, is shown in the pie-chart. The extra money spent on education as compared to transport (in percent) is_____.



(A) 5

(B) 33.3

(C) 50

(D) 100

CE1: Civil Engineering

Q1 - Q25 carry one mark each.

Q.No. 1

In the following partial differential equation, θ is a function of t and z, and D and K are functions of θ

$$D(\theta)\frac{\partial^2\theta}{\partial z^2} + \frac{\partial K(\theta)}{\partial z} - \frac{\partial\theta}{\partial t} = 0$$

The above equation is

(A) a second order linear equation

(B) a second degree linear equation

(C) a second order non-linear equation

(D) a second degree non-linear equation

Q.No. 2 The value of $\lim_{x\to\infty} \frac{x^2-5x+4}{4x^2+2x}$ is

(A) 0

(B) $\frac{1}{4}$

(C) $\frac{1}{2}$

(D) 1

Q.No. 3 The true value of ln(2) is 0.69. If the value of ln(2) is obtained by linear interpolation between ln(1) and ln(6), the percentage of absolute error (*round off to the nearest integer*), is

(A) 35

(B) 48

(C) 69

(D) 84

Q.No. 4 The area of an ellipse represented by an equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is

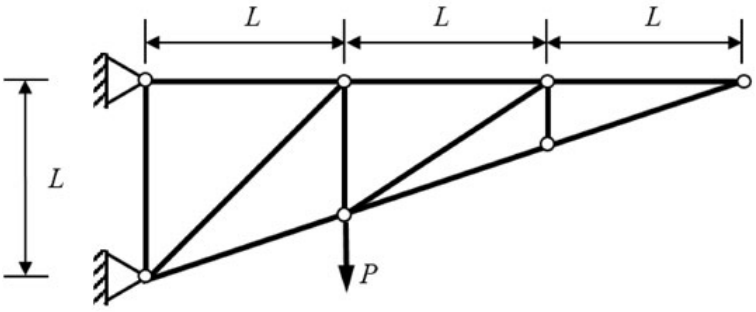
(A) $\frac{\pi ab}{4}$

(B) $\frac{\pi ab}{2}$

(C) πab

(D) $\frac{4\pi ab}{3}$

Q.No. 5 Consider the planar truss shown in the figure (*not drawn to the scale*)



Neglecting self-weight of the members, the number of zero-force members in the truss under the action of the load P, is

(A) 6

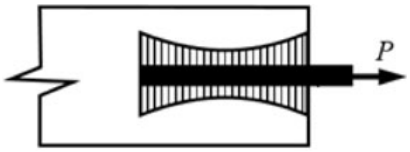
(B) 7

(C) 8

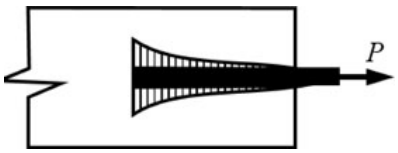
(D) 9

Q.No. 6 A reinforcing steel bar, partially embedded in concrete, is subjected to a tensile force *P*. The figure that appropriately represents the distribution of the magnitude of bond stress (represented as hatched region), along the embedded length of the bar, is

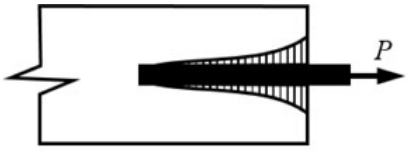
(A)



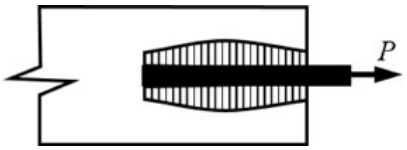
(B)



(C)



(D)



Q.No. 7 In a two-dimensional stress analysis, the state of stress at a point *P* is

$$[\sigma] = \begin{bmatrix} \sigma_{xx} & \tau_{xy} \\ \tau_{xy} & \sigma_{yy} \end{bmatrix}$$

The necessary and sufficient condition for existence of the state of pure shear at the point *P*, is

(A) $\sigma_{xx}\sigma_{yy} - \tau_{xy}^2 = 0$

(B) $\tau_{xy} = 0$

(C) $\sigma_{xx} + \sigma_{yy} = 0$

(D) $(\sigma_{xx} - \sigma_{yy})^2 + 4\tau_{xy}^2 = 0$

Q.No. 8 During the process of hydration of cement, due to increase in Dicalcium Silicate (C_2S) content in cement clinker, the heat of hydration

(A) increases

(B) decreases

(C) intially decreases and then increases

(D) does not change

Q.No. 9 The Los Angeles test for stone aggregates is used to examine

(A) abrasion resistance

(B) crushing strength

(C) soundness

(D) specific gravity

Q.No. 10 Which one of the following statements is **NOT** correct?

(A) A clay deposit with a liquidity index greater than unity is in a state of plastic consistency.

(B) The cohesion of normally consolidated clay is zero when triaxial test is conducted under consolidated undrained condition.

(C) The ultimate bearing capacity of a strip foundation supported on the surface of sandy soil increases in direct proportion to the width of footing.

(D) In case of a point load, Boussinesq's equation predicts higher value of vertical stress at a point directly beneath the load as compared to Westergaard's equation.

Q.No. 11 In a soil investigation work at a site, Standard Penetration Test (SPT) was conducted at every 1.5 m interval up to 30 m depth. At 3 m depth, the observed number of hammer blows for three successive 150 mm penetrations were 8, 6 and 9, respectively. The SPT N-value at 3 m depth, is

(A) 23

(B) 17

(C) 15

(D) 14

Q.No. 12 Velocity of flow is proportional to the first power of hydraulic gradient in Darcy's law. This law is applicable to

(A) laminar flow in porous media

(B) transitional flow in porous media

(C) turbulent flow in porous media

(D) laminar as well as turbulent flow in porous media

Q.No. 13 A body floating in a liquid is in a stable state of equilibrium if its

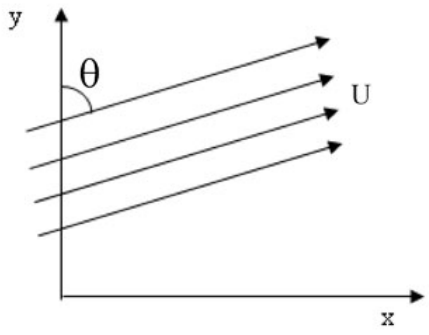
(A) metacentre lies above its centre of gravity

(B) metacentre lies below its centre of gravity

(C) metacentre coincides with its centre of gravity

(D) centre of gravity is below its centre of bouyancy

Q.No. 14 Uniform flow with velocity U makes an angle θ with the y-axis, as shown in the figure



The velocity potential (ϕ), is

(A) $\pm U(x \sin\theta + y \cos\theta)$

(B) $\pm U(y \sin\theta - x \cos\theta)$

(C) $\pm U(x \sin\theta - y \cos\theta)$

(D) $\pm U(y \sin\theta + x \cos\theta)$

Q.No. 15

The data for an agricultural field for a specific month are given below:

Pan Evaporation = 100 mm

Effective Rainfall = 20 mm (after deducting losses due to runoff and deep percolation)

Crop Coefficient = 0.4

Irrigation Efficiency = 0.5

The amount of irrigation water (in mm) to be applied to the field in that month, is

(A) 0

(B) 20

(C) 40

(D) 80

Q.No. 16 During chlorination process, aqueous (aq) chlorine reacts rapidly with water to form Cl^-, HOCl, and H^+ as shown below

$$Cl_2\,(aq) + H_2O \rightleftharpoons HOCl + Cl^- + H^+$$

The most active disinfectant in the chlorination process from amongst the following, is

(A) H^+

(B) HOCl

(C) Cl^-

(D) H_2O

Q.No. 17 An amount of 35.67 mg HCl is added to distilled water and the total solution volume is made to one litre. The atomic weights of H and Cl are 1 and 35.5, respectively. Neglecting the dissociation of water, the pH of the solution, is

(A) 3.50

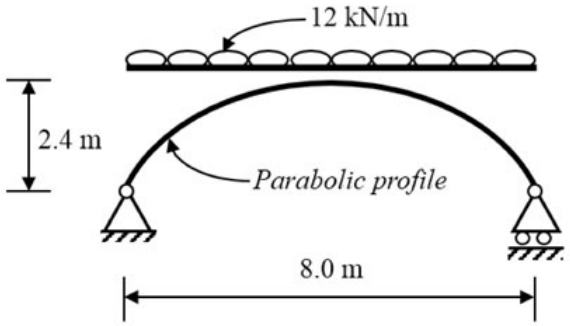
(B) 3.01

(C) 2.50

(D) 2.01

Q.No. 18 The probability that a 50 year flood may **NOT** occur at all during 25 years life of a project (*round off to two decimal places*), is _____.

Q.No. 19 A planar elastic structure is subjected to uniformly distributed load, as shown in the figure (*not drawn to the scale*)



Neglecting self-weight, the maximum bending moment generated in the structure (in kN.m, *round off to the nearest integer*), is _____.

Q.No. 20 In an urban area, a median is provided to separate the opposing streams of traffic. As per IRC:86-1983, the desirable minimum width (in m, *expressed as integer*) of the median, is _____.

Q.No. 21 A road in a hilly terrain is to be laid at a gradient of 4.5%. A horizontal curve of radius 100 m is laid at a location on this road. Gradient needs to be eased due to combination of curved horizontal and vertical profiles of the road. As per IRC, the compensated gradient (in %, *round off to one decimal place*), is _____.

Q.No. 22 In a drained triaxial compression test, a sample of sand fails at deviator stress of 150 kPa under confining pressure of 50 kPa. The angle of internal friction (in degree, *round off to the nearest integer*) of the sample, is _____.

Q.No. 23 A fully submerged infinite sandy slope has an inclination of 30° with the horizontal. The saturated unit weight and effective angle of internal friction of sand are 18 kN/m^3 and 38°, respectively. The unit weight of water is 10 kN/m^3. Assume that the seepage is parallel to the slope. Against shear failure of the slope, the factor of safety (*round off to two decimal places*) is _____.

Q.No. 24 A 4 m wide rectangular channel carries 6 m^3/s of water. The Manning's 'n' of the open channel is 0.02. Considering g = 9.81 m/s^2, the critical velocity of flow (in m/s, *round off to two decimal places*) in the channel, is _____.

Q.No. 25 A river has a flow of 1000 million litres per day (MLD), BOD_5 of 5 mg/litre and Dissolved Oxygen (DO) level of 8 mg/litre before receiving the wastewater discharge at a location. For the existing environmental conditions, the saturation DO level is 10 mg/litre in the river. Wastewater discharge of 100 MLD with the BOD_5 of 200 mg/litre and DO level of 2 mg/litre falls at that location. Assuming complete mixing of wastewater and river water, the immediate DO deficit (in mg/litre, *round off to two decimal places*), is _____.

Q26 - Q55 carry two marks each.

Q.No. 26 For the Ordinary Differential Equation $\frac{d^2x}{dt^2} - 5\frac{dx}{dt} + 6x = 0$, with initial conditions $x(0) = 0$ and $\frac{dx}{dt}(0) = 10$, the solution is

(A) $-5e^{2t} + 6e^{3t}$

(B) $5e^{2t} + 6e^{3t}$

(C) $-10e^{2t} + 10e^{3t}$

(D) $10e^{2t} + 10e^{3t}$

Q.No. 27 A continuous function $f(x)$ is defined. If the third derivative at x_i is to be computed by using the fourth order central finite-divided-difference scheme (with step length = h), the correct formula is

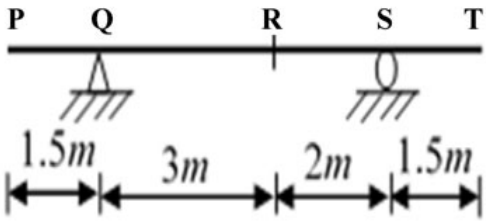
(A) $f'''(x_i) = \frac{-f(x_{i+3})+8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})-8f(x_{i-2})+f(x_{i-3})}{8h^3}$

(B) $f'''(x_i) = \frac{f(x_{i+3})-8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})+8f(x_{i-2})+f(x_{i-3})}{8h^3}$

(C) $f'''(x_i) = \frac{-f(x_{i+3})-8f(x_{i+2})-13f(x_{i+1})+13f(x_{i-1})+8f(x_{i-2})-f(x_{i-3})}{8h^3}$

(D) $f'''(x_i) = \frac{f(x_{i+3})-8f(x_{i+2})+13f(x_{i+1})+13f(x_{i-1})-8f(x_{i-2})-f(x_{i-3})}{8h^3}$

Q.No. 28 Distributed load(s) of 50 kN/m may occupy any position(s) (either continuously or in patches) on the girder **PQRST** as shown in the figure (*not drawn to the scale*)



The maximum negative (hogging) bending moment (in kN.m) that occurs at point **R**, is

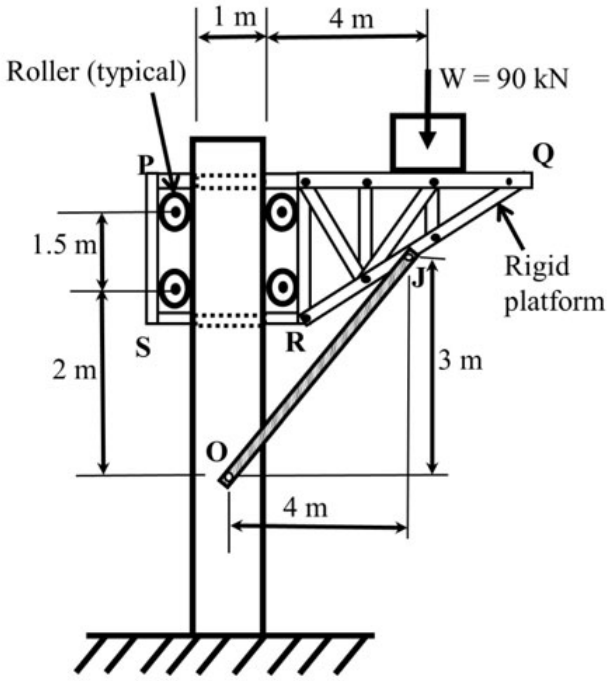
(A) 22.50

(B) 56.25

(C) 93.75

(D) 150.00

Q.No. 29 A rigid weightless platform **PQRS** shown in the figure (*not drawn to the scale*) can slide freely in the vertical direction. The platform is held in position by the weightless member **OJ** and four weightless, frictionless rollers. Points **O** and **J** are pin connections. A block of 90 kN rests on the platform as shown in the figure



The magnitude of horizontal component of the reaction (in kN) at pin **O**, is

(A) 90

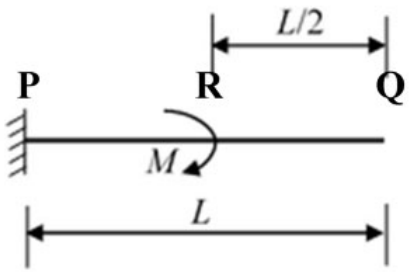
(B) 120

(C) 150

(D) 180

Q.No. 30

A cantilever beam **PQ** of uniform flexural rigidity (EI) is subjected to a concentrated moment M at **R** as shown in the figure



The deflection at the free end **Q** is

(A) $\frac{ML^2}{6EI}$

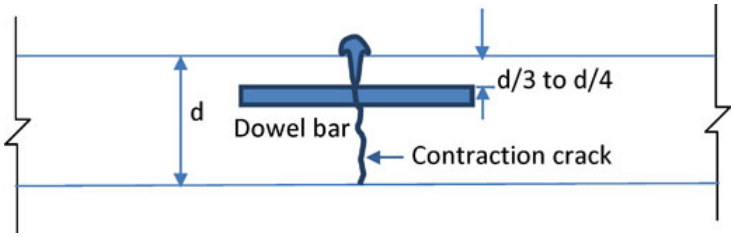
(B) $\frac{ML^2}{4EI}$

(C) $\frac{3ML^2}{8EI}$

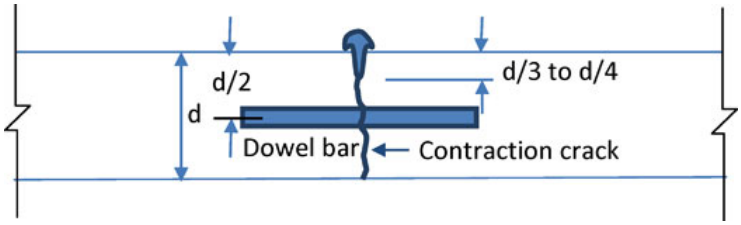
(D) $\frac{3ML^2}{4EI}$

Q.No. 31 A dowel bar is placed at a contraction joint. When contraction occurs, the concrete slab cracks at predetermined location(s). Identify the arrangement, which shows the correct placement of dowel bar and the place of occurrence of the contraction crack(s).

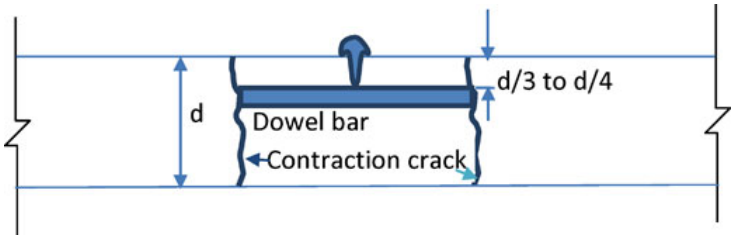
(A)



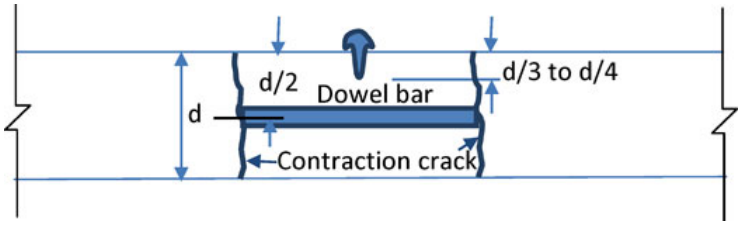
(B)



(C)

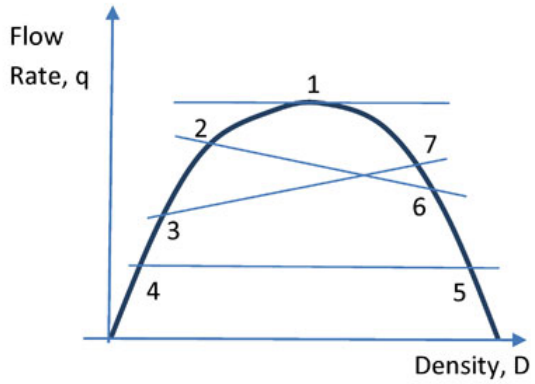


(D)



Q.No. 32

The relationship between traffic flow rate (q) and density (D) is shown in the figure



The shock wave condition is depicted by

(A) flow with respect to point 1 ($q_1 = q_{max}$)

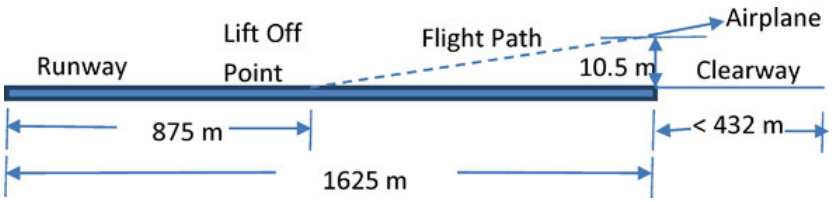
(B) flow changing from point 2 to point 6 ($q_2 > q_6$)

(C) flow changing from point 3 to point 7 ($q_3 < q_7$)

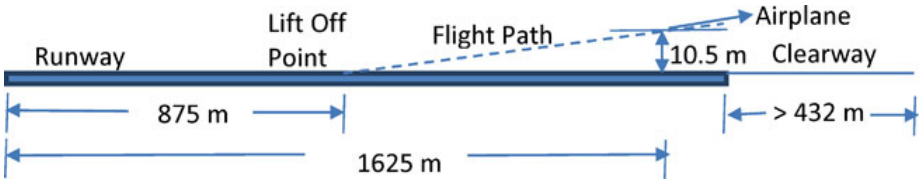
(D) flow with respect to point 4 and point 5 ($q_4 = q_5$)

Q.No. 33 The appropriate design length of a clearway is calculated on the basis of 'Normal Take-off' condition. Which one of the following options correctly depicts the length of the clearway? (*Note: None of the options are drawn to scale*)

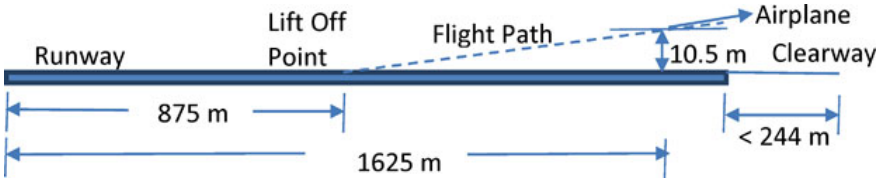
(A)



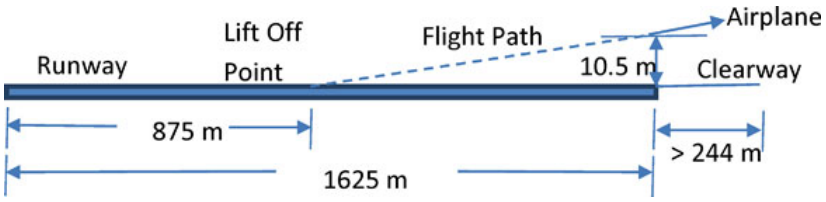
(B)



(C)

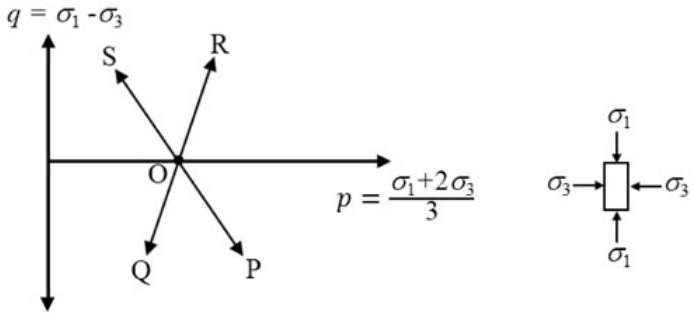


(D)



Q.No. 34

The total stress paths corresponding to different loading conditions, for a soil specimen under the isotropically consolidated stress state (O), are shown below



Stress Path	Loading Condition
OP	I - Compression loading (σ_1 – *increasing;* σ_3 – *constant*)
OQ	II - Compression unloading (σ_1 – *constant;* σ_3 – *decreasing*)
OR	III - Extension unloading (σ_1 – *decreasing;* σ_3 – *constant*)
OS	IV - Extension loading (σ_1 – *constant;* σ_3 – *increasing*)

The correct match between the stress paths and the listed loading conditions, is

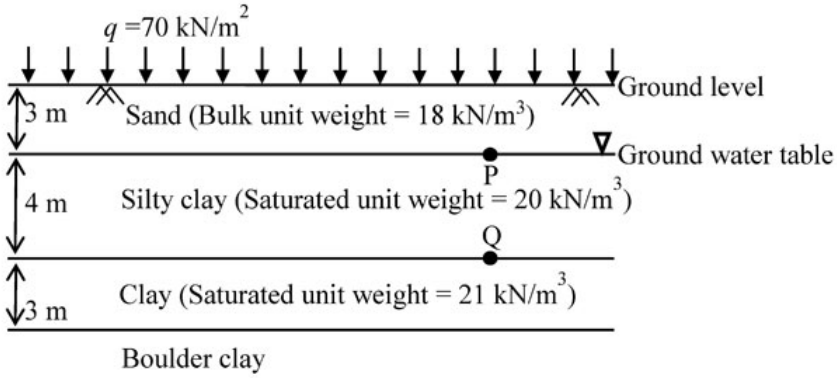
(A) OP – I, OQ – II, OR – IV, OS – III

(B) OP – IV, OQ – III, OR – I, OS – II

(C) OP – III, OQ – II, OR – I, OS – IV

(D) OP – I, OQ – III, OR – II, OS – IV

Q.No. 35 The soil profile at a site up to a depth of 10 m is shown in the figure (*not drawn to the scale*). The soil is preloaded with a uniform surcharge (q) of 70 kN/m^2 at the ground level. The water table is at a depth of 3 m below ground level. The soil unit weight of the respective layers is shown in the figure. Consider unit weight of water as 9.81 kN/m^3 and assume that the surcharge (q) is applied instantaneously.



Immediately after preloading, the effective stresses (in kPa) at points P and Q, respectively, are

(A) 124 and 204

(B) 36 and 90

(C) 36 and 126

(D) 54 and 95

Q.No. 36 Water flows at the rate of 12 m^3/s in a 6 m wide rectangular channel. A hydraulic jump is formed in the channel at a point where the upstream depth is 30 cm (just before the jump). Considering acceleration due to gravity as 9.81 m/s^2 and density of water as 1000 kg/m^3, the energy loss in the jump is

(A) 114.2 kW
(B) 114.2 MW
(C) 141.2 h.p.
(D) 141.2 J/s

Q.No. 37 A water supply scheme transports 10 MLD (Million Litres per Day) water through a 450 mm diameter pipeline for a distance of 2.5 km. A chlorine dose of 3.50 mg/litre is applied at the starting point of the pipeline to attain a certain level of disinfection at the downstream end. It is decided to increase the flow rate from 10 MLD to 13 MLD in the pipeline. Assume exponent for concentration, n = 0.86. With this increased flow, in order to attain the same level of disinfection, the chlorine dose (in mg/litre) to be applied at the starting point should be

(A) 3.95
(B) 4.40
(C) 4.75
(D) 5.55

Q.No. 38 An open traverse PQRST is surveyed using theodolite and the consecutive coordinates obtained are given in the table

Line	Consecutive Coordinates			
	Northing (m)	Southing (m)	Easting (m)	Westing (m)
PQ	110.2	-	45.5	-
QR	80.6	-	-	60.1
RS	-	90.7	-	70.8
ST	-	105.4	55.5	-

If the independent coordinates (Northing, Easting) of station P are (400 m, 200 m), the independent coordinates (in m) of station T, are

(A) 194.7, 370.1
(B) 205.3, 429.9
(C) 394.7, 170.1
(D) 405.3, 229.9

Q.No. 39 If C represents a line segment between (0,0,0) and (1,1,1) in Cartesian coordinate system, the value (*expressed as integer*) of the line integral

$$\int_C [(y+z)dx + (x+z)dy + (x+y)dz]$$

is _____.

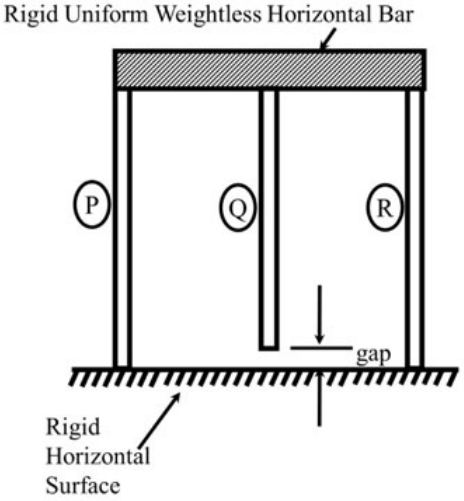
Q.No. 40

Consider the system of equations

$$\begin{bmatrix} 1 & 3 & 2 \\ 2 & 2 & -3 \\ 4 & 4 & -6 \\ 2 & 5 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 2 \\ 1 \end{bmatrix}$$

The value of x_3 (*round off to the nearest integer*), is _____.

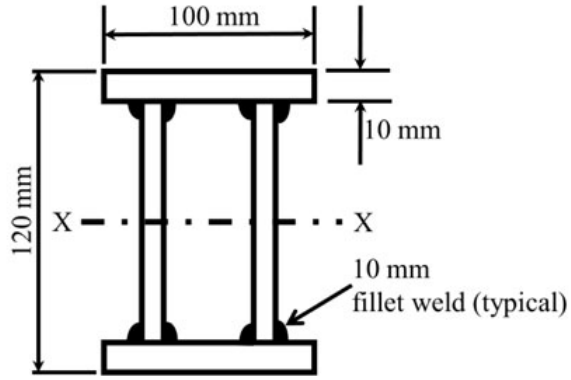
Q.No. 41 A rigid, uniform, weightless, horizontal bar is connected to three vertical members P, Q and R as shown in the figure (*not drawn to the scale*). All three members have identical axial stiffness of 10 kN/mm. The lower ends of bars P and R rest on a rigid horizontal surface. When **NO** load is applied, a gap of 2 mm exists between the lower end of the bar Q and the rigid horizontal surface. When a vertical load W is placed on the horizontal bar in the downward direction, the bar still remains horizontal and gets displaced by 5 mm in the vertically downward direction.



The magnitude of the load W (in kN, *round off to the nearest integer*), is _____.

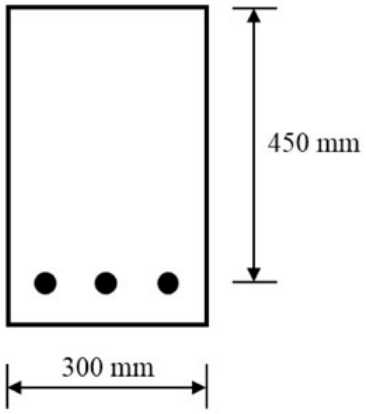
Q.No. 42

The flange and web plates of the doubly symmetric built-up section are connected by continuous 10 mm thick fillet welds as shown in the figure (*not drawn to the scale*). The moment of inertia of the section about its principal axis X−X is 7.73×10^6 mm^4. The permissible shear stress in the fillet welds is 100 N/mm^2. The design shear strength of the section is governed by the capacity of the fillet welds.



The maximum shear force (in kN, *round off to one decimal place*) that can be carried by the section, is _____.

Q.No. 43 The singly reinforced concrete beam section shown in the figure (*not drawn to the scale*) is made of M25 grade concrete and Fe500 grade reinforcing steel. The total cross-sectional area of the tension steel is 942 mm^2.



As per Limit State Design of IS 456:2000, the design moment capacity (in kN.m, *round off to two decimal places*) of the beam section, is _____.

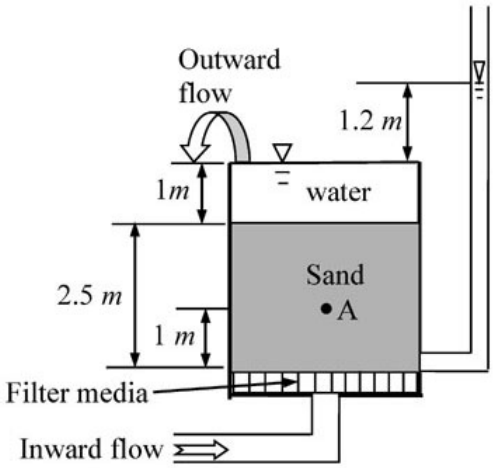
Q.No. 44 A simply supported prismatic concrete beam of rectangular cross-section, having a span of 8 m, is prestressed with an effective prestressing force of 600 kN. The eccentricity of the prestressing tendon is zero at supports and varies linearly to a value of e at the mid-span. In order to balance an external concentrated load of 12 kN applied at the mid-span, the required value of e (in mm, *round off to the nearest integer*) of the tendon, is _____.

Q.No. 45

Traffic volume count has been collected on a 2-lane road section which needs upgradation due to severe traffic flow condition. Maximum service flow rate per lane is observed as 1280 veh/h at level of service 'C'. The Peak Hour Factor is reported as 0.78125. Historical traffic volume count provides Annual Average Daily Traffic as 12270 veh/day. Directional split of the traffic flow is observed to be 60:40. Assuming that traffic stream consists of 'All Cars' and all drivers are 'Regular Commuters', the number of extra lane(s) (*round off to the next higher integer*) to be provided, is _____.

Q.No. 46 A vertical retaining wall of 5 m height has to support soil having unit weight of 18 kN/m^3, effective cohesion of 12 kN/m^2, and effective friction angle of 30°. As per Rankine's earth pressure theory and assuming that a tension crack has occurred, the lateral active thrust on the wall per meter length (in kN/m, *round off to two decimal places*), is _____.

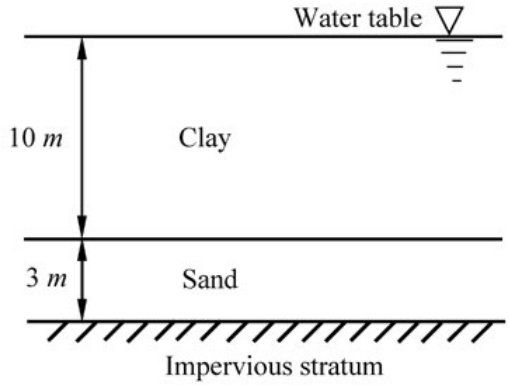
Q.No. 47 Water flows in the upward direction in a tank through 2.5 m thick sand layer as shown in the figure. The void ratio and specific gravity of sand are 0.58 and 2.7, respectively. The sand is fully saturated. Unit weight of water is 10 kN/m^3.



The effective stress (in kPa, *round off to two decimal places*) at point **A**, located 1 m above the base of tank, is _____.

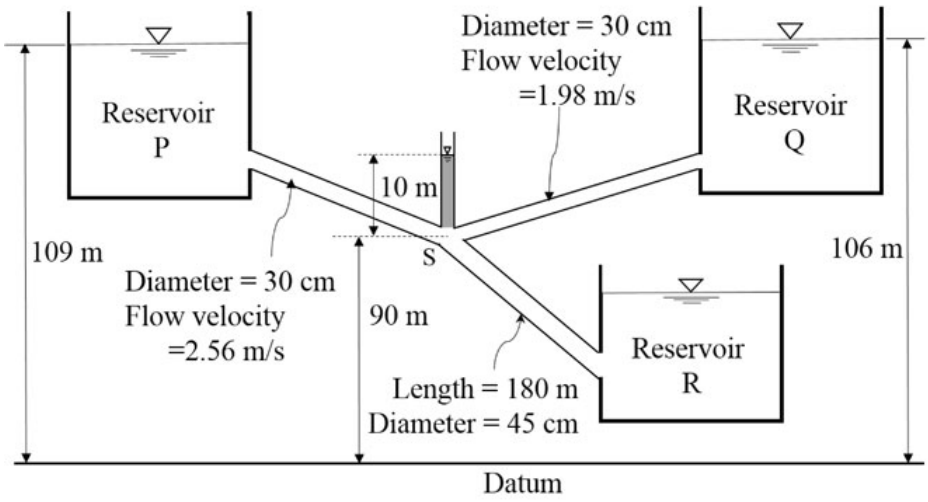
Q.No. 48

A 10 m thick clay layer is resting over a 3 m thick sand layer and is submerged. A fill of 2 m thick sand with unit weight of 20 kN/m^3 is placed above the clay layer to accelerate the rate of consolidation of the clay layer. Coefficient of consolidation of clay is 9×10^{-2} m^2/year and coefficient of volume compressibility of clay is 2.2×10^{-4} m^2/kN. Assume Taylor's relation between time factor and average degree of consolidation.



The settlement (in mm, *round off to two decimal places*) of the clay layer, 10 years after the construction of the fill, is _____.

Q.No. 49 Three reservoirs P, Q, and R are interconnected by pipes as shown in the figure (*not drawn to the scale*). Piezometric head at the junction S of the pipes is 100 m. Assume acceleration due to gravity as 9.81 m/s^2 and density of water as 1000 kg/m^3. The length of the pipe from junction S to the inlet of reservoir R is 180 m.



Considering head loss only due to friction (with friction factor of 0.03 for all the pipes), the height of water level in the lowermost reservoir R (in m, *round off to one decimal place*) with respect to the datum, is _____.

Q.No. 50

In a homogeneous unconfined aquifer of area 3.00 km^2, the water table was at an elevation of 102.00 m. After a natural recharge of volume 0.90 million cubic meter (Mm^3), the water table rose to 103.20 m. After this recharge, ground water pumping took place and the water table dropped down to 101.20 m. The volume of ground water pumped after the natural recharge, expressed (in Mm^3 and *round off to two decimal places*), is _____.

Q.No. 51 A circular water tank of 2 m diameter has a circular orifice of diameter 0.1 m at the bottom. Water enters the tank steadily at a flow rate of 20 litre/s and escapes through the orifice. The coefficient of discharge of the orifice is 0.8. Consider the acceleration due to gravity as 9.81 m/s^2 and neglect frictional losses. The height of the water level (in m, *round off to two decimal places*) in the tank at the steady state, is _____.

Q.No. 52 Surface Overflow Rate (SOR) of a primary settling tank (discrete settling) is 20000 litre/m^2 per day. Kinematic viscosity of water in the tank is 1.01×10^{-2} cm^2/s. Specific gravity of the settling particles is 2.64. Acceleration due to gravity is 9.81 m/s^2. The minimum diameter (in µm, *round off to one decimal place*) of the particles that will be removed with 80% efficiency in the tank, is _____.

Q.No. 53 A gaseous chemical has a concentration of 41.6 µmol/m^3 in air at 1 atm pressure and temperature 293 K. The universal gas constant R is 82.05×10^{-6} (m^3 atm)/(mol K). Assuming that ideal gas law is valid, the concentration of the gaseous chemical (in ppm, *round off to one decimal place*), is _____.

Q.No. 54 A stream with a flow rate of 5 m^3/s is having an ultimate BOD of 30 mg/litre. A wastewater discharge of 0.20 m^3/s having BOD_5 of 500 mg/litre joins the stream at a location and instantaneously gets mixed up completely. The cross-sectional area of the stream is 40 m^2 which remains constant. BOD exertion rate constant is 0.3 per day (logarithm base to e). The BOD (in mg/litre, *round off to two decimal places*) remaining at 3 km downstream from the mixing location, is _____.

Q.No. 55 The lengths and bearings of a traverse PQRS are:

Segment	Length (m)	Bearing
PQ	40	80^o
QR	50	10^o
RS	30	210^o

The length of line segment SP (in m, *round off to two decimal places*), is _____.

GATE 2020

Graduate Aptitude Test in Engineering 2020

IIT Delhi
Organising Institute

Answer Key - CE1: Civil Engineering

Q.No.	Session	Que.Type	Sec. Name	Key	Marks
1	7	MCQ	GA	B	1
2	7	MCQ	GA	C	1
3	7	MCQ	GA	A	1
4	7	MCQ	GA	B	1
5	7	MCQ	GA	D	1
6	7	MCQ	GA	D	2
7	7	MCQ	GA	A	2
8	7	MCQ	GA	C	2
9	7	MCQ	GA	A	2
10	7	MCQ	GA	C	2
1	7	MCQ	CE	C	1
2	7	MCQ	CE	B	1
3	7	MCQ	CE	B	1
4	7	MCQ	CE	C	1
5	7	MCQ	CE	C	1
6	7	MCQ	CE	C	1
7	7	MCQ	CE	C	1
8	7	MCQ	CE	B	1
9	7	MCQ	CE	A	1
10	7	MCQ	CE	A	1
11	7	MCQ	CE	C	1
12	7	MCQ	CE	A	1
13	7	MCQ	CE	A	1
14	7	MCQ	CE	A	1
15	7	MCQ	CE	C	1
16	7	MCQ	CE	B	1
17	7	MCQ	CE	B	1
18	7	NAT	CE	0.59 to 0.61	1
19	7	NAT	CE	95 to 97	1
20	7	NAT	CE	5 to 5	1
21	7	NAT	CE	4.0 to 4.0	1
22	7	NAT	CE	36 to 38	1
23	7	NAT	CE	0.59 to 0.61	1
24	7	NAT	CE	2.35 to 2.55	1
25	7	NAT	CE	2.45 to 2.65	1
26	7	MCQ	CE	C	2
27	7	MCQ	CE	A	2
28	7	MCQ	CE	B	2
29	7	MCQ	CE	B	2
30	7	MCQ	CE	C	2
31	7	MCQ	CE	B	2
32	7	MCQ	CE	MTA	2
33	7	MCQ	CE	C	2

34	7	MCQ	CE	B	2
35	7	MCQ	CE	D	2
36	7	MCQ	CE	A	2
37	7	MCQ	CE	C	2
38	7	MCQ	CE	C	2
39	7	NAT	CE	3 to 3	2
40	7	NAT	CE	3 to 3	2
41	7	NAT	CE	129 to 131	2
42	7	NAT	CE	393.5 to 399.1	2
43	7	NAT	CE	158.00 to 158.80	2
44	7	NAT	CE	39 to 41	2
45	7	NAT	CE	MTA	2
46	7	NAT	CE	21.00 to 23.00	2
47	7	NAT	CE	8.70 to 9.30	2
48	7	NAT	CE	18.40 to 19.50	2
49	7	NAT	CE	97.2 to 97.8	2
50	7	NAT	CE	1.40 to 1.60	2
51	7	NAT	CE	0.50 to 0.54	2
52	7	NAT	CE	14.0 to 15.0	2
53	7	NAT	CE	0.9 to 1.1	2
54	7	NAT	CE	49.00 to 50.00	2
55	7	NAT	CE	44.00 to 45.00	2

SESSION - 2

CE2: Civil Engineering

GA - General Aptitude

Q1 - Q5 carry one mark each.

Q.No. 1 Rescue teams deployed_____disaster hit areas combat_____a lot of difficulties to save the people.

(A) with, at
(B) in, with
(C) with, with
(D) to, to

Q.No. 2 Select the most appropriate word that can replace the underlined word without changing the meaning of the sentence:

Now-a-days, most children have a tendency to belittle the legitimate concerns of their parents.

(A) disparage
(B) applaud
(C) reduce
(D) begrudge

Q.No. 3 Select the word that fits the analogy:

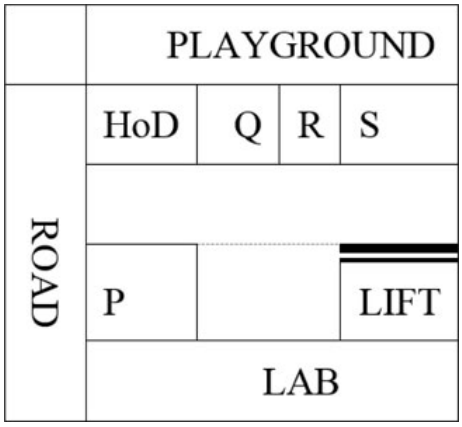
Partial : Impartial : : Popular : _____

(A) Impopular
(B) Dispopular
(C) Mispopular
(D) Unpopular

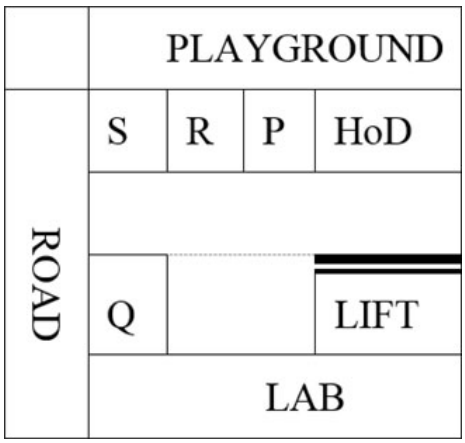
Q.No. 4 After the inauguration of the new building, the Head of the Department (HoD) collated faculty preferences for office space. P wanted a room adjacent to the lab. Q wanted to be close to the lift. R wanted a view of the playground and S wanted a corner office.

Assuming that everyone was satisfied, which among the following shows a possible allocation?

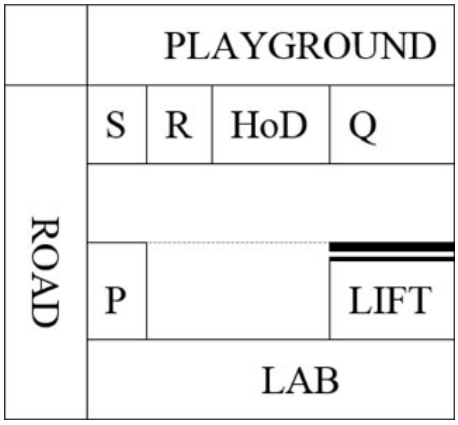
(A)



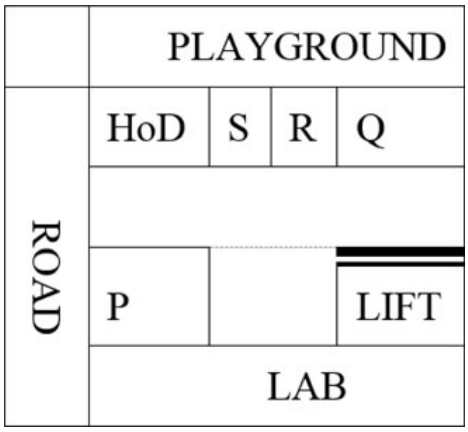
(B)



(C)



(D)



Q.No. 5 If $f(x) = x^2$ for each $x \in (-\infty, \infty)$, then $\frac{f(f(f(x)))}{f(x)}$ is equal to _____.

(A) $f(x)$

(B) $(f(x))^2$

(C) $(f(x))^3$

(D) $(f(x))^4$

Q6 - Q10 carry two marks each.

Q.No. 6 Nominal interest rate is defined as the amount paid by the borrower to the lender for using the borrowed amount for a specific period of time. Real interest rate calculated on the basis of actual value (inflation-adjusted), is approximately equal to the difference between nominal rate and expected rate of inflation in the economy.

Which of the following assertions is best supported by the above information?

(A) Under high inflation, real interest rate is low and borrowers get benefited.

(B) Under low inflation, real interest rate is high and borrowers get benefited.

(C) Under high inflation, real interest rate is low and lenders get benefited.

(D) Under low inflation, real interest rate is low and borrowers get benefited.

Q.No. 7 For the year 2019, which of the previous year's calendar can be used?

(A) 2011

(B) 2012

(C) 2013

(D) 2014

Q.No. 8 The ratio of 'the sum of the odd positive integers from 1 to 100' to 'the sum of the even positive integers from 150 to 200' is ____.

(A) 45 : 95

(B) 1 : 2

(C) 50 : 91

(D) 1 : 1

Q.No. 9 In a school of 1000 students, 300 students play chess and 600 students play football. If 50 students play both chess and football, the number of students who play neither is_____.

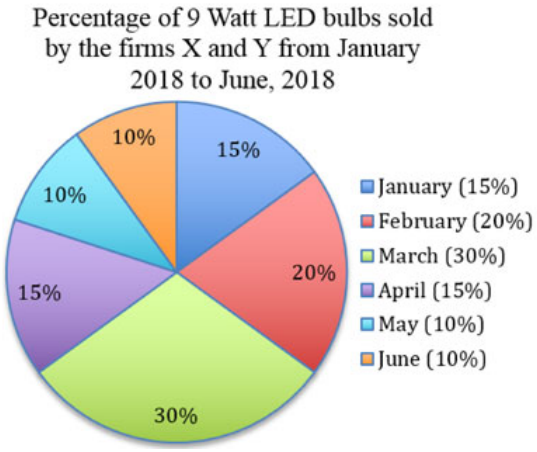
(A) 200

(B) 150

(C) 100

(D) 50

Q.No. 10 The monthly distribution of 9 Watt LED bulbs sold by two firms X and Y from January to June 2018 is shown in the pie-chart and the corresponding table. If the total number of LED bulbs sold by two firms during April-June 2018 is 50000, then the number of LED bulbs sold by the firm Y during April-June 2018 is_____.



Month	Ratio of LED bulbs sold by two firms (X : Y)
January	7 : 8
February	2 : 3
March	2 : 1
April	3 : 2
May	1 : 4
June	9 : 11

(A) 11250

(B) 9750

(C) 8750

(D) 8250

CE2: Civil Engineering

Q1 - Q25 carry one mark each.

Q.No. 1 The ordinary differential equation $\frac{d^2u}{dx^2} - 2x^2u + \sin x = 0$ is

(A) linear and homogeneous

(B) linear and nonhomogeneous

(C) nonlinear and homogeneous

(D) nonlinear and nonhomogeneous

Q.No. 2 The value of $\lim_{x\to\infty} \frac{\sqrt{9x^2+2020}}{x+7}$ is

(A) $\frac{7}{9}$

(B) 1

(C) 3

(D) indeterminable

Q.No. 3 The integral

$$\int_0^1 (5x^3 + 4x^2 + 3x + 2)\mathrm{d}x$$

is estimated numerically using three alternative methods namely the rectangular, trapezoidal and Simpson's rules with a common step size. In this context, which one of the following statements is **TRUE**?

(A) Simpson's rule as well as rectangular rule of estimation will give NON-zero error.

(B) Simpson's rule, rectangular rule as well as trapezoidal rule of estimation will give NON-zero error.

(C) Only the rectangular rule of estimation will give zero error.

(D) Only Simpson's rule of estimation will give zero error.

Q.No. 4 The following partial differential equation is defined for *u:u (x,y)*

$$\frac{\partial u}{\partial y} = \frac{\partial^2 u}{\partial x^2}; \quad y \geq 0; \; x_1 \leq x \leq x_2$$

The set of auxiliary conditions necessary to solve the equation uniquely, is

(A) three initial conditions

(B) three boundary conditions

(C) two initial conditions and one boundary condition

(D) one initial condition and two boundary conditions

Q.No. 5 The ratio of the plastic moment capacity of a beam section to its yield moment capacity is termed as

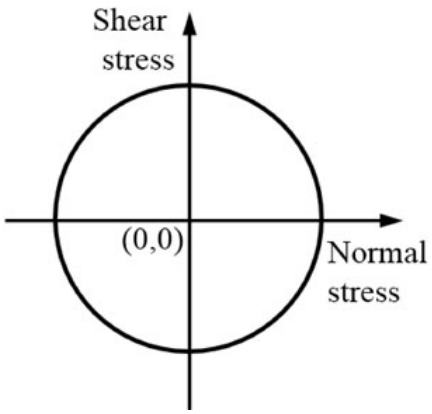
(A) aspect ratio

(B) load factor

(C) shape factor

(D) slenderness ratio

Q.No. 6 The state of stress represented by Mohr's circle shown in the figure is



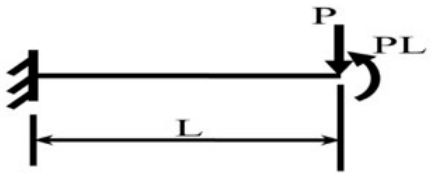
(A) uniaxial tension

(B) biaxial tension of equal magnitude

(C) hydrostatic stress

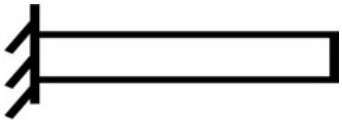
(D) pure shear

Q.No. 7 A weightless cantilever beam of span L is loaded as shown in the figure. For the entire span of the beam, the material properties are identical and the cross section is rectangular with constant width.



From the flexure-critical perspective, the most economical longitudinal profile of the beam to carry the given loads amongst the options given below, is

(A)



(B)

(C)

(D)

Q.No. 8 As per IS 456:2000, the pH value of water for concrete mix shall **NOT** be less than

(A) 4.5

(B) 5.0

(C) 5.5

(D) 6.0

Q.No. 9 The traffic starts discharging from an approach at an intersection with the signal turning green. The constant headway considered from the fourth or fifth headway position is referred to as

(A) discharge headway

(B) effective headway

(C) intersection headway

(D) saturation headway

Q.No. 10 Soil deposit formed due to transportation by wind is termed as

(A) aeolian deposit

(B) alluvial deposit

(C) estuarine deposit

(D) lacustrine deposit

Q.No. 11

A sample of 500 g dry sand, when poured into a 2 litre capacity cylinder which is partially filled with water, displaces 188 cm^3 of water. The density of water is 1 g/cm^3. The specific gravity of the sand is

(A) 2.72
(B) 2.66
(C) 2.55
(D) 2.52

Q.No. 12 Muskingum method is used in

(A) hydrologic reservoir routing
(B) hydrologic channel routing
(C) hydraulic channel routing
(D) hydraulic reservoir routing

Q.No. 13 Superpassage is a canal cross-drainage structure in which

(A) natural stream water flows with free surface below a canal
(B) natural stream water flows under pressure below a canal
(C) canal water flows with free surface below a natural stream
(D) canal water flows under pressure below a natural stream

Q.No. 14 A triangular direct runoff hydrograph due to a storm has a time base of 90 hours. The peak flow of 60 m^3/s occurs at 20 hours from the start of the storm. The area of catchment is 300 km^2. The rainfall excess of the storm (in cm), is

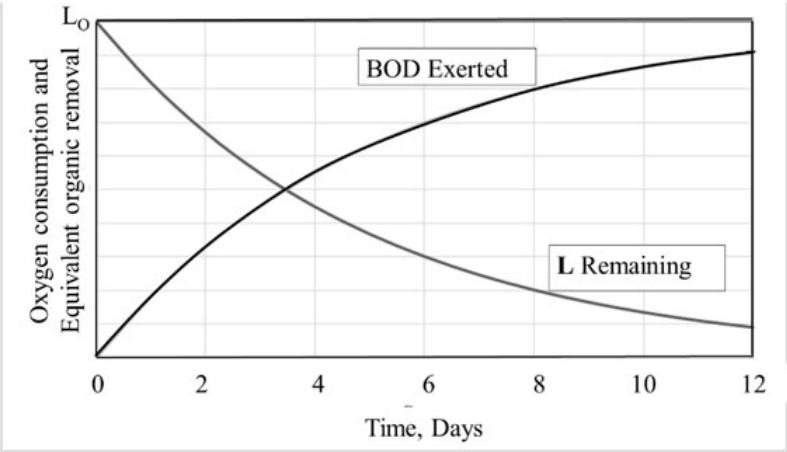
(A) 2.00
(B) 3.24
(C) 5.40
(D) 6.48

Q.No. 15 The velocity components in the x and y directions for an incompressible flow are given as $u = (-5 + 6x)$ and $v = -(9 + 6y)$, respectively. The equation of the streamline is

(A) $(-5 + 6x) - (9 + 6y) = \text{constant}$
(B) $\dfrac{-5 + 6x}{9 + 6y} = \text{constant}$
(C) $(-5 + 6x)(9 + 6y) = \text{constant}$
(D) $\dfrac{9 + 6y}{-5 + 6x} = \text{constant}$

Q.No. 16

The relationship between oxygen consumption and equivalent biodegradable organic removal (i.e., BOD) in a closed container with respect to time is shown in the figure



Assume that the rate of oxygen consumption is directly proportional to the amount of degradable organic matter and is expressed as $\frac{dL_t}{dt} = -kL_t$, where, L_t (in mg/litre) is the oxygen equivalent of the organics remaining at time t and k (in d^{-1}) is the degradation rate constant. L_0 is the oxygen equivalent of organic matter at time, $t = 0$.

In the above context, the correct expression is

(A) $BOD_5 = L_5$

(B) $BOD_t = L_0 - L_t$

(C) $L_0 = L_t e^{-kt}$

(D) $L_t = L_0 (1 - e^{-kt})$

Q.No. 17 A gas contains two types of suspended particles having average sizes of 2 μm and 50 μm. Amongst the options given below, the most suitable pollution control strategy for removal of these particles is

(A) settling chamber followed by bag filter

(B) electrostatic precipitator followed by venturi scrubber

(C) electrostatic precipitator followed by cyclonic separator

(D) bag filter followed by electrostatic precipitator

Q.No. 18 A fair (unbiased) coin is tossed 15 times. The probability of getting exactly 8 Heads (*round off to three decimal places*), is _____.

Q.No. 19 The maximum applied load on a cylindrical concrete specimen of diameter 150 mm and length 300 mm tested as per the split tensile strength test guidelines of IS 5816:1999 is 157 kN. The split tensile strength (in MPa, *round off to one decimal place*) of the specimen is _____.

Q.No. 20 For an axle load of 15 tonne on a road, the Vehicle Damage Factor (*round off to two decimal places*), in terms of the standard axle load of 8 tonne, is _____.

Q.No. 21

24-h traffic count at a road section was observed to be 1000 vehicles on a Tuesday in the month of July. If daily adjustment factor for Tuesday is 1.121 and monthly adjustment factor for July is 0.913, the Annual Average Daily Traffic (in veh/day, *round off to the nearest integer*) is _____.

Q.No. 22 A soil has dry unit weight of 15.5 kN/m^3, specific gravity of 2.65 and degree of saturation of 72%. Considering the unit weight of water as 10 kN/m^3, the water content of the soil (in %, *round off to two decimal places*) is _____.

Q.No. 23 A one-dimensional consolidation test is carried out on a standard 19 mm thick clay sample. The oedometer's deflection gauge indicates a reading of 2.1 mm, just before removal of the load, without allowing any swelling. The void ratio is 0.62 at this stage. The initial void ratio (*round off to two decimal places*) of the standard specimen is _____.

Q.No. 24 Velocity distribution in a boundary layer is given by $\frac{u}{U_\infty} = \sin\left(\frac{\pi}{2}\frac{y}{\delta}\right)$, where u is the velocity at vertical coordinate y, U_∞ is the free stream velocity and δ is the boundary layer thickness. The values of U_∞ and δ are 0.3 m/s and 1.0 m, respectively. The velocity gradient $(\frac{\partial u}{\partial y})$ (in s^{-1}, *round off to two decimal places*) at $y = 0$, is _____.

Q.No. 25 Two identically sized primary settling tanks receive water for Type-I settling (discrete particles in dilute suspension) under laminar flow conditions. The Surface Overflow Rate (SOR) maintained in the two tanks are 30 m^3/m^2.d and 15 m^3/m^2.d. The lowest diameters of the particles, which shall be settled out completely under SORs of 30 m^3/m^2.d and 15 m^3/m^2.d are designated as d_{30} and d_{15}, respectively. The ratio, d_{30}/d_{15} (*round off to two decimal places*), is _____.

Q26 - Q55 carry two marks each.

Q.No. 26 An ordinary differential equation is given below

$$6\frac{d^2y}{dx^2} + \frac{dy}{dx} - y = 0$$

The general solution of the above equation (with constants C_1 and C_2), is

(A) $y(x) = C_1 e^{-\frac{x}{3}} + C_2 e^{\frac{x}{2}}$

(B) $y(x) = C_1 e^{\frac{x}{3}} + C_2 e^{-\frac{x}{2}}$

(C) $y(x) = C_1 x e^{-\frac{x}{3}} + C_2 e^{\frac{x}{2}}$

(D) $y(x) = C_1 e^{-\frac{x}{3}} + C_2 x e^{\frac{x}{2}}$

Q.No. 27

A 4×4 matrix $[P]$ is given below

$$[P]=\begin{bmatrix} 0 & 1 & 3 & 0 \\ -2 & 3 & 0 & 4 \\ 0 & 0 & 6 & 1 \\ 0 & 0 & 1 & 6 \end{bmatrix}$$

The eigenvalues of $[P]$ are

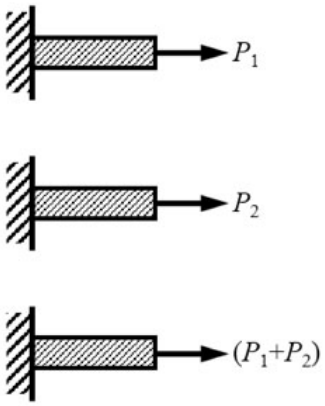
(A) 0, 3, 6, 6

(B) 1, 2, 3, 4

(C) 3, 4, 5, 7

(D) 1, 2, 5, 7

Q.No. 28 A prismatic linearly elastic bar of length L, cross-sectional area A, and made up of a material with Young's modulus E, is subjected to axial tensile force as shown in the figures. When the bar is subjected to axial tensile forces P_1 and P_2, the strain energies stored in the bar are U_1 and U_2, respectively.



If U is the strain energy stored in the same bar when subjected to an axial tensile force $(P_1 + P_2)$, the correct relationship is

(A) $U = U_1 + U_2$

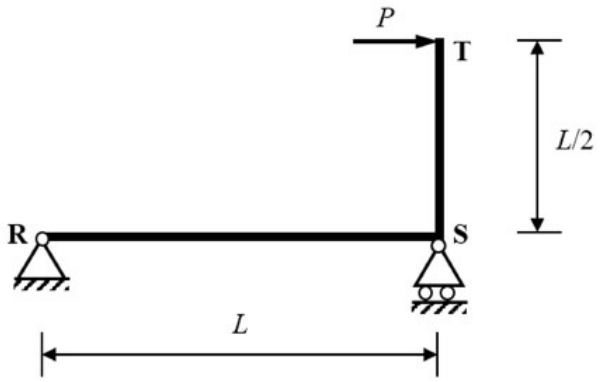
(B) $U = U_1 - U_2$

(C) $U < U_1 + U_2$

(D) $U > U_1 + U_2$

Q.No. 29

The planar structure RST shown in the figure is roller-supported at S and pin-supported at R. Members RS and ST have uniform flexural rigidity (EI) and S is a rigid joint. Consider only bending deformation and neglect effects of self-weight and axial stiffening.



When the structure is subjected to a concentrated horizontal load P at the end T, the magnitude of rotation at the support R, is

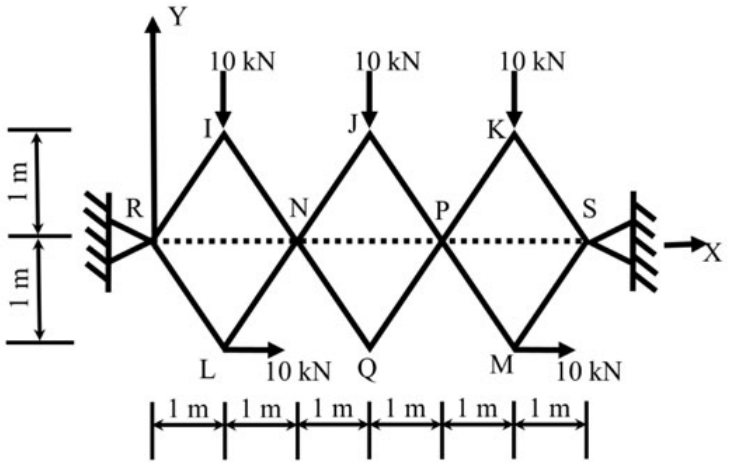
(A) $\frac{PL^3}{12EI}$

(B) $\frac{PL^2}{12EI}$

(C) $\frac{PL^2}{6EI}$

(D) $\frac{PL}{6EI}$

Q.No. 30 Joints I, J, K, L, Q and M of the frame shown in the figure (*not drawn to the scale*) are pins. Continuous members IQ and LJ are connected through a pin at N. Continuous members JM and KQ are connected through a pin at P. The frame has hinge supports at joints R and S. The loads acting at joints I, J and K are along the negative Y direction and the loads acting at joints L and M are along the positive X direction.



The magnitude of the horizontal component of reaction (in kN) at S, is

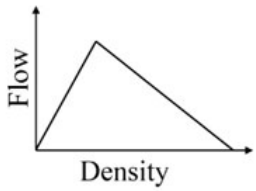
(A) 5

(B) 10

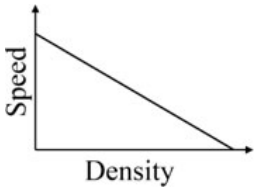
(C) 15

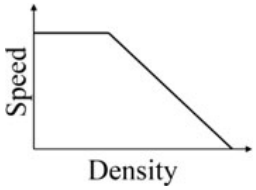
(D) 20

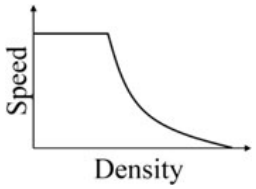
Q.No. 31 The flow-density relationship of traffic on a highway is shown in the figure

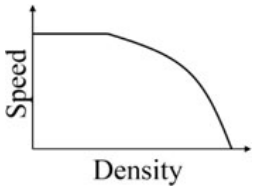


The correct representation of speed-density relationship of the traffic on this highway is

(A)


(B)


(C)


(D)


Q.No. 32 Group-I gives a list of test methods for evaluating properties of aggregates. Group-II gives the list of properties to be evaluated.

Group-I: Test methods	**Group-II: Properties**
P. Soundness test	1. Strength
Q. Crushing test	2. Resistance to weathering
R. Los Angeles abrasion test	3. Adhesion
S. Stripping value test	4. Hardness

The correct match of test methods under Group-I to properties under Group-II, is

(A) P-4; Q-1; R-2; S-3

(B) P-2; Q-1; R-4; S-3

(C) P-3; Q-4; R-1; S-2

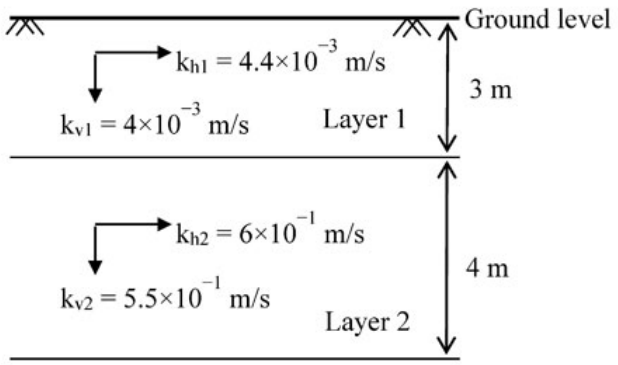
(D) P-2; Q-4; R-3; S-1

Q.No. 33

For the hottest month of the year at the proposed airport site, the monthly mean of the average daily temperature is 39°C. The monthly mean of the maximum daily temperature is 48°C for the same month of the year. From the given information, the calculated Airport Reference Temperature (in °C), is

(A) 36
(B) 39
(C) 42
(D) 48

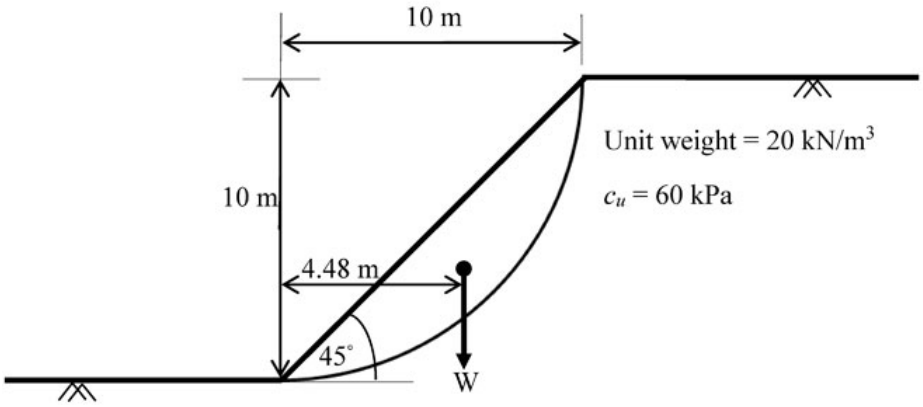
Q.No. 34 Permeability tests were carried out on the samples collected from two different layers as shown in the figure (*not drawn to the scale*). The relevant horizontal (k_h) and vertical (k_v) coefficients of permeability are indicated for each layer.



The ratio of the equivalent horizontal to vertical coefficients of permeability, is

(A) 37.29
(B) 80.20
(C) 68.25
(D) 0.03

Q.No. 35 A 10 m high slope of dry clay soil (unit weight = 20 kN/m^3), with a slope angle of 45° and the circular slip surface, is shown in the figure (*not drawn to the scale*). The weight of the slip wedge is denoted by W. The undrained unit cohesion (c_u) is 60 kPa.



The factor of safety of the slope against slip failure, is

(A) 1.84
(B) 1.57
(C) 0.58
(D) 1.67

Q.No. 36

Crops are grown in a field having soil, which has field capacity of 30% and permanent wilting point of 13%. The effective depth of root zone is 80 cm. Irrigation water is supplied when the average soil moisture drops to 20%. Consider density of the soil as 1500 kg/m^3 and density of water as 1000 kg/m^3. If the daily consumptive use of water for the crops is 2 mm, the frequency of irrigating the crops (in days), is

(A) 7
(B) 10
(C) 11
(D) 13

Q.No. 37 Alkalinity of water, in equivalent/litre (eq/litre), is given by

$$\{HCO_3^-\} + 2\{CO_3^{2-}\} + \{OH^-\} - \{H^+\}$$

Where, { } represents concentration in mol/litre. For a water sample, the concentrations of $HCO_3^- = 2\times10^{-3}$ mol/litre, $CO_3^{2-} = 3.04 \times10^{-4}$ mol/litre and the pH of water = 9.0. The atomic weights are: Ca = 40; C = 12; and O = 16. If the concentration of OH^- and H^+ are NEGLECTED, the alkalinity of the water sample (in mg/litre as $CaCO_3$), is

(A) 130.4
(B) 100.0
(C) 50.0
(D) 65.2

Q.No. 38 A theodolite was set up at a station P. The angle of depression to a vane 2 m above the foot of a staff held at another station Q was 45°. The horizontal distance between stations P and Q is 20 m. The staff reading at a benchmark S of RL 433.050 m is 2.905 m. Neglecting the errors due to curvature and refraction, the RL of the station Q (in m), is

(A) 413.050
(B) 413.955
(C) 431.050
(D) 435.955

Q.No. 39 The Fourier series to represent $x - x^2$ for $-\pi \le x \le \pi$ is given by

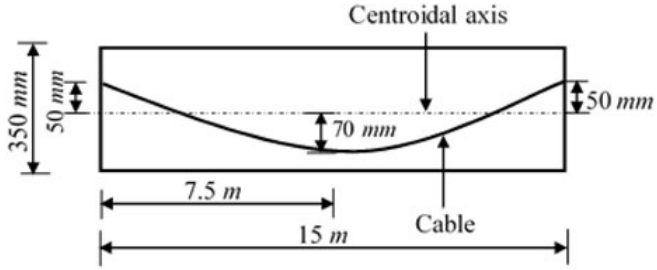
$$x - x^2 = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos nx + \sum_{n=1}^{\infty} b_n \sin nx$$

The value of a_0 (*round off to two decimal places*), is _____.

Q.No. 40 The diameter and height of a right circular cylinder are 3 cm and 4 cm, respectively. The absolute error in each of these two measurements is 0.2 cm. The absolute error in the computed volume (in cm^3, *round off to three decimal places*), is _____.

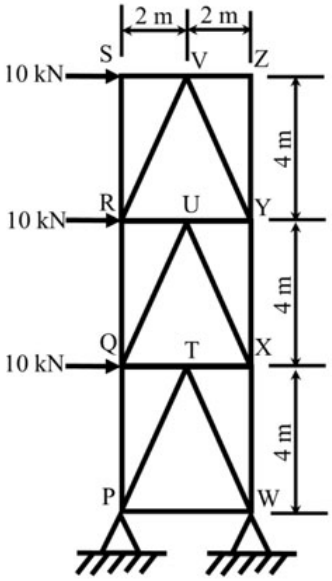
Q.No. 41

A concrete beam of span 15 m, 150 mm wide and 350 mm deep is prestressed with a parabolic cable as shown in the figure (*not drawn to the scale*). Coefficient of friction for the cable is 0.35, and coefficient of wave effect is 0.0015 per meter.



If the cable is tensioned from one end only, the percentage loss (*round off to one decimal place*) in the cable force due to friction, is _____.

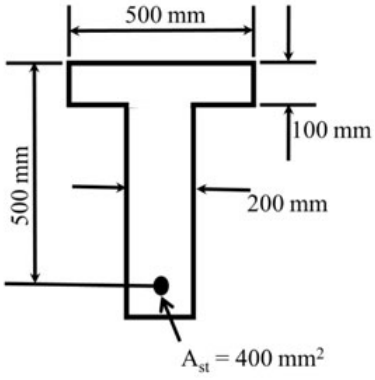
Q.No. 42 The plane truss has hinge supports at P and W and is subjected to the horizontal forces as shown in the figure (*not drawn to the scale*)



Representing the tensile force with '+' sign and the compressive force with '−' sign, the force in member XW (in kN, *round off to the nearest integer*), is _____.

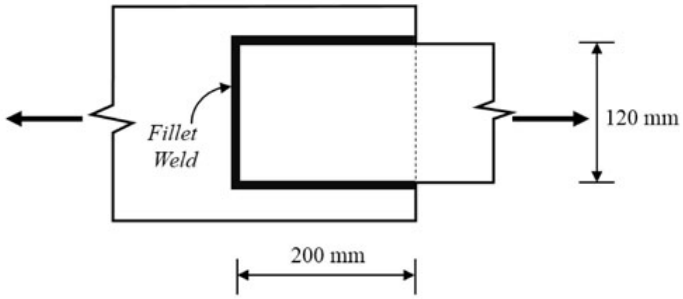
Q.No. 43

The cross-section of the reinforced concrete beam having an effective depth of 500 mm is shown in the figure (*not drawn to the scale*). The grades of concrete and steel used are M35 and Fe550, respectively. The area of tension reinforcement is 400 mm^2. It is given that corresponding to 0.2% proof stress, the material safety factor is 1.15 and the yield strain of Fe550 steel is 0.0044.



As per IS 456:2000, the limiting depth (in mm, *round off to the nearest integer*) of the neutral axis measured from the extreme compression fiber, is _____.

Q.No. 44 Two steel plates are lap jointed in a workshop using 6 mm thick fillet weld as shown in the figure (*not drawn to the scale*). The ultimate strength of the weld is 410 MPa.

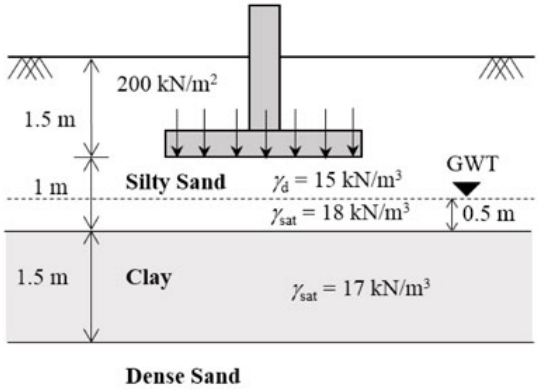


As per Limit State Design of IS 800:2007, the design capacity (in kN, *round off to three decimal places*) of the welded connection, is _____.

Q.No. 45 The design speed of a two-lane two-way road is 60 km/h and the longitudinal coefficient of friction is 0.36. The reaction time of a driver is 2.5 seconds. Consider acceleration due to gravity as 9.8 m/s^2. The intermediate sight distance (in m, *round off to the nearest integer*) required for the road is _____.

Q.No. 46

A footing of size 2 m × 2 m transferring a pressure of 200 kN/m^2, is placed at a depth of 1.5 m below the ground as shown in the figure (*not drawn to the scale*). The clay stratum is normally consolidated. The clay has specific gravity of 2.65 and compression index of 0.3.



Considering 2:1 (vertical to horizontal) method of load distribution and $\gamma_w = 10$ kN/m^3, the primary consolidation settlement (in mm, *round off to two decimal places*) of the clay stratum is _____.

Q.No. 47 A constant-head permeability test was conducted on a soil specimen under a hydraulic gradient of 2.5. The soil specimen has specific gravity of 2.65 and saturated water content of 20%. If the coefficient of permeability of the soil is 0.1 cm/s, the seepage velocity (in cm/s, *round off to two decimal places*) through the soil specimen is _____.

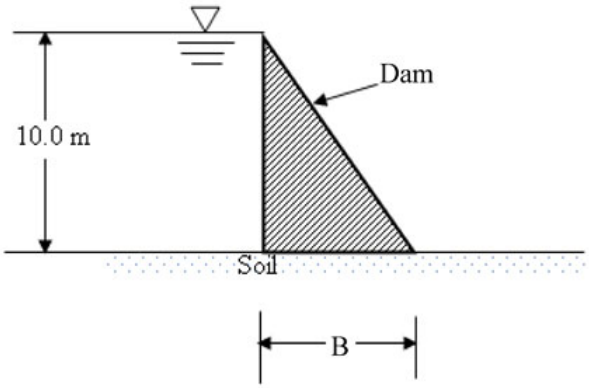
Q.No. 48 A 5 m high vertical wall has a saturated clay backfill. The saturated unit weight and cohesion of clay are 18 kN/m^3 and 20 kPa, respectively. The angle of internal friction of clay is zero. In order to prevent development of tension zone, the height of the wall is required to be increased. Dry sand is used as backfill above the clay for the increased portion of the wall. The unit weight and angle of internal friction of sand are 16 kN/m^3 and 30°, respectively. Assume that the back of the wall is smooth and top of the backfill is horizontal. To prevent the development of tension zone, the minimum height (in m, *round off to one decimal place*) by which the wall has to be raised, is _____.

Q.No. 49 A cast iron pipe of diameter 600 mm and length 400 m carries water from a tank and discharges freely into air at a point 4.5 m below the water surface in the tank. The friction factor of the pipe is 0.018. Consider acceleration due to gravity as 9.81 m/s^2. The velocity of the flow in pipe (in m/s, *round off to two decimal places*) is _____.

Q.No. 50 A hydraulic jump occurs in a triangular (V-shaped) channel with side slopes 1:1 (vertical to horizontal). The sequent depths are 0.5 m and 1.5 m. The flow rate (in m^3/s, *round off to two decimal places*) in the channel is _____.

Q.No. 51

A concrete dam holds 10 m of static water as shown in the figure (*not drawn to the scale)*. The uplift is assumed to vary linearly from full hydrostatic head at the heel, to zero at the toe of dam. The coefficient of friction between the dam and foundation soil is 0.45. Specific weights of concrete and water are 24 kN/m^3 and 9.81 kN/m^3, respectively.



For NO sliding condition, the required minimum base width B (in m, *round off to two decimal places*) is _____.

Q.No. 52 The ion product of water (pK_w) is 14. If a rain water sample has a pH of 5.6, the concentration of OH^- in the sample (in 10^{-9} mol/litre, *round off to one decimal place*), is _____.

Q.No. 53 A waste to energy plant burns dry solid waste of composition: Carbon = 35%, Oxygen = 26%, Hydrogen = 10%, Sulphur = 6%, Nitrogen = 3% and Inerts = 20%. Burning rate is 1000 tonnes/d. Oxygen in air by weight is 23%. Assume complete conversion of Carbon to CO_2, Hydrogen to H_2O, Sulphur to SO_2 and Nitrogen to NO_2.

Given Atomic weights: H = 1, C = 12, N = 14, O = 16, S = 32

The stoichiometric (theoretical) amount of air (in tonnes/d, *round off to the nearest integer*) required for complete burning of this waste, is _____.

Q.No. 54 A sample of water contains an organic compound $C_8H_{16}O_8$ at a concentration of 10^{-3} mol/litre. Given that the atomic weight of C = 12 g/mol, H = 1 g/mol, and O = 16 g/mol, the theoretical oxygen demand of water (in g of O_2 per litre, *round off to two decimal places*), is _____.

Q.No. 55 A theodolite is set up at station A. The RL of instrument axis is 212.250 m. The angle of elevation to the top of a 4 m long staff, held vertical at station B, is 7°. The horizontal distance between stations A and B is 400 m. Neglecting the errors due to curvature of earth and refraction, the RL (in m, *round off to three decimal places*) of station B is _____.

Answer Key - CE2: Civil Engineering

Q.No.	Session	Que.Type	Sec. Name	Key	Marks
1	8	MCQ	GA	B	1
2	8	MCQ	GA	A	1
3	8	MCQ	GA	D	1
4	8	MCQ	GA	C	1
5	8	MCQ	GA	C	1
6	8	MCQ	GA	A	2
7	8	MCQ	GA	C	2
8	8	MCQ	GA	C	2
9	8	MCQ	GA	B	2
10	8	MCQ	GA	MTA	2
1	8	MCQ	CE	B	1
2	8	MCQ	CE	C	1
3	8	MCQ	CE	D	1
4	8	MCQ	CE	D	1
5	8	MCQ	CE	C	1
6	8	MCQ	CE	D	1
7	8	MCQ	CE	C	1
8	8	MCQ	CE	D	1
9	8	MCQ	CE	D	1
10	8	MCQ	CE	A	1
11	8	MCQ	CE	B	1
12	8	MCQ	CE	B	1
13	8	MCQ	CE	C	1
14	8	MCQ	CE	B	1
15	8	MCQ	CE	C	1
16	8	MCQ	CE	B	1
17	8	MCQ	CE	A	1
18	8	NAT	CE	0.190 to 0.200	1
19	8	NAT	CE	2.0 to 2.4	1
20	8	NAT	CE	12.30 to 12.40	1
21	8	NAT	CE	1021 to 1024	1
22	8	NAT	CE	19.00 to 19.50	1
23	8	NAT	CE	0.78 to 0.88	1
24	8	NAT	CE	0.45 to 0.49	1
25	8	NAT	CE	1.40 to 1.42	1
26	8	MCQ	CE	B	2
27	8	MCQ	CE	D	2
28	8	MCQ	CE	D	2
29	8	MCQ	CE	B	2
30	8	MCQ	CE	C	2
31	8	MCQ	CE	C	2
32	8	MCQ	CE	B	2
33	8	MCQ	CE	C	2

34	8	MCQ	CE	A	2
35	8	MCQ	CE	MTA	2
36	8	MCQ	CE	MTA	2
37	8	MCQ	CE	A	2
38	8	MCQ	CE	B	2
39	8	NAT	CE	-6.61 to -6.55	2
40	8	NAT	CE	5.180 to 5.200	2
41	8	NAT	CE	3.8 to 4.7	2
42	8	NAT	CE	-31 to -29	2
43	8	NAT	CE	220 to 224	2
44	8	NAT	CE	400 to 420	2
45	8	NAT	CE	154 to 178	2
46	8	NAT	CE	74.00 to 76.00	2
47	8	NAT	CE	0.70 to 0.73	2
48	8	NAT	CE	2.4 to 2.6	2
49	8	NAT	CE	2.40 to 2.70	2
50	8	NAT	CE	1.70 to 1.76	2
51	8	NAT	CE	15.00 to 16.00	2
52	8	NAT	CE	3.8 to 4.1	2
53	8	NAT	CE	6963 to 6967	2
54	8	NAT	CE	0.24 to 0.27	2
55	8	NAT	CE	257.200 to 257.600	2