Q. 1 – Q. 5 carry one mark each.

Q.1 Out of the following four sentences, select the most suitable sentence with respect to grammar and usage.

(A) I will not leave the place until the minister does not meet me.

(B) I will not leave the place until the minister doesn’t meet me.

(C) I will not leave the place until the minister meet me.

(D) I will not leave the place until the minister meets me.

Q.2 A rewording of something written or spoken is a ______________.

(A) paraphrase (B) paradox (C) paradigm (D) paraffin

Q.3 Archimedes said, “Give me a lever long enough and a fulcrum on which to place it, and I will move the world.”

The sentence above is an example of a ___________ statement.

(A) figurative (B) collateral

(C) literal (D) figurine

Q.4 If ‘relftaga’ means carefree, ‘otaga’ means careful and ‘fertaga’ means careless, which of the following could mean ‘aftercare’?

(A) zentaga (B) tagafer (C) tagazen (D) relffer

Q.5 A cube is built using 64 cubic blocks of side one unit. After it is built, one cubic block is removed from every corner of the cube. The resulting surface area of the body (in square units) after the removal is __________.

(A) 56 (B) 64 (C) 72 (D) 96

Q. 6 – Q. 10 carry two marks each.

Q.6 A shaving set company sells 4 different types of razors, Elegance, Smooth, Soft and Executive. Elegance sells at Rs. 48, Smooth at Rs. 63, Soft at Rs. 78 and Executive at Rs. 173 per piece. The table below shows the numbers of each razor sold in each quarter of a year.

Quarter \ Product	Elegance	Smooth	Soft	Executive
Q1	27300	20009	17602	9999
Q2	25222	19392	18445	8942
Q3	28976	22429	19544	10234
Q4	21012	18229	16595	10109

Which product contributes the greatest fraction to the revenue of the company in that year?

(A) Elegance (B) Executive (C) Smooth (D) Soft

Q.7 Indian currency notes show the denomination indicated in at least seventeen languages. If this is not an indication of the nation's diversity, nothing else is.

Which of the following can be logically inferred from the above sentences?

(A) India is a country of exactly seventeen languages.

(B) Linguistic pluralism is the only indicator of a nation's diversity.

(C) Indian currency notes have sufficient space for all the Indian languages.

(D) Linguistic pluralism is strong evidence of India's diversity.

Q.8 Consider the following statements relating to the level of poker play of four players **P**, **Q**, **R** and **S**.

I. **P** always beats **Q**
II. **R** always beats **S**
III. **S** loses to **P** only sometimes
IV. **R** always loses to **Q**

Which of the following can be logically inferred from the above statements?

(i) **P** is likely to beat all the three other players
(ii) **S** is the absolute worst player in the set

(A) (i) only (B) (ii) only (C) (i) and (ii) (D) neither (i) nor (ii)

Q.9 If $f(x) = 2x^7 + 3x - 5$, which of the following is a factor of $f(x)$?

(A) (x^3+8) (B) $(x-1)$ (C) $(2x-5)$ (D) $(x+1)$

Q.10 In a process, the number of cycles to failure decreases exponentially with an increase in load. At a load of 80 units, it takes 100 cycles for failure. When the load is halved, it takes 10000 cycles for failure. The load for which the failure will happen in 5000 cycles is ________.

(A) 40.00 (B) 46.02 (C) 60.01 (D) 92.02

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each

Q.1 Newton-Raphson method is to be used to find root of equation $3x - e^x + \sin x = 0$. If the initial trial value for the root is taken as 0.333, the next approximation for the root would be __________ (*note: answer up to three decimal*)

Q.2 The type of partial differential equation $\frac{\partial^2 P}{\partial x^2} + \frac{\partial^2 P}{\partial y^2} + 3\frac{\partial^2 P}{\partial x \partial y} + 2\frac{\partial P}{\partial x} - \frac{\partial P}{\partial y} = 0$ is

(A) elliptic (B) parabolic (C) hyperbolic (D) none of these

Q.3 If the entries in each column of a square matrix M add up to 1, then an eigenvalue of M is

(A) 4 (B) 3 (C) 2 (D) 1

Q.4 Type II error in hypothesis testing is

(A) acceptance of the null hypothesis when it is false and should be rejected
(B) rejection of the null hypothesis when it is true and should be accepted
(C) rejection of the null hypothesis when it is false and should be rejected
(D) acceptance of the null hypothesis when it is true and should be accepted

Q.5 The solution of the partial differential equation $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$ is of the form

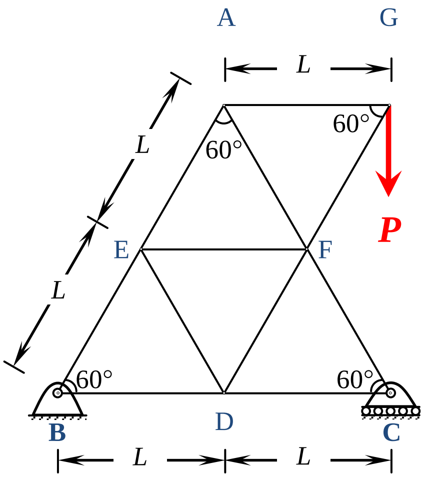
(A) $C\cos(kt)\left[C_1 e^{(\sqrt{k/\alpha})x} + C_2 e^{-(\sqrt{k/\alpha})x}\right]$

(B) $Ce^{kt}\left[C_1 e^{(\sqrt{k/\alpha})x} + C_2 e^{-(\sqrt{k/\alpha})x}\right]$

(C) $Ce^{kt}\left[C_1 \cos\left(\sqrt{k/\alpha}\right)x + C_2 \sin(-\sqrt{k/\alpha})x\right]$

(D) $C\sin(kt)\left[C_1 \cos\left(\sqrt{k/\alpha}\right)x + C_2 \sin(-\sqrt{k/\alpha})x\right]$

Q.6 Consider the plane truss with load P as shown in the figure. Let the horizontal and vertical reactions at the joint B be H_B and V_B, respectively and V_C be the vertical reaction at the joint C.



Which one of the following sets gives the correct values of V_B, H_B and V_C?

(A) $V_B = 0$; $H_B = 0$; $V_C = P$

(B) $V_B = P/2$; $H_B = 0$; $V_C = P/2$

(C) $V_B = P/2$; $H_B = P (\sin 60°)$; $V_C = P/2$

(D) $V_B = P$; $H_B = P (\cos 60°)$; $V_C = 0$

Q.7 In shear design of an RC beam, other than the allowable shear strength of concrete (τ_c), there is also an additional check suggested in IS 456-2000 with respect to the maximum permissible shear stress $(\tau_{c\max})$. The check for $\tau_{c\max}$ is required to take care of

(A) additional shear resistance from reinforcing steel
(B) additional shear stress that comes from accidental loading
(C) possibility of failure of concrete by diagonal tension
(D) possibility of crushing of concrete by diagonal compression

Q.8 The semi-compact section of a laterally unsupported steel beam has an elastic section modulus, plastic section modulus and design bending compressive stress of 500 cm^3, 650 cm^3 and 200 MPa, respectively. The design flexural capacity (expressed in kNm) of the section is _________

Q.9 Bull's trench kiln is used in the manufacturing of

(A) lime (B) cement (C) bricks (D) none of these

Q.10 The compound which is largely responsible for initial setting and early strength gain of Ordinary Portland Cement is

(A) C_3A (B) C_3S (C) C_2S (D) C_4AF

Q.11 In the consolidated undrained triaxial test on a saturated soil sample, the pore water pressure is zero

(A) during shearing stage only
(B) at the end of consolidation stage only
(C) both at the end of consolidation and during shearing stages
(D) under none of the above conditions

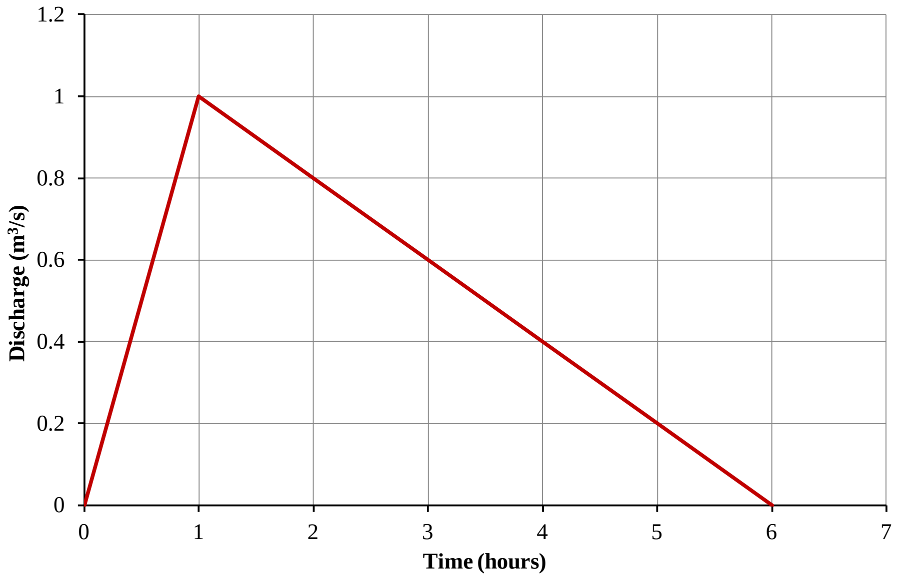
Q.12 A fine grained soil is found to be plastic in the water content range of 26-48%. As per Indian Standard Classification System, the soil is classified as

(A) CL (B) CH (C) CL-ML (D) CI

Q.13 A vertical cut is to be made in a soil mass having cohesion c, angle of internal friction φ, and unit weight γ. Considering K_a and K_p as the coefficients of active and passive earth pressures, respectively, the maximum depth of unsupported excavation is

(A) $\dfrac{4c}{\gamma\sqrt{K_p}}$ (B) $\dfrac{2c\sqrt{K_p}}{\gamma}$ (C) $\dfrac{4c\sqrt{K_a}}{\gamma}$ (D) $\dfrac{4c}{\gamma\sqrt{K_a}}$

Q.14 The direct runoff hydrograph in response to 5 cm rainfall excess in a catchment is shown in the figure. The area of the catchment (expressed in hectares) is________



Q.15 The type of flood routing (Group I) and the equation(s) used for the purpose (Group II) are given below.

Group I	Group II
P Hydrologic flood routing	1. Continuity equation
Q Hydraulic flood routing	2. Momentum equation
	3. Energy equation

The correct match is

(A) P - 1; Q - 1, 2 & 3 (B) P - 1; Q - 1 & 2
(C) P - 1 & 2; Q - 1 (D) P - 1 & 2; Q - 1 & 2

Q.16 The pre-jump Froude Number for a particular flow in a horizontal rectangular channel is 10. The ratio of sequent depths (i.e., post-jump depth to pre-jump depth) is ________

Q.17 Pre-cursors to photochemical oxidants are

(A) NO_X, VOCs and sunlight
(B) SO_2, CO_2 and sunlight
(C) H_2S, CO and sunlight
(D) SO_2, NH_3 and sunlight

Q.18 Crown corrosion in a reinforced concrete sewer is caused by:

(A) H_2S (B) CO_2 (C) CH_4 (D) NH_3

Q.19 It was decided to construct a fabric filter, using bags of 0.45 m diameter and 7.5 m long, for removing industrial stack gas containing particulates. The expected rate of airflow into the filter is 10 m^3/s. If the filtering velocity is 2.0 m/min, the minimum number of bags (rounded to nearest higher integer) required for continuous cleaning operation is

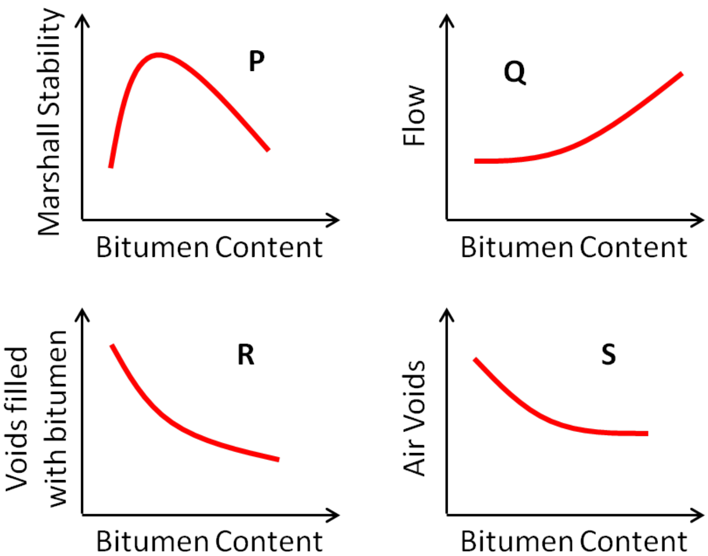
(A) 27 (B) 29 (C) 31 (D) 32

Q.20 Match the items in Group – I with those in Group – II and choose the right combination.

Group - I	Group - II
P. Activated sludge process	1. Nitrifiers and denitrifiers
Q. Rising of sludge	2. Autotrophic bacteria
R. Conventional nitrification	3. Heterotrophic bacteria
S. Biological nitrogen removal	4. Denitrifiers

(A) P-3, Q-4, R-2, S-1 (B) P-2, Q-3, R-4, S-1
(C) P-3, Q-2, R-4, S-1 (D) P-1, Q-4, R-2, S-3

Q.21 During a forensic investigation of pavement failure, an engineer reconstructed the graphs P, Q, R and S, using partial and damaged old reports.



Theoretically plausible correct graphs according to the 'Marshall mixture design output' are

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

Q.22 In a one-lane one-way homogeneous traffic stream, the observed average headway is 3.0 s. The flow (expressed in vehicles/hr) in this traffic stream is________

Q.23 The minimum number of satellites needed for a GPS to determine its position precisely is

(A) 2 (B) 3 (C) 4 (D) 24

Q.24 The system that uses the Sun as a source of electromagnetic energy and records the naturally radiated and reflected energy from the object is called

(A) Geographical Information System
(B) Global Positioning System
(C) Passive Remote Sensing
(D) Active Remote Sensing

Q.25 The staff reading taken on a workshop floor using a level is 0.645 m. The inverted staff reading taken to the bottom of a beam is 2.960 m. The reduced level of the floor is 40.500 m. The reduced level (expressed in m) of the bottom of the beam is

(A) 44.105 (B) 43.460 (C) 42.815 (D) 41.145

Q. 26 – Q. 55 carry two marks each

Q.26 Probability density function of a random variable X is given below

$$f(x) = \begin{cases} 0.25 & \text{if } 1 \leq x \leq 5 \\ 0 & \text{otherwise} \end{cases}$$

P($X \leq 4$) is

(A) $\frac{3}{4}$ (B) $\frac{1}{2}$ (C) $\frac{1}{4}$ (D) $\frac{1}{8}$

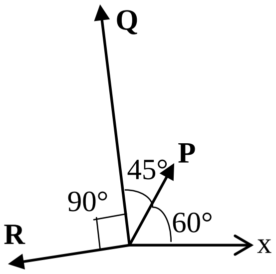
Q.27 The value of $\int_0^\infty \frac{1}{1+x^2} dx + \int_0^\infty \frac{\sin x}{x} dx$ is

(A) $\frac{\pi}{2}$ (B) π (C) $\frac{3\pi}{2}$ (D) 1

Q.28 The area of the region bounded by the parabola $y = x^2 + 1$ and the straight line $x + y = 3$ is

(A) $\frac{59}{6}$ (B) $\frac{9}{2}$ (C) $\frac{10}{3}$ (D) $\frac{7}{6}$

Q.29 The magnitudes of vectors **P, Q** and **R** are 100 kN, 250 kN and 150 kN, respectively as shown in the figure.



The respective values of the magnitude (in kN) and the direction (with respect to the x-axis) of the resultant vector are

(A) 290.9 and 96.0° (B) 368.1 and 94.7° (C) 330.4 and 118.9° (D) 400.1 and 113.5°

Q.30 The respective expressions for complimentary function and particular integral part of the solution of the differential equation $\frac{d^4y}{dx^4}+3\frac{d^2y}{dx^2}=108x^2$ are

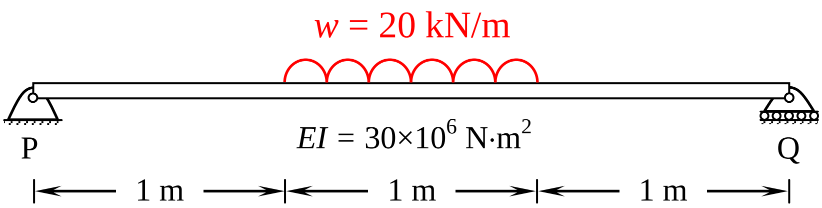
(A) $\left[c_1+c_2x+c_3\sin\sqrt{3}x+c_4\cos\sqrt{3}x\right]$ and $\left[3x^4-12x^2+c\right]$

(B) $\left[c_2x+c_3\sin\sqrt{3}x+c_4\cos\sqrt{3}x\right]$ and $\left[5x^4-12x^2+c\right]$

(C) $\left[c_1+c_3\sin\sqrt{3}x+c_4\cos\sqrt{3}x\right]$ and $\left[3x^4-12x^2+c\right]$

(D) $\left[c_1+c_2x+c_3\sin\sqrt{3}x+c_4\cos\sqrt{3}x\right]$ and $\left[5x^4-12x^2+c\right]$

Q.31 A 3 m long simply supported beam of uniform cross section is subjected to a uniformly distributed load of w = 20 kN/m in the central 1 m as shown in the figure.



If the flexural rigidity (EI) of the beam is 30 x 10^6 N-m^2, the maximum slope (expressed in radians) of the deformed beam is

(A) 0.681×10^{-7} (B) 0.943×10^{-7} (C) 4.310×10^{-7} (D) 5.910×10^{-7}

Q.32 Two beams PQ (fixed at P and with a roller support at Q, as shown in Figure I, which allows vertical movement) and XZ (with a hinge at Y) are shown in the Figures I and II respectively. The spans of PQ and XZ are L and 2L respectively. Both the beams are under the action of uniformly distributed load (W) and have the same flexural stiffness, *EI* (where, *E* and *I* respectively denote modulus of elasticity and moment of inertia about axis of bending). Let the maximum deflection and maximum rotation be δ_{max1} and θ_{max1}, respectively, in the case of beam PQ and the corresponding quantities for the beam XZ be δ_{max2} and θ_{max2}, respectively.

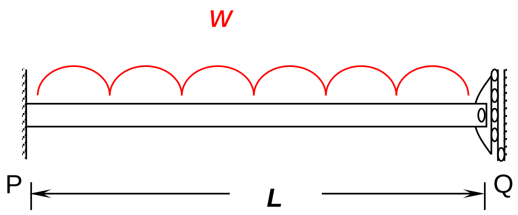


Figure I

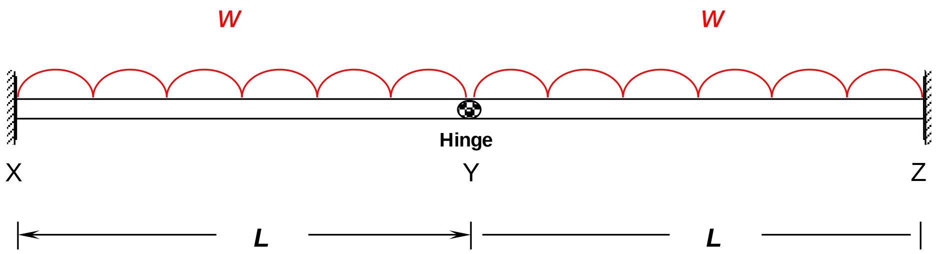
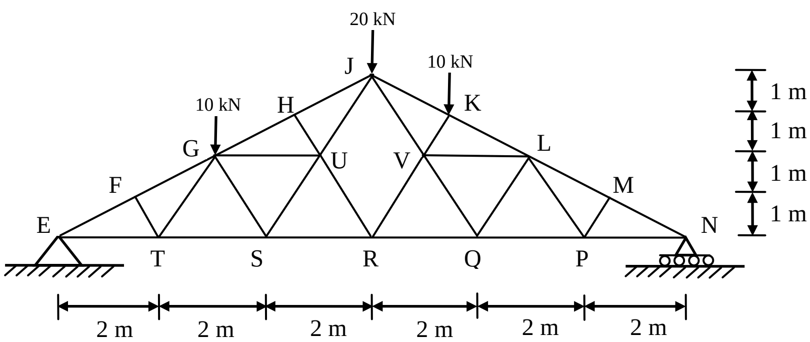


Figure II

Which one of the following relationships is true?

(A) $\delta_{max1} \neq \delta_{max2}$ and $\theta_{max1} \neq \theta_{max2}$
(B) $\delta_{max1} = \delta_{max2}$ and $\theta_{max1} \neq \theta_{max2}$
(C) $\delta_{max1} \neq \delta_{max2}$ and $\theta_{max1} = \theta_{max2}$
(D) $\delta_{max1} = \delta_{max2}$ and $\theta_{max1} = \theta_{max2}$

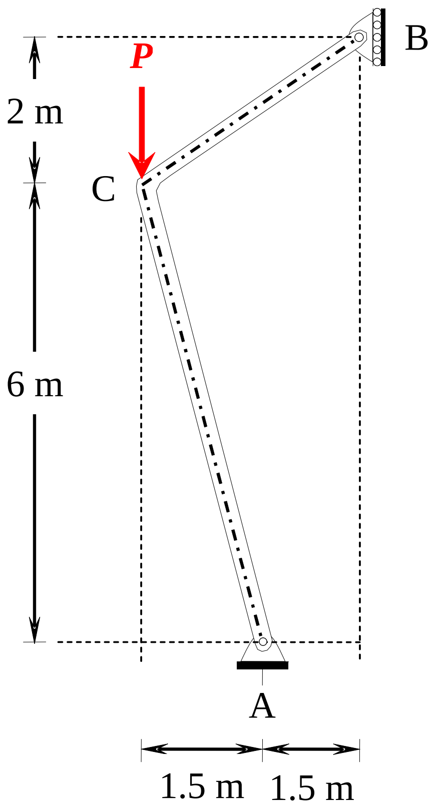
Q.33 A plane truss with applied loads is shown in the figure.



The members which do not carry any force are

(A) FT, TG, HU, MP, PL
(B) ET, GS, UR, VR, QL
(C) FT, GS, HU, MP, QL
(D) MP, PL, HU, FT, UR

Q.34 A rigid member ACB is shown in the figure. The member is supported at A and B by pinned and guided roller supports, respectively. A force **P** acts at C as shown. Let R_{Ah} and R_{Bh} be the horizontal reactions at supports A and B, respectively, and R_{Av} be the vertical reaction at support A. Self-weight of the member may be ignored.



Which one of the following sets gives the correct magnitudes of R_{Av}, R_{Bh} and R_{Ah} ?

(A) $R_{\mathrm{Av}} = 0$; $R_{\mathrm{Bh}} = \dfrac{1}{3}P$; and $R_{\mathrm{Ah}} = \dfrac{2}{3}P$

(B) $R_{\mathrm{Av}} = 0$; $R_{\mathrm{Bh}} = \dfrac{2}{3}P$; and $R_{\mathrm{Ah}} = \dfrac{1}{3}P$

(C) $R_{\mathrm{Av}} = P$; $R_{\mathrm{Bh}} = \dfrac{3}{8}P$; and $R_{\mathrm{Ah}} = \dfrac{1.5}{8}P$

(D) $R_{\mathrm{Av}} = P$; $R_{\mathrm{Bh}} = \dfrac{1.5}{8}P$; and $R_{\mathrm{Ah}} = \dfrac{1.5}{8}P$

Q.35 A reinforced concrete (RC) beam with width of 250 mm and effective depth of 400 mm is reinforced with Fe415 steel. As per the provisions of IS 456-2000, the minimum and maximum amount of tensile reinforcement (expressed in mm^2) for the section are, respectively

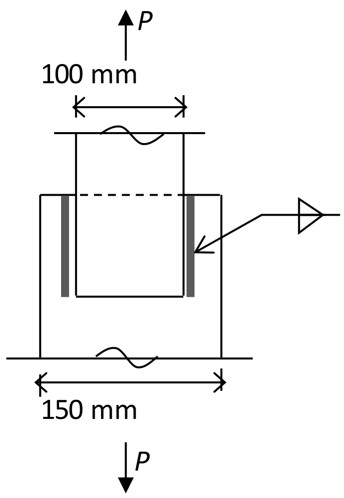
(A) 250 and 3500 (B) 205 and 4000
(C) 270 and 2000 (D) 300 and 2500

Q.36 For M25 concrete with creep coefficient of 1.5, the long-term static modulus of elasticity (expressed in MPa) as per the provisions of IS:456-2000 is ________

Q.37 A propped cantilever of span L carries a vertical concentrated load at the mid-span. If the plastic moment capacity of the section is M_p, the magnitude of the collapse load is

(A) $\frac{8M_p}{L}$ (B) $\frac{6M_p}{L}$ (C) $\frac{4M_p}{L}$ (D) $\frac{2M_p}{L}$

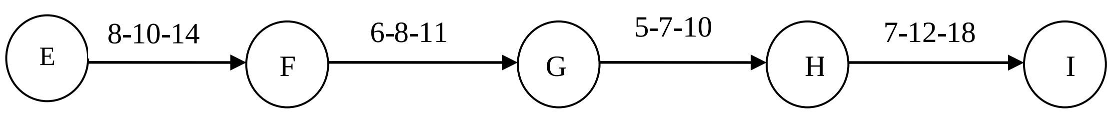
Q.38 Two plates are connected by fillet welds of size 10 mm and subjected to tension, as shown in the figure. The thickness of each plate is 12 mm. The yield stress and the ultimate tensile stress of steel are 250 MPa and 410 MPa, respectively. The welding is done in the workshop (γ_{mw} = 1.25).



As per the Limit State Method of IS 800: 2007, the minimum length (rounded off to the nearest higher multiple of 5 mm) of each weld to transmit a force P equal to 270 kN (factored) is

(A) 90 mm (B) 105 mm (C) 110 mm (D) 115 mm

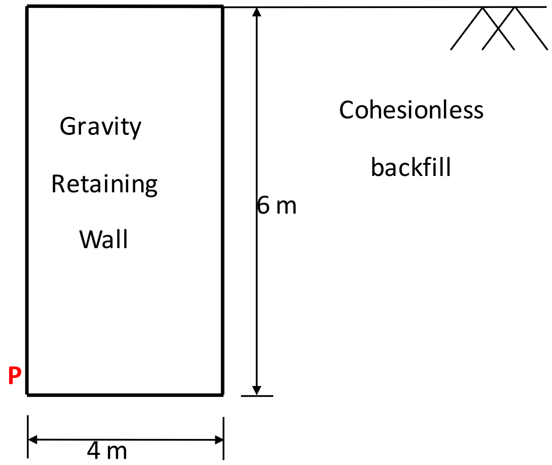
Q.39 The Optimistic Time (O), Most likely Time (M) and Pessimistic Time (P) (in days) of the activities in the critical path are given below in the format O-M-P.



The expected completion time (in days) of the project is _________

Q.40 The porosity (n) and the degree of saturation (S) of a soil sample are 0.7 and 40%, respectively. In a 100 m^3 volume of the soil, the volume (expressed in m^3) of air is _________

Q.41 A homogeneous gravity retaining wall supporting a cohesionless backfill is shown in the figure. The lateral active earth pressure at the bottom of the wall is 40 kPa.



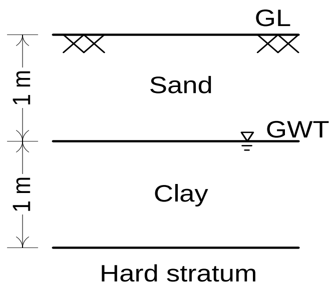
The minimum weight of the wall (expressed in kN per m length) required to prevent it from overturning about its toe (Point P) is

(A) 120 (B) 180 (C) 240 (D) 360

Q.42 An undisturbed soil sample was taken from the middle of a clay layer (i.e., 1.5 m below GL), as shown in figure. The water table was at the top of clay layer. Laboratory test results are as follows:

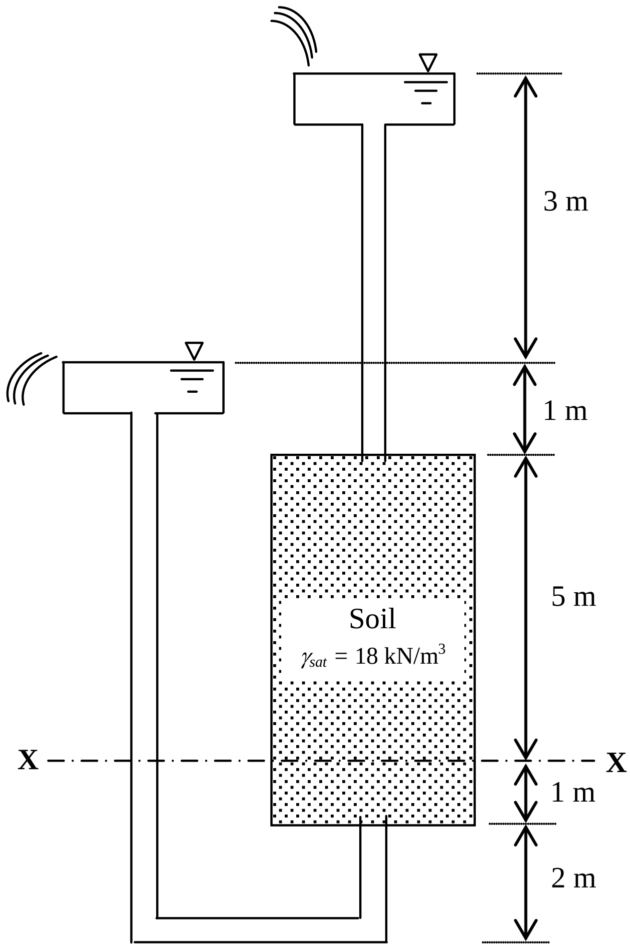
Natural water content of clay	:	25%
Preconsolidation pressure of clay	:	60 kPa
Compression index of clay	:	0.50
Recompression index of clay	:	0.05
Specific gravity of clay	:	2.70
Bulk unit weight of sand	:	17 kN/m^3

A compacted fill of 2.5 m height with unit weight of 20 kN/m^3 is placed at the ground level.



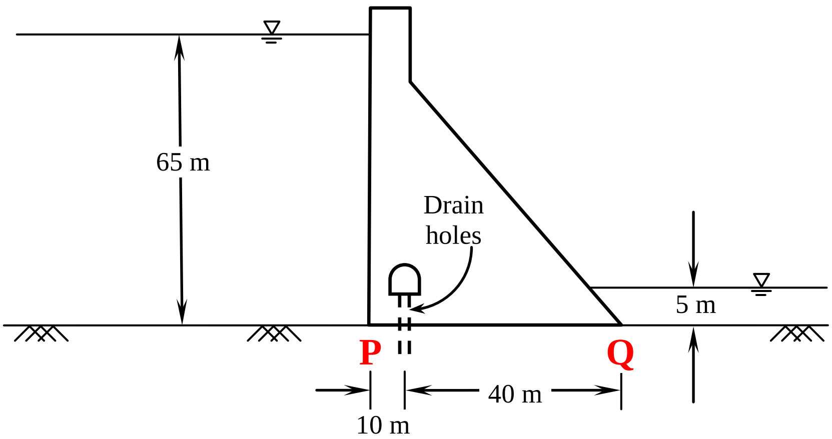
Assuming unit weight of water as10 kN/m^3, the ultimate consolidation settlement (expressed in mm) of the clay layer is _____________

Q.43 A seepage flow condition is shown in the figure. The saturated unit weight of the soil γ_{sat} = 18 kN/m^3. Using unit weight of water, γ_w = 9.81 kN/m^3, the effective vertical stress (expressed in kN/m^2) on plane X-X is ________

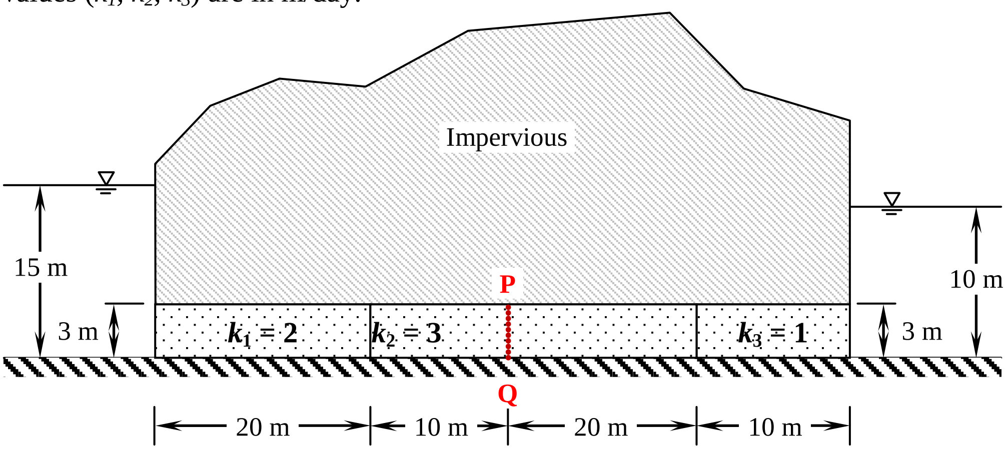


Q.44 A drained triaxial compression test on a saturated clay yielded the effective shear strength parameters as c' = 15 kPa and ϕ' = 22^o. Consolidated Undrained triaxial test on an identical sample of this clay at a cell pressure of 200 kPa developed a pore water pressure of 150 kPa at failure. The deviator stress (expressed in kPa) at failure is _________

Q.45 A concrete gravity dam section is shown in the figure. Assuming unit weight of water as 10 kN/m^3 and unit weight of concrete as 24 kN/m^3, the uplift force per unit length of the dam (expressed in kN/m) at PQ is __________



Q.46 Seepage is occurring through a porous media shown in the figure. The hydraulic conductivity values (k_1, k_2, k_3) are in m/day.



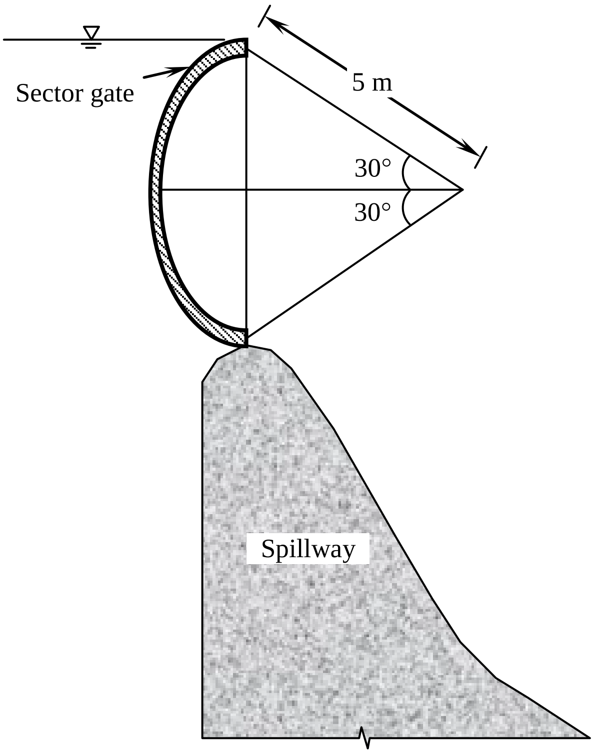
The seepage discharge (m^3/day per m) through the porous media at section PQ is

(A) $\frac{7}{12}$ (B) $\frac{1}{2}$ (C) $\frac{9}{16}$ (D) $\frac{3}{4}$

Q.47 A 4 m wide rectangular channel, having bed slope of 0.001 carries a discharge of 16 m^3/s. Considering Manning's roughness coefficient = 0.012 and g = 10 m/s^2, the category of the channel slope is

(A) horizontal (B) mild (C) critical (D) steep

Q.48 A sector gate is provided on a spillway as shown in the figure. Assuming g = 10 m/s^2, the resultant force per meter length (expressed in kN/m) on the gate will be __________



Q.49 A hydraulically efficient trapezoidal channel section has a uniform flow depth of 2 m. The bed width (expressed in m) of the channel is __________

Q.50 Effluent from an industry 'A' has a pH of 4.2. The effluent from another industry 'B' has double the hydroxyl (OH^-) ion concentration than the effluent from industry 'A'. pH of effluent from the industry 'B' will be __________

Q.51 An electrostatic precipitator (ESP) with 5600 m^2 of collector plate area is 96 percent efficient in treating 185 m^3/s of flue gas from a 200 MW thermal power plant. It was found that in order to achieve 97 percent efficiency, the collector plate area should be 6100 m^2. In order to increase the efficiency to 99 percent, the ESP collector plate area (expressed in m^2) would be ______

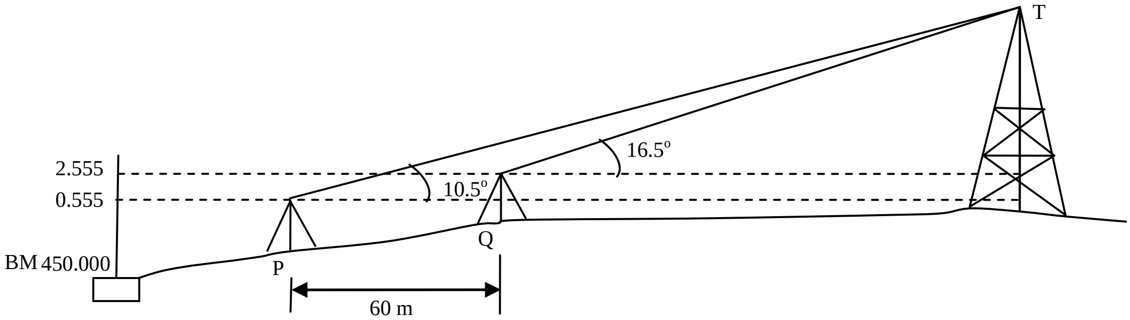
Q.52 The 2-day and 4-day BOD values of a sewage sample are 100 mg/L and 155 mg/L, respectively. The value of BOD rate constant (expressed in per day) is _________

Q.53 A two lane, one-way road with radius of 50 m is predominantly carrying lorries with wheelbase of 5 m. The speed of lorries is restricted to be between 60 kmph and 80 kmph. The mechanical widening and psychological widening required at 60 kmph are designated as $w_{me,60}$ and $w_{ps,60}$, respectively. The mechanical widening and psychological widening required at 80 kmph are designated as $w_{me,80}$ and $w_{ps,80}$, respectively. The correct values of $w_{me,60}$, $w_{ps,60}$, $w_{me,80}$, $w_{ps,80}$, respectively are

(A) 0.89 m, 0.50 m, 1.19 m, and 0.50 m
(B) 0.50 m, 0.89 m, 0.50 m, and 1.19 m
(C) 0.50 m, 1.19 m, 0.50 m, and 0.89 m
(D) 1.19 m, 0.50 m, 0.89 m, and 0.50 m

Q.54 While traveling along and against the traffic stream, a moving observer measured the relative flows as 50 vehicles/hr and 200 vehicles/hr, respectively. The average speeds of the moving observer while traveling along and against the stream are 20 km/hr and 30 km/hr, respectively. The density of the traffic stream (expressed in vehicles/km) is _________

Q.55 The vertical angles subtended by the top of a tower T at two instrument stations set up at P and Q, are shown in the figure. The two stations are in line with the tower and spaced at a distance of 60 m. Readings taken from these two stations on a leveling staff placed at the benchmark (BM = 450.000 m) are also shown in the figure. The reduced level of the top of the tower T (expressed in m) is _________



END OF THE QUESTION PAPER

Q. No	Type	Section	Key	Marks
1	MCQ	GA	D	1
2	MCQ	GA	A	1
3	MCQ	GA	A	1
4	MCQ	GA	C	1
5	MCQ	GA	D	1
6	MCQ	GA	B	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	B	2
10	MCQ	GA	B	2
1	NAT	CE-1	0.355 : 0.365	1
2	MCQ	CE-1	C	1
3	MCQ	CE-1	D	1
4	MCQ	CE-1	A	1
5	MCQ	CE-1	B	1
6	MCQ	CE-1	A	1
7	MCQ	CE-1	D	1
8	NAT	CE-1	99.9 : 100.1	1
9	MCQ	CE-1	C	1
10	MCQ	CE-1	B	1
11	MCQ	CE-1	B	1
12	MCQ	CE-1	D	1
13	MCQ	CE-1	D	1
14	NAT	CE-1	21.5 : 21.7	1
15	MCQ	CE-1	B	1
16	NAT	CE-1	13.6 : 13.7	1
17	MCQ	CE-1	A	1
18	MCQ	CE-1	A	1
19	MCQ	CE-1	B	1
20	MCQ	CE-1	A	1
21	MCQ	CE-1	B	1
22	NAT	CE-1	1199 : 1201	1
23	MCQ	CE-1	C	1
24	MCQ	CE-1	C	1
25	MCQ	CE-1	A	1
26	MCQ	CE-1	A	2
27	MCQ	CE-1	B	2
28	MCQ	CE-1	B	2
29	MCQ	CE-1	C	2
30	MCQ	CE-1	A	2
31	MCQ	CE-1	C	2
32	MCQ	CE-1	D	2
33	MCQ	CE-1	A	2
34	MCQ	CE-1	D	2
35	MCQ	CE-1	B	2
36	NAT	CE-1	9999 : 10001	2
37	MCQ	CE-1	B	2
38	MCQ	CE-1	B	2
39	NAT	CE-1	37 : 38	2

40	NAT	CE-1	41 : 43	2
41	MCQ	CE-1	A	2
42	NAT	CE-1	36 : 38	2
43	NAT	CE-1	65.3 : 65.6	2
44	NAT	CE-1	100 : 110	2
45	NAT	CE-1	10490 : 10510	2
46	MCQ	CE-1	B	2
47	MCQ	CE-1	B	2
48	NAT	CE-1	126 : 128	2
49	NAT	CE-1	2.29 : 2.32	2
50	NAT	CE-1	4.4 : 4.6	2
51	NAT	CE-1	8000 : 8020	2
52	NAT	CE-1	0.29 : 0.31	2
53	MCQ	CE-1	B	2
54	NAT	CE-1	2.9 : 3.1	2
55	NAT	CE-1	476.500 : 477.500	2

Q. No	Type	Section	Key	Marks
1	MCQ	GA	D	1
2	MCQ	GA	A	1
3	MCQ	GA	A	1
4	MCQ	GA	C	1
5	MCQ	GA	D	1
6	MCQ	GA	B	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	B	2
10	MCQ	GA	B	2
1	NAT	CE-1	0.355 : 0.365	1
2	MCQ	CE-1	C	1
3	MCQ	CE-1	D	1
4	MCQ	CE-1	A	1
5	MCQ	CE-1	B	1
6	MCQ	CE-1	A	1
7	MCQ	CE-1	D	1
8	NAT	CE-1	99.9 : 100.1	1
9	MCQ	CE-1	C	1
10	MCQ	CE-1	B	1
11	MCQ	CE-1	B	1
12	MCQ	CE-1	D	1
13	MCQ	CE-1	D	1
14	NAT	CE-1	21.5 : 21.7	1
15	MCQ	CE-1	B	1
16	NAT	CE-1	13.6 : 13.7	1
17	MCQ	CE-1	A	1
18	MCQ	CE-1	A	1
19	MCQ	CE-1	B	1
20	MCQ	CE-1	A	1
21	MCQ	CE-1	B	1
22	NAT	CE-1	1199 : 1201	1
23	MCQ	CE-1	C	1
24	MCQ	CE-1	C	1
25	MCQ	CE-1	A	1
26	MCQ	CE-1	A	2
27	MCQ	CE-1	B	2
28	MCQ	CE-1	B	2
29	MCQ	CE-1	C	2
30	MCQ	CE-1	A	2
31	MCQ	CE-1	MTA	2
32	MCQ	CE-1	D	2
33	MCQ	CE-1	A	2
34	MCQ	CE-1	D	2
35	MCQ	CE-1	B	2
36	NAT	CE-1	9999 : 10001	2
37	MCQ	CE-1	B	2
38	MCQ	CE-1	B	2
39	NAT	CE-1	37 : 38	2

40	NAT	CE-1	41 : 43	2
41	MCQ	CE-1	A	2
42	NAT	CE-1	36 : 38	2
43	NAT	CE-1	65.3 : 65.6	2
44	NAT	CE-1	100 : 110	2
45	NAT	CE-1	10490 : 10510	2
46	MCQ	CE-1	B	2
47	MCQ	CE-1	B	2
48	NAT	CE-1	126 : 128	2
49	NAT	CE-1	2.29 : 2.32	2
50	NAT	CE-1	4.4 : 4.6	2
51	NAT	CE-1	8000 : 8040	2
52	NAT	CE-1	0.29 : 0.31	2
53	MCQ	CE-1	B	2
54	NAT	CE-1	2.9 : 3.1	2
55	NAT	CE-1	476.500 : 477.500	2

Q. 1 – Q. 5 carry one mark each.

Q.1 If I were you, I __________ that laptop. It's much too expensive.

(A) won't buy (B) shan't buy

(C) wouldn't buy (D) would buy

Q.2 He turned a deaf ear to my request.

What does the underlined phrasal verb mean?

(A) ignored (B) appreciated (C) twisted (D) returned

Q.3 Choose the most appropriate set of words from the options given below to complete the following sentence.

_________ ___________ is a will, _________ is a way.

(A) Wear, there, their (B) Were, their, there

(C) Where, there, there (D) Where, their, their

Q.4 (x % of y) + (y % of x) is equivalent to ______.

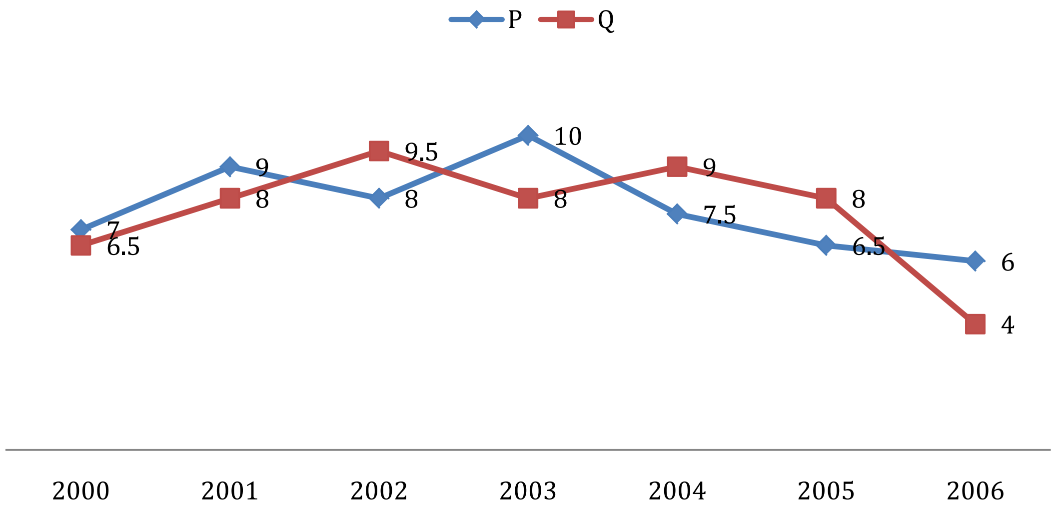
(A) 2 % of xy (B) 2 % of (xy/100) (C) xy % of 100 (D) 100 % of xy

Q.5 The sum of the digits of a two digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number.

(A) 39 (B) 57 (C) 66 (D) 93

Q. 6 – Q. 10 carry two marks each.

Q.6 Two finance companies, P and Q, declared fixed annual rates of interest on the amounts invested with them. The rates of interest offered by these companies may differ from year to year. Year-wise annual rates of interest offered by these companies are shown by the line graph provided below.



If the amounts invested in the companies, P and Q, in 2006 are in the ratio 8:9, then the amounts received after one year as interests from companies P and Q would be in the ratio:

(A) 2:3
(B) 3:4
(C) 6:7
(D) 4:3

Q.7 Today, we consider Ashoka as a great ruler because of the copious evidence he left behind in the form of stone carved edicts. Historians tend to correlate greatness of a king at his time with the availability of evidence today.

Which of the following can be logically inferred from the above sentences?

(A) Emperors who do not leave significant sculpted evidence are completely forgotten.

(B) Ashoka produced stone carved edicts to ensure that later historians will respect him.

(C) Statues of kings are a reminder of their greatness.

(D) A king’s greatness, as we know him today, is interpreted by historians.

Q.8 Fact 1: Humans are mammals.
Fact 2: Some humans are engineers.
Fact 3: Engineers build houses.

If the above statements are facts, which of the following can be logically inferred?

I. All mammals build houses.
II. Engineers are mammals.
III. Some humans are not engineers.

(A) II only. (B) III only.

(C) I, II and III. (D) I only.

Q.9 A square pyramid has a base perimeter x, and the slant height is half of the perimeter. What is the lateral surface area of the pyramid?

(A) x^2 (B) $0.75\,x^2$ (C) $0.50\,x^2$ (D) $0.25\,x^2$

Q.10 Ananth takes 6 hours and Bharath takes 4 hours to read a book. Both started reading copies of the book at the same time. After how many hours is the number of pages **to be** read by Ananth, twice that **to be** read by Bharath? Assume Ananth and Bharath read all the pages with constant pace.

(A) 1 (B) 2 (C) 3 (D) 4

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each

Q.1 The spot speeds (expressed in km/hr) observed at a road section are 66, 62, 45, 79, 32, 51, 56, 60, 53, and 49. The median speed (expressed in km/hr) is __________
(Note: answer with one decimal accuracy)

Q.2 The optimum value of the function $f(x) = x^2 - 4x + 2$ is

(A) 2 (maximum) (B) 2 (minimum) (C) –2 (maximum) (D) –2 (minimum)

Q.3 The Fourier series of the function,

$$f(x) = 0, \quad -\pi < x \leq 0$$
$$= \pi - x, \quad 0 < x < \pi$$

in the interval $[-\pi, \pi]$ is

$$f(x) = \frac{\pi}{4} + \frac{2}{\pi}\left[\frac{\cos x}{1^2} + \frac{\cos 3x}{3^2} + \dots\dots\dots\right] + \left[\frac{\sin x}{1} + \frac{\sin 2x}{2} + \frac{\sin 3x}{3} + \dots\dots.\right].$$

The convergence of the above Fourier series at $x = 0$ gives

(A) $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$

(B) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^2} = \frac{\pi^2}{12}$

(C) $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^2} = \frac{\pi^2}{8}$

(D) $\sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{2n-1} = \frac{\pi}{4}$

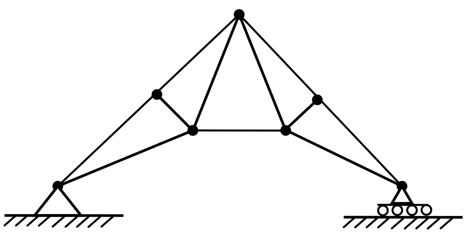
Q.4 X and Y are two random independent events. It is known that $P(X) = 0.40$ and $P(X \cup Y^C) = 0.7$. Which one of the following is the value of $P(X \cup Y)$?

(A) 0.7 (B) 0.5 (C) 0.4 (D) 0.3

Q.5 What is the value of $\lim\limits_{\substack{x \to 0 \\ y \to 0}} \frac{xy}{x^2 + y^2}$?

(A) 1 (B) –1 (C) 0 (D) Limit does not exist

Q.6 The kinematic indeterminacy of the plane truss shown in the figure is

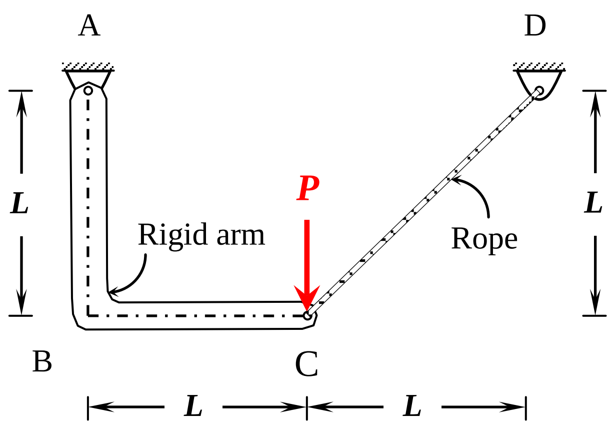


(A) 11 (B) 8 (C) 3 (D) 0

Q.7 As per IS 456-2000 for the design of reinforced concrete beam, the maximum allowable shear stress $(\tau_{c\max})$ depends on the

(A) grade of concrete and grade of steel
(B) grade of concrete only
(C) grade of steel only
(D) grade of concrete and percentage of reinforcement

Q.8 An assembly made of a rigid arm A-B-C hinged at end A and supported by an elastic rope C-D at end C is shown in the figure. The members may be assumed to be weightless and the lengths of the respective members are as shown in the figure.



Under the action of a concentrated load P at C as shown, the magnitude of tension developed in the rope is

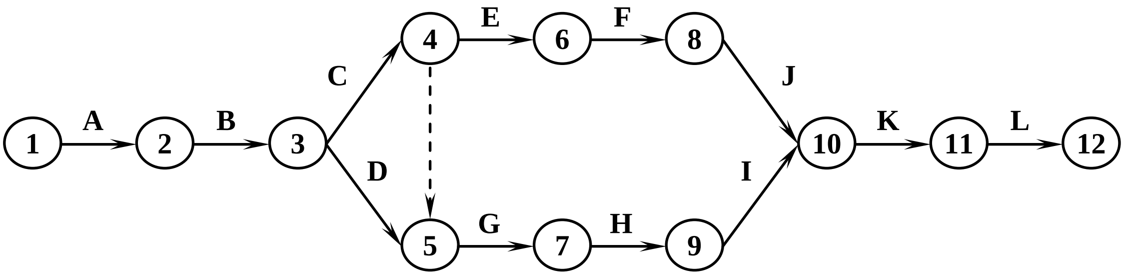
(A) $\frac{3P}{\sqrt{2}}$ (B) $\frac{P}{\sqrt{2}}$ (C) $\frac{3P}{8}$ (D) $\sqrt{2}P$

Q.9 As per Indian standards for bricks, minimum acceptable compressive strength of any class of burnt clay bricks in dry state is

(A) 10.0 MPa (B) 7.5 MPa (C) 5.0 MPa (D) 3.5 MPa

Q.10 A construction project consists of twelve activities. The estimated duration (in days) required to complete each of the activities along with the corresponding network diagram is shown below.

Activity		Duration (days)	Activity		Duration (days)
A	Inauguration	1	G	Flooring	25
B	Foundation work	7	H	Electrification	7
C	Structural construction-1	30	I	Plumbing	7
D	Structural construction-2	30	J	Wood work	7
E	Brick masonry work	25	K	Coloring	3
F	Plastering	7	L	Handing over function	1



Total floats (in days) for the activities 5-7 and 11-12 for the project are, respectively,

(A) 25 and 1
(B) 1 and 1
(C) 0 and 0
(D) 81 and 0

Q.11 A strip footing is resting on the surface of a purely clayey soil deposit. If the width of the footing is doubled, the ultimate bearing capacity of the soil

(A) becomes double (B) becomes half (C) becomes four-times (D) remains the same

Q.12 The relationship between the specific gravity of sand (G) and the hydraulic gradient (i) to initiate quick condition in the sand layer having porosity of 30% is

(A) $G = 0.7i + 1$
(B) $G = 1.43i - 1$
(C) $G = 1.43i + 1$
(D) $G = 0.7i - 1$

Q.13 The results of a consolidation test on an undisturbed soil, sampled at a depth of 10 m below the ground level are as follows:

Saturated unit weight	:	16 kN/m^3
Pre-consolidation pressure	:	90 kPa

The water table was encountered at the ground level. Assuming the unit weight of water as 10 kN/m^3, the over-consolidation ratio of the soil is

(A) 0.67 (B) 1.50 (C) 1.77 (D) 2.00

Q.14 Profile of a weir on permeable foundation is shown in figure I and an elementary profile of 'upstream pile only case' according to Khosla's theory is shown in figure II. The uplift pressure heads at key points Q, R and S are 3.14 m, 2.75 m and 0 m, respectively (refer figure II).

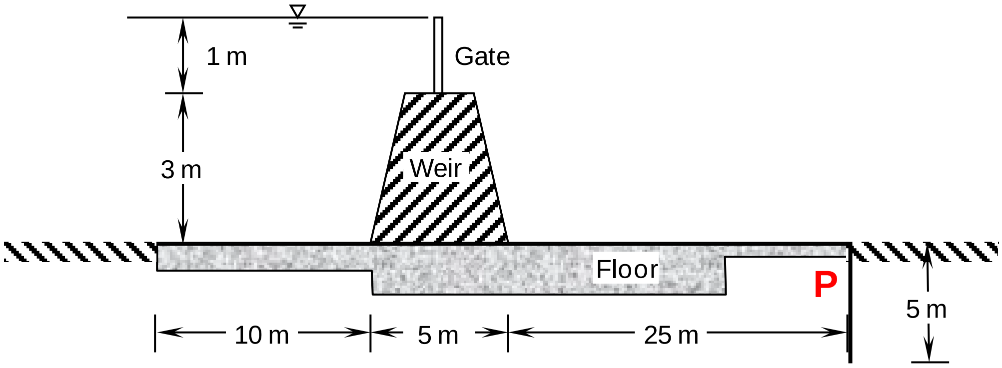


Figure I

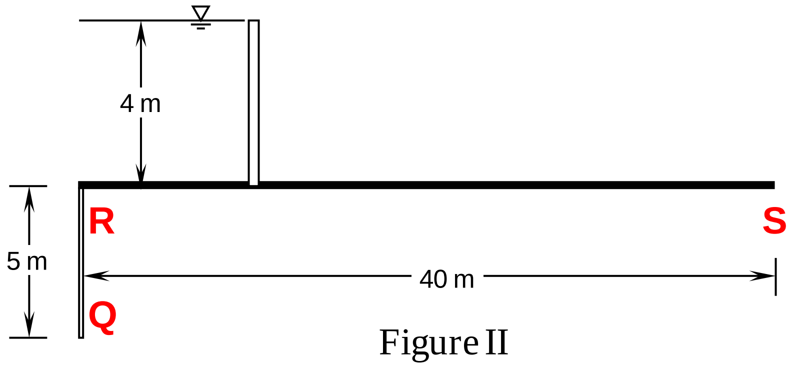


Figure II

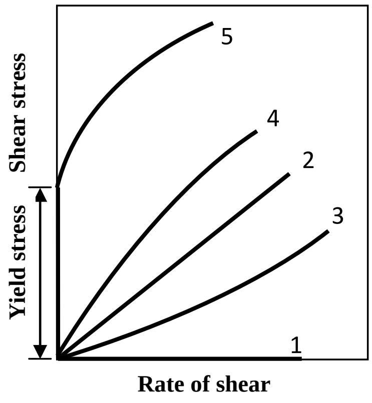
What is the uplift pressure head at point P downstream of the weir (junction of floor and pile as shown in the figure I)?

(A) 2.75 m (B) 1.25 m (C) 0.8 m (D) Data not sufficient

Q.15 Water table of an aquifer drops by 100 cm over an area of 1000 km^2. The porosity and specific retention of the aquifer material are 25% and 5%, respectively. The amount of water (expressed in km^3) drained out from the area is __________

Q.16 Group I contains the types of fluids while Group II contains the shear stress - rate of shear relationship of different types of fluids, as shown in the figure.

	Group I		Group II
P.	Newtonian fluid	1.	Curve 1
Q.	Pseudo plastic fluid	2.	Curve 2
R.	Plastic fluid	3.	Curve 3
S.	Dilatant fluid	4.	Curve 4
		5.	Curve 5



The correct match between Group I and Group II is

(A) P-2, Q-4, R-1, S-5
(B) P-2, Q-5, R-4, S-1
(C) P-2, Q-4, R-5, S-3
(D) P-2, Q-1, R-3, S-4

Q.17 The atmospheric layer closest to the earth surface is

(A) the mesosphere
(B) the stratosphere
(C) the thermosphere
(D) the troposphere

Q.18 A water supply board is responsible for treating 1500 m^3/day of water. A settling column analysis indicates that an overflow rate of 20 m/day will produce satisfactory removal for a depth of 3.1 m. It is decided to have two circular settling tanks in parallel. The required diameter (expressed in m) of the settling tanks is ___________

Q.19 The hardness of a ground water sample was found to be 420 mg/L as $CaCO_3$. A softener containing ion exchange resins was installed to reduce the total hardness to 75 mg/L as $CaCO_3$ before supplying to 4 households. Each household gets treated water at a rate of 540 L/day. If the efficiency of the softener is 100%, the bypass flow rate (expressed in L/day) is _________

Q.20 The sound pressure (expressed in µPa) of the faintest sound that a normal healthy individual can hear is

(A) 0.2
(B) 2
(C) 20
(D) 55

Q.21 In the context of the IRC 58-2011 guidelines for rigid pavement design, consider the following pair of statements.

I: Radius of relative stiffness is directly related to modulus of elasticity of concrete and inversely related to Poisson's ratio
II: Radius of relative stiffness is directly related to thickness of slab and modulus of subgrade reaction.

Which one of the following combinations is correct?

(A) I: True; II: True
(B) I: False; II: False
(C) I: True; II: False
(D) I: False; II: True

Q.22 If the total number of commercial vehicles per day ranges from 3000 to 6000, the minimum percentage of commercial traffic to be surveyed for axle load is

(A) 15
(B) 20
(C) 25
(D) 30

Q.23 Optimal flight planning for a photogrammetric survey should be carried out considering

(A) only side-lap
(B) only end-lap
(C) either side-lap or end-lap
(D) both side-lap as well as end-lap

Q.24 The reduced bearing of a 10 m long line is N30°E. The departure of the line is

(A) 10.00 m (B) 8.66 m (C) 7.52 m (D) 5.00 m

Q.25 A circular curve of radius R connects two straights with a deflection angle of 60°. The tangent length is

(A) 0.577 R (B) 1.155 R (C) 1.732 R (D) 3.464 R

Q. 26 – Q. 55 carry two marks each

Q.26 Consider the following linear system.

$x + 2y - 3z = a$
$2x + 3y + 3z = b$
$5x + 9y - 6z = c$

This system is consistent if a, b and c satisfy the equation

(A) $7a - b - c = 0$ (B) $3a + b - c = 0$ (C) $3a - b + c = 0$ (D) $7a - b + c = 0$

Q.27 If $f(x)$ and $g(x)$ are two probability density functions,

$$f(x) = \begin{cases} \frac{x}{a} + 1 & : -a \le x < 0 \\ -\frac{x}{a} + 1 & : \ 0 \le x \le a \\ 0 & : \ otherwise \end{cases}$$

$$g(x) = \begin{cases} -\frac{x}{a} & : -a \le x < 0 \\ \frac{x}{a} & : \ 0 \le x \le a \\ 0 & : \ otherwise \end{cases}$$

Which one of the following statements is true?

(A) Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are same
(B) Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are different
(C) Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are same
(D) Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are different

Q.28 The angle of intersection of the curves $x^2 = 4y$ and $y^2 = 4x$ at point (0, 0) is

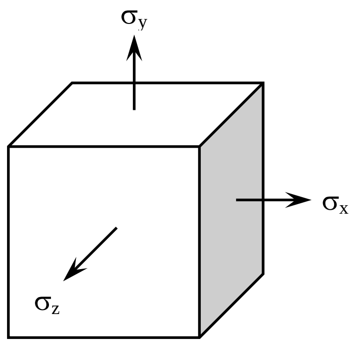
(A) 0^o (B) 30^o (C) 45^o (D) 90^o

Q.29 The area between the parabola $x^2 = 8y$ and the straight line $y = 8$ is _________.

Q.30 The quadratic approximation of $f(x) = x^3 - 3x^2 - 5$ at the point $x = 0$ is

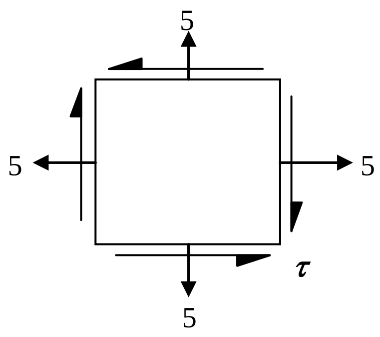
(A) $3x^2 - 6x - 5$ (B) $-3x^2 - 5$
(C) $-3x^2 + 6x - 5$ (D) $3x^2 - 5$

Q.31 An elastic isotropic body is in a hydrostatic state of stress as shown in the figure. For no change in the volume to occur, what should be its Poisson's ratio?



(A) 0.00 (B) 0.25 (C) 0.50 (D) 1.00

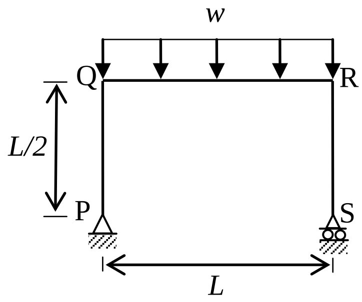
Q.32 For the stress state (in MPa) shown in the figure, the major principal stress is 10 MPa.



The shear stress τ is

(A) 10.0 MPa (B) 5.0 MPa (C) 2.5 MPa (D) 0.0 MPa

Q.33 The portal frame shown in the figure is subjected to a uniformly distributed vertical load w (per unit length).



The bending moment in the beam at the joint 'Q' is

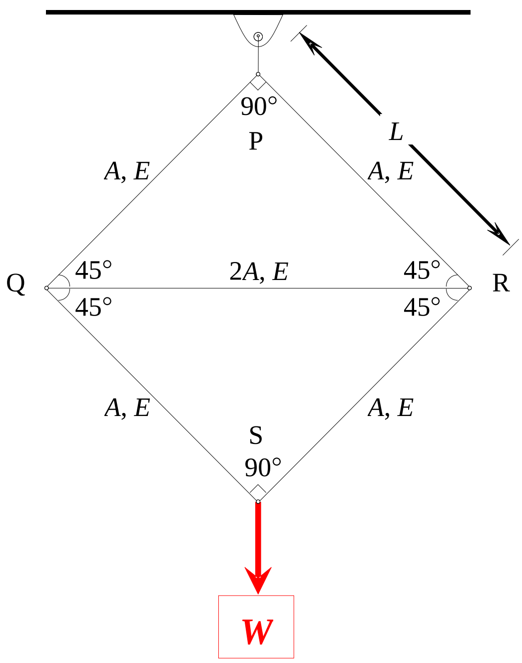
(A) zero

(B) $\frac{wL^2}{24}$ (hogging)

(C) $\frac{wL^2}{12}$ (hogging)

(D) $\frac{wL^2}{8}$ (sagging)

Q.34 Consider the structural system shown in the figure under the action of weight W. All the joints are hinged. The properties of the members in terms of length (L), area (A) and the modulus of elasticity (E) are also given in the figure. Let L, A and E be 1 m, 0.05 m^2 and 30×10^6 N/m^2, respectively, and W be 100 kN.



Which one of the following sets gives the correct values of the force, stress and change in length of the horizontal member QR?

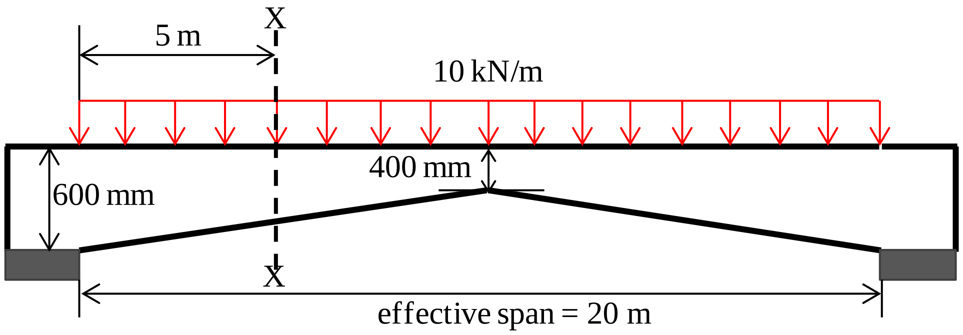
(A) Compressive force = 25 kN; Stress = 250 kN/m^2; Shortening = 0.0118 m

(B) Compressive force = 14.14 kN; Stress = 141.4 kN/m^2; Extension = 0.0118 m

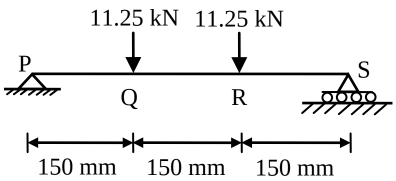
(C) Compressive force = 100 kN; Stress = 1000 kN/m^2; Shortening = 0.0417 m

(D) Compressive force = 100 kN; Stress = 1000 kN/m^2; Extension = 0.0417 m

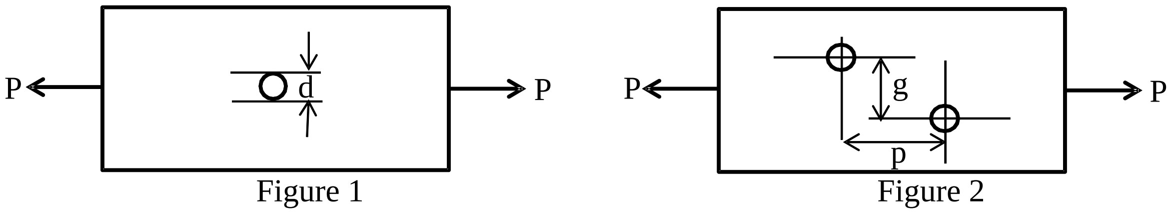
Q.35 A haunched (varying depth) reinforced concrete beam is simply supported at both ends, as shown in the figure. The beam is subjected to a uniformly distributed factored load of intensity 10 kN/m. The design shear force (expressed in kN) at the section X-X of the beam is ______



Q.36 A 450 mm long plain concrete prism is subjected to the concentrated vertical loads as shown in the figure. Cross section of the prism is given as 150 mm × 150 mm. Considering linear stress distribution across the cross-section, the modulus of rupture (expressed in MPa) is ________



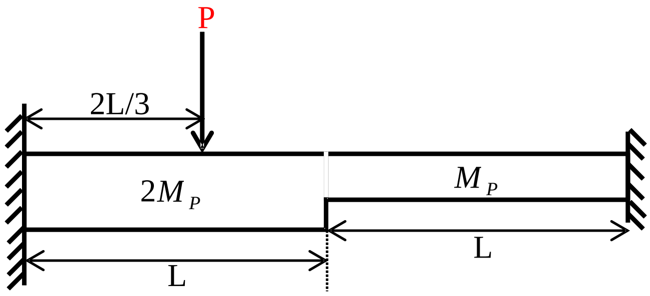
Q.37 Two bolted plates under tension with alternative arrangement of bolt holes are shown in figures 1 and 2. The hole diameter, pitch, and gauge length are d, p and g, respectively.



Which one of the following conditions must be ensured to have higher net tensile capacity of configuration shown in Figure 2 than that shown in Figure 1 ?

(A) $p^2 > 2gd$ (B) $p^2 < \sqrt{4gd}$ (C) $p^2 > 4gd$ (D) $p > 4gd$

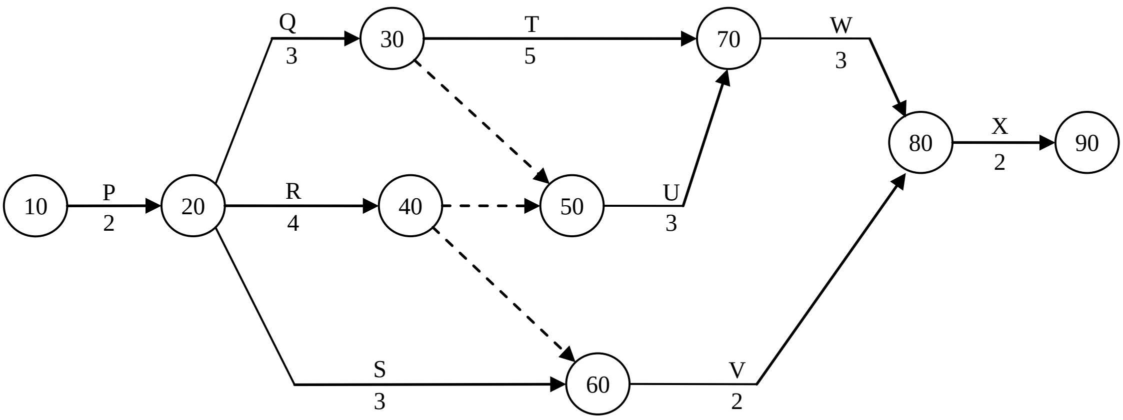
Q.38 A fixed-end beam is subjected to a concentrated load (P) as shown in the figure. The beam has two different segments having different plastic moment capacities $(M_p, 2M_p)$ as shown.



The minimum value of load (P) at which the beam would collapse (ultimate load) is

(A) $7.5M_P/L$ (B) $5.0M_P/L$ (C) $4.5M_P/L$ (D) $2.5M_P/L$

Q.39 The activity-on-arrow network of activities for a construction project is shown in the figure. The durations (expressed in days) of the activities are mentioned below the arrows.

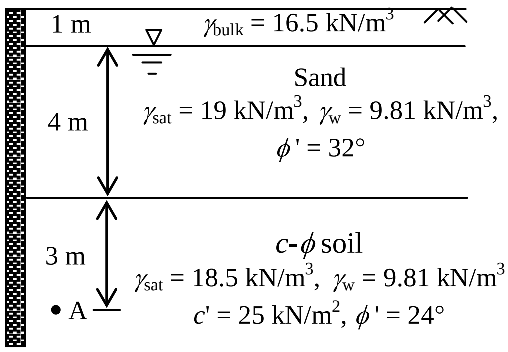


The critical duration for this construction project is

(A) 13 days (B) 14 days (C) 15 days (D) 16 days

Q.40 The seepage occurring through an earthen dam is represented by a flownet comprising of 10 equipotential drops and 20 flow channels. The coefficient of permeability of the soil is 3 mm/min and the head loss is 5 m. The rate of seepage (expressed in cm^3/s per m length of the dam) through the earthen dam is __________

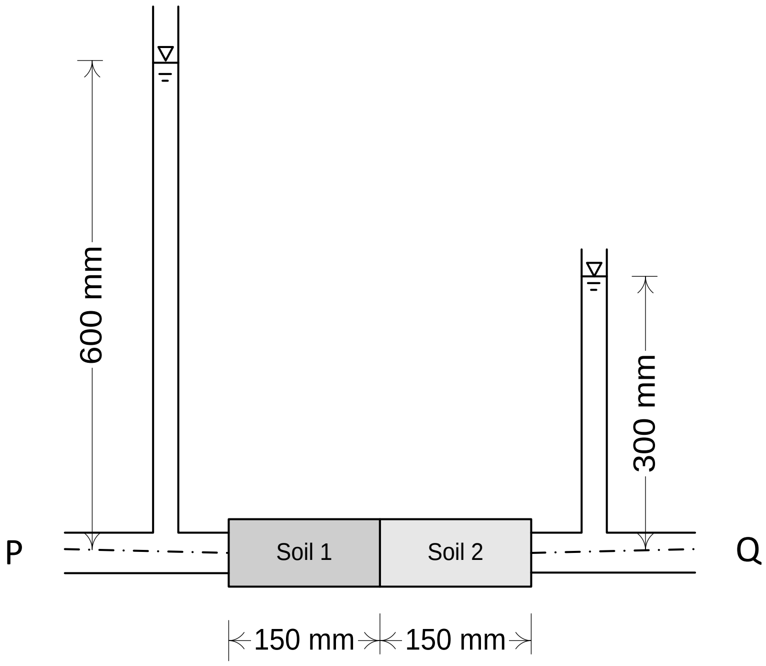
Q.41 The soil profile at a site consists of a 5 m thick sand layer underlain by a c-ϕ soil as shown in figure. The water table is found 1 m below the ground level. The entire soil mass is retained by a concrete retaining wall and is in the active state. The back of the wall is smooth and vertical. The total active earth pressure (expressed in kN/m^2) at point A as per Rankine's theory is _________



Q.42 OMC-SP and MDD-SP denote the optimum moisture content and maximum dry density obtained from standard Proctor compaction test, respectively. OMC-MP and MDD-MP denote the optimum moisture content and maximum dry density obtained from the modified Proctor compaction test, respectively. Which one of the following is correct?

(A) OMC-SP < OMC-MP and MDD-SP < MDD-MP
(B) OMC-SP > OMC-MP and MDD-SP < MDD-MP
(C) OMC-SP < OMC-MP and MDD-SP > MDD-MP
(D) OMC-SP > OMC-MP and MDD-SP > MDD-MP

Q.43 Water flows from P to Q through two soil samples, Soil 1 and Soil 2, having cross sectional area of 80 cm^2 as shown in the figure. Over a period of 15 minutes, 200 ml of water was observed to pass through any cross section. The flow conditions can be assumed to be steady state. If the coefficient of permeability of Soil 1 is 0.02 mm/s, the coefficient of permeability of Soil 2 (expressed in mm/s) would be ________



Q.44 A 4 m wide strip footing is founded at a depth of 1.5 m below the ground surface in a c-ϕ soil as shown in the figure. The water table is at a depth of 5.5 m below ground surface. The soil properties are: $c' = 35$ kN/m^2, $\phi' = 28.63°$, $\gamma_{sat} = 19$ kN/m^3, $\gamma_{bulk} = 17$ kN/m^3 and $\gamma_w = 9.81$ kN/m^3. The values of bearing capacity factors for different ϕ' are given below.

ϕ'	N_c	N_q	N_γ
15°	12.9	4.4	2.5
20°	17.7	7.4	5.0
25°	25.1	12.7	9.7
30°	37.2	22.5	19.7

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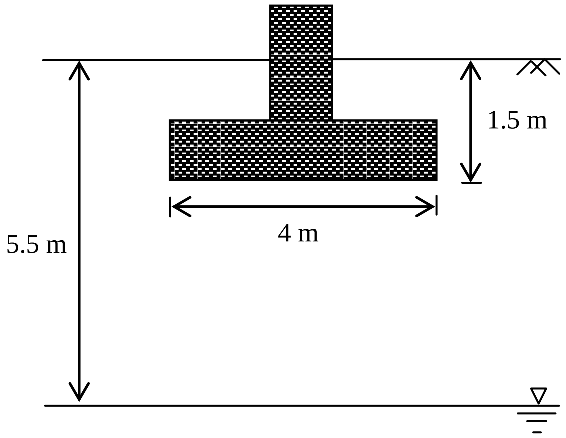
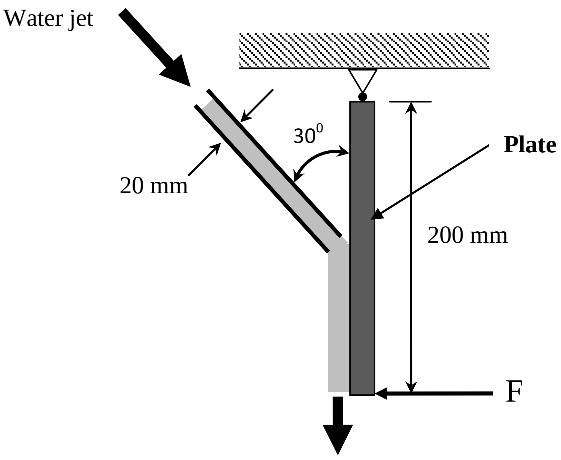


Using Terzaghi's bearing capacity equation and a factor of safety $F_s = 2.5$, the net safe bearing capacity (expressed in kN/m^2) for local shear failure of the soil is ___________

Q.45 A square plate is suspended vertically from one of its edges using a hinge support as shown in figure. A water jet of 20 mm diameter having a velocity of 10 m/s strikes the plate at its mid-point, at an angle of 30° with the vertical. Consider g as 9.81 m/s^2 and neglect the self-weight of the plate. The force F (expressed in N) required to keep the plate in its vertical position is __________



Q.46 The ordinates of a one-hour unit hydrograph at sixty minute interval are 0, 3, 12, 8, 6, 3 and 0 m^3/s. A two-hour storm of 4 cm excess rainfall occurred in the basin from 10 AM. Considering constant base flow of 20 m^3/s, the flow of the river (expressed in m^3/s) at 1 PM is __________

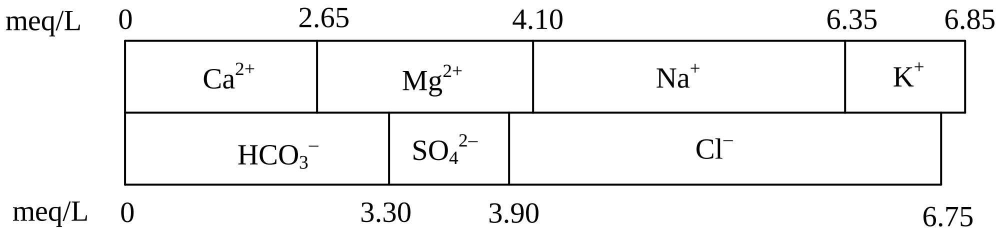
Q.47 A 3 m wide rectangular channel carries a flow of 6 m^3/s. The depth of flow at a section P is 0.5 m. A flat-topped hump is to be placed at the downstream of the section P. Assume negligible energy loss between section P and hump, and consider g as $9.81\ m/s^2$. The maximum height of the hump (expressed in m) which will not change the depth of flow at section P is __________

Q.48 A penstock of 1 m diameter and 5 km length is used to supply water from a reservoir to an impulse turbine. A nozzle of 15 cm diameter is fixed at the end of the penstock. The elevation difference between the turbine and water level in the reservoir is 500 m. Consider the head loss due to friction as 5% of the velocity head available at the jet. Assume unit weight of water = 10 kN/m^3 and acceleration due to gravity (g) = 10 m/s^2. If the overall efficiency is 80%, power generated (expressed in kW and rounded to nearest integer) is ________________

Q.49 A tracer takes 100 days to travel from Well-1 to Well-2 which are 100 m apart. The elevation of water surface in Well-2 is 3 m below that in Well-1. Assuming porosity equal to 15%, the coefficient of permeability (expressed in m/day) is

(A) 0.30 (B) 0.45 (C) 1.00 (D) 5.00

Q.50 A sample of water has been analyzed for common ions and results are presented in the form of a bar diagram as shown.



The non-carbonate hardness (expressed in mg/L as $CaCO_3$) of the sample is

(A) 40 (B) 165 (C) 195 (D) 205

Q.51 A noise meter located at a distance of 30 m from a point source recorded 74 dB. The reading at a distance of 60 m from the point source would be __________

Q.52 For a wastewater sample, the three-day biochemical oxygen demand at incubation temperature of 20°C ($BOD_{3day,\ 20°C}$) is estimated as 200 mg/L. Taking the value of the first order BOD reaction rate constant as 0.22 day^{-1}, the five-day BOD (expressed in mg/L) of the wastewater at incubation temperature of 20°C ($BOD_{5day,\ 20°c}$) would be __________

Q.53 The critical flow ratios for a three-phase signal are found to be 0.30, 0.25, and 0.25. The total time lost in the cycle is 10 s. Pedestrian crossings at this junction are not significant. The respective Green times (expressed in seconds and rounded off to the nearest integer) for the three phases are

(A) 34, 28, and 28 (B) 40, 25, and 25 (C) 40, 30, and 30 (D) 50, 25, and 25

Q.54 A motorist traveling at 100 km/h on a highway needs to take the next exit, which has a speed limit of 50 km/h. The section of the roadway before the ramp entry has a downgrade of 3% and coefficient of friction (f) is 0.35. In order to enter the ramp at the maximum allowable speed limit, the braking distance (expressed in m) from the exit ramp is _________

Q.55 A tall tower was photographed from an elevation of 700 m above the datum. The radial distances of the top and bottom of the tower from the principal points are 112.50 mm and 82.40 mm, respectively. If the bottom of the tower is at an elevation 250 m above the datum, then the height (expressed in m) of the tower is _________

END OF THE QUESTION PAPER

Q. No	Type	Section	Key	Marks
1	MCQ	GA	C	1
2	MCQ	GA	A	1
3	MCQ	GA	C	1
4	MCQ	GA	A	1
5	MCQ	GA	A	1
6	MCQ	GA	D	2
7	MCQ	GA	D	2
8	MCQ	GA	B	2
9	MCQ	GA	D	2
10	MCQ	GA	C	2
1	NAT	CE-2	54.49 : 54.51	1
2	MCQ	CE-2	D	1
3	MCQ	CE-2	C	1
4	MCQ	CE-2	A	1
5	MCQ	CE-2	D	1
6	MCQ	CE-2	A	1
7	MCQ	CE-2	B	1
8	MCQ	CE-2	B	1
9	MCQ	CE-2	D	1
10	MCQ	CE-2	C	1
11	MCQ	CE-2	D	1
12	MCQ	CE-2	C	1
13	MCQ	CE-2	B	1
14	MCQ	CE-2	B	1
15	NAT	CE-2	0.19 : 0.21	1
16	MCQ	CE-2	C	1
17	MCQ	CE-2	D	1
18	NAT	CE-2	6.8 : 7.0	1
19	NAT	CE-2	380 : 390	1
20	MCQ	CE-2	C	1
21	MCQ	CE-2	C	1
22	MCQ	CE-2	A	1
23	MCQ	CE-2	D	1
24	MCQ	CE-2	D	1
25	MCQ	CE-2	A	1
26	MCQ	CE-2	B	2
27	MCQ	CE-2	B	2
28	MCQ	CE-2	D	2
29	NAT	CE-2	85.0 : 85.5	2
30	MCQ	CE-2	B	2
31	MCQ	CE-2	C	2
32	MCQ	CE-2	B	2
33	MCQ	CE-2	A	2
34	MCQ	CE-2	C	2
35	NAT	CE-2	64 : 66	2
36	NAT	CE-2	2.9 : 3.1	2
37	MCQ	CE-2	C	2
38	MCQ	CE-2	A	2
39	MCQ	CE-2	C	2

40	NAT	CE-2	495 : 505	2
41	NAT	CE-2	69.0 : 70.5	2
42	MCQ	CE-2	B	2
43	NAT	CE-2	0.04 : 0.05	2
44	NAT	CE-2	298 : 299	2
45	NAT	CE-2	7.4 : 8.0	2
46	NAT	CE-2	59 : 61	2
47	NAT	CE-2	0.19 : 0.21	2
48	NAT	CE-2	6560 : 6580	2
49	MCQ	CE-2	D	2
50	MCQ	CE-2	A	2
51	NAT	CE-2	67 : 69	2
52	NAT	CE-2	275 : 277	2
53	MCQ	CE-2	A	2
54	NAT	CE-2	92 : 93	2
55	NAT	CE-2	120 : 121	2

Q. No	Type	Section	Key	Marks
1	MCQ	GA	C	1
2	MCQ	GA	A	1
3	MCQ	GA	C	1
4	MCQ	GA	A	1
5	MCQ	GA	A	1
6	MCQ	GA	D	2
7	MCQ	GA	D	2
8	MCQ	GA	B	2
9	MCQ	GA	D	2
10	MCQ	GA	C	2
1	NAT	CE-2	54.49 : 54.51	1
2	MCQ	CE-2	D	1
3	MCQ	CE-2	C	1
4	MCQ	CE-2	A	1
5	MCQ	CE-2	D	1
6	MCQ	CE-2	A	1
7	MCQ	CE-2	B	1
8	MCQ	CE-2	B	1
9	MCQ	CE-2	D	1
10	MCQ	CE-2	C	1
11	MCQ	CE-2	D	1
12	MCQ	CE-2	C	1
13	MCQ	CE-2	B	1
14	MCQ	CE-2	B	1
15	NAT	CE-2	0.19 : 0.21	1
16	MCQ	CE-2	C	1
17	MCQ	CE-2	D	1
18	NAT	CE-2	6.8 : 7.0	1
19	NAT	CE-2	380 : 390	1
20	MCQ	CE-2	C	1
21	MCQ	CE-2	B	1
22	MCQ	CE-2	A	1
23	MCQ	CE-2	D	1
24	MCQ	CE-2	D	1
25	MCQ	CE-2	A	1
26	MCQ	CE-2	B	2
27	MCQ	CE-2	B	2
28	MCQ	CE-2	D	2
29	NAT	CE-2	85.0 : 85.5	2
30	MCQ	CE-2	B	2
31	MCQ	CE-2	C	2
32	MCQ	CE-2	B	2
33	MCQ	CE-2	A	2
34	MCQ	CE-2	C	2
35	NAT	CE-2	64 : 66	2
36	NAT	CE-2	2.9 : 3.1	2
37	MCQ	CE-2	C	2
38	MCQ	CE-2	A	2
39	MCQ	CE-2	C	2

40	NAT	CE-2	495 : 505	2
41	NAT	CE-2	69.0 : 70.5	2
42	MCQ	CE-2	B	2
43	NAT	CE-2	0.04 : 0.05	2
44	NAT	CE-2	298 : 300	2
45	NAT	CE-2	7.4 : 8.0	2
46	NAT	CE-2	59 : 61	2
47	NAT	CE-2	0.19 : 0.21	2
48	NAT	CE-2	6560 : 6580	2
49	MCQ	CE-2	D	2
50	MCQ	CE-2	A	2
51	NAT	CE-2	67 : 69	2
52	NAT	CE-2	275 : 278	2
53	MCQ	CE-2	A	2
54	NAT	CE-2	92 : 93	2
55	NAT	CE-2	120 : 121	2