GATE 2014: General Instructions during Examination
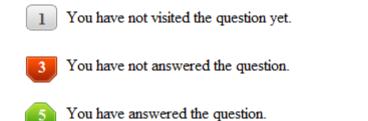
1. Total duration of the GATE examination is **180** minutes.
2. The clock will be set at the server. The countdown timer at the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You need not terminate the examination or submit your paper.
3. Any useful data required for your paper can be viewed by clicking on the **Useful Common Data** button that appears on the screen.
4. Use the scribble pad provided to you for any rough work. Submit the scribble pad at the end of the examination.
5. You are allowed to use a non-programmable type calculator, however, sharing of calculators is not allowed.
6. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

1	You have not visited the question yet.
3	You have not answered the question.
5	You have answered the question.
7	You have NOT answered the question, but have marked the question for review.
9	You have answered the question, but marked it for review.

The **Marked for Review** status for a question simply indicates that you would like to look at that question again. *If a question is answered, but marked for review, then the answer will be considered for evaluation unless the status is modified by the candidate.*

Navigating to a Question :

7. To answer a question, do the following:
   a. Click on the question number in the Question Palette to go to that question directly.
   b. Select an answer for a multiple choice type question by clicking on the bubble placed before the 4 choices, namely A, B, C and D. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
   c. Click on **Save & Next** to save your answer for the current question and then go to the next question.
   d. Click on **Mark for Review & Next** to save your answer for the current question and also mark it for review, and then go to the next question.

Caution: Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on a question number without saving the answer to the previous question.

You can view all the questions by clicking on the **Question Paper** button. This feature is provided, so that if you want you can just see the entire question paper at a glance.

<u>Answering a Question :</u>

8. Procedure for answering a multiple choice (MCQ) type question:
    a. Choose one answer from the 4 options (A,B,C,D) given below the question, click on the bubble placed before the chosen option.
    b. To deselect your chosen answer, click on the bubble of the chosen option again or click on the **Clear Response** button.
    c. To change your chosen answer, click on the bubble of another option.
    d. To save your answer, you MUST click on the **Save & Next** button.

9. Procedure for answering a numerical answer type question:
    a. To enter a number as your answer, use the virtual numerical keypad.
    b. A fraction (e.g. -0.3 or -.3) can be entered as an answer with or without '0' before the decimal point. As many as four decimal points, e.g. 12.5435 or 0.003 or -932.6711 or 12.82 can be entered.
    c. To clear your answer, click on the **Clear Response** button.
    d. To save your answer, you MUST click on the **Save & Next** button

10. To mark a question for review, click on the **Mark for Review & Next** button. *If an answer is selected (for MCQ) or entered (for numerical answer type) for a question that is **Marked for Review**, that answer will be considered in the evaluation unless the status is modified by the candidate.*

11. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.

12. Note that ONLY Questions for which answers are *saved* or *marked for review after answering* will be considered for evaluation.

<u>Choosing a Section :</u>

13. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing will be highlighted.

14. A checkbox is displayed for every optional Section, if any, in the Question Paper. To select the optional Section for answering, click on the checkbox for that Section.

15. If the checkbox for an optional Section is not selected, the **Save & Next** button and the **Mark for Review & Next** button will NOT be enabled for that Section. You will

only be able to see questions in this Section, but you will not be able to answer questions in the Section.

16. After clicking the **Save & Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.

17. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

Changing the Optional Section :

18. After answering the chosen optional Section, partially or completely, you can change the optional Section by selecting the checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section. If you do not want to reset the Section and want to continue answering the previously chosen optional Section, then click on the **BACK** button.

19. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.

20. You can shuffle between different Sections or change the optional Sections any number of times.

GATE 2014 Examination

CE: Civil Engineering

Duration: **180 minutes**   *Maximum Marks*: **100**

Read the following instructions carefully.

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen.
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory.
   The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.
   The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.

5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (○) placed before the choice.
10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices**. For these questions, the answer should be entered**by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of⅓ marks for a 1-mark question and ⅔ marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.

13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

Declaration by the candidate:

"I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition".

Q. 1 – Q. 5 carry one mark each.

Q.1   A student is required to demonstrate a high level of <u>comprehension</u> of the subject, especially in the social sciences.

The word closest in meaning to <u>comprehension</u> is

(A) understanding   (B) meaning   (C) concentration   (D) stability

Q.2   Choose the most appropriate word from the options given below to complete the following sentence.

One of his biggest _____ was his ability to forgive.

(A) vice   (B) virtues   (C) choices   (D) strength

Q.3   Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently.

Which one of the statements below is logically valid and can be inferred from the above sentences?

(A) Rajan has decided to work only in a group.
(B) Rajan and Sajan were formed into a group against their wishes.
(C) Sajan had decided to give in to Rajan's request to work with him.
(D) Rajan had believed that Sajan and he would be working together.

Q.4   If $y = 5x^2 + 3$, then the tangent at $x = 0$, $y = 3$

(A) passes through $x = 0$, $y = 0$ (B) has a slope of $+1$
(C) is parallel to the x-axis   (D) has a slope of -1

Q.5   A foundry has a fixed daily cost of Rs 50,000 whenever it operates and a variable cost of Rs 800Q, where Q is the daily production in tonnes. What is the cost of production in Rs per tonne for a daily production of 100 tonnes?

Q. 6 – Q. 10 carry two marks each.

Q.6   Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK
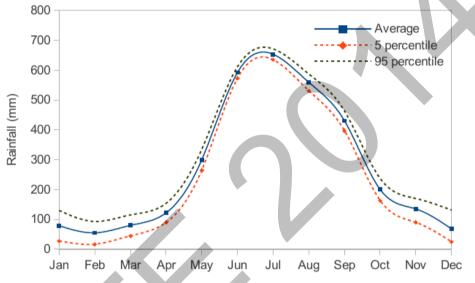
(A) ALRVX   (B) EPVZB   (C) ITZDF   (D) OYEIK

Q.7   Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storeyed building (the ground floor is numbered 1, the floor above it 2, and so on). Anuj lives on an even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

Q.8   The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?

Q.9   One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than 6 ft. There are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage of people taller than 6 ft?

(A) 3.0   (B) 2.5   (C) 1.5   (D) 1.25

Q.10 The monthly rainfall chart based on 50 years of rainfall in Agra is shown in the following figure. Which of the following are true? (k percentile is the value such that k percent of the data fall below that value)

(i) On average, it rains more in July than in December
(ii) Every year, the amount of rainfall in August is more than that in January
(iii) July rainfall can be estimated with better confidence than February rainfall
(iv) In August, there is at least 500 mm of rainfall

(A) (i) and (ii)   (B) (i) and (iii)
(C) (ii) and (iii)   (D) (iii) and (iv)

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

Q.1　$\underset{x\to\infty}{Lim}\left(\dfrac{x+\sin x}{x}\right)$ equals to

(A) $-\infty$　　　　　　(B) 0　　　　　　(C) 1　　　　　　(D) ∞

Q.2　Given the matrices $J=\begin{bmatrix}3&2&1\\2&4&2\\1&2&6\end{bmatrix}$ and $K=\begin{bmatrix}1\\2\\-1\end{bmatrix}$, the product $K^{T}JK$ is _____

Q.3　The probability density function of evaporation E on any day during a year in a watershed is given by

$$f(E)=\begin{cases}\dfrac{1}{5}&0\le E\le 5\ \text{mm/day}\\0&\text{otherwise}\end{cases}$$

The probability that E lies in between 2 and 4 mm/day in a day in the watershed is (in decimal) _____

Q.4　The sum of Eigen values of the matrix, [M] is

where $[M]=\begin{bmatrix}215&650&795\\655&150&835\\485&355&550\end{bmatrix}$

(A) 915　　　　　　(B) 1355　　　　　　(C) 1640　　　　　　(D) 2180

Q.5　With reference to the conventional Cartesian (x, y) coordinate system, the vertices of a triangle have the following coordinates: $(x_1, y_1) = (1, 0)$; $(x_2, y_2) = (2, 2)$; and $(x_3, y_3) = (4, 3)$. The area of the triangle is equal to
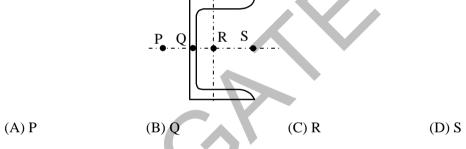
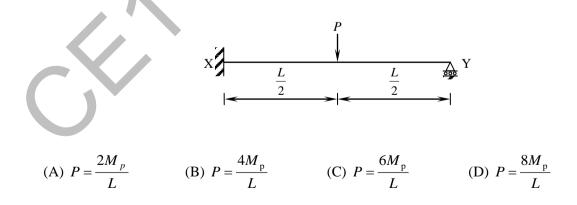(A) $\dfrac{3}{2}$　　　　　　(B) $\dfrac{3}{4}$　　　　　　(C) $\dfrac{4}{5}$　　　　　　(D) $\dfrac{5}{2}$

Q.6   Match the information given in Group – I with those in Group - II.

	Group – I		Group – II
P	Factor to decrease ultimate strength to design strength	1	Upper bound on ultimate load
Q	Factor to increase working load to ultimate load for design	2	Lower bound on ultimate load
R	Statical method of ultimate load analysis	3	Material partial safety factor
S	Kinematical mechanism method of ultimate load analysis	4	Load factor

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

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

Q.7   The possible location of shear centre of the channel section, shown below, is

(A) P   (B) Q   (C) R   (D) S
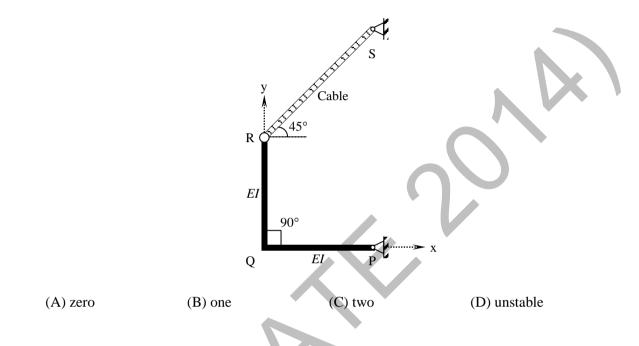
Q.8   The ultimate collapse load (P) in terms of plastic moment M_p by kinematic approach for a propped cantilever of length L with P acting at its mid-span as shown in the figure, would be

(A) $P = \dfrac{2M_p}{L}$ (B) $P = \dfrac{4M_p}{L}$ (C) $P = \dfrac{6M_p}{L}$ (D) $P = \dfrac{8M_p}{L}$
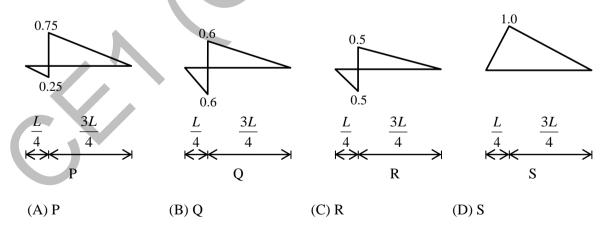
Q.9   While designing, for a steel column of Fe250 grade, a base plate resting on a concrete pedestal of M20 grade, the bearing strength of concrete (in N/mm^2) in limit state method of design as per IS:456-2000 is _____

Q.10   A steel section is subjected to a combination of shear and bending actions. The applied shear force is V and the shear capacity of the section is V_s. For such a section, high shear force (as per IS:800-2007) is defined as

(A) $V > 0.6V_s$ (B) $V > 0.7V_s$ (C) $V > 0.8V_s$ (D) $V > 0.9V_s$

Q.11   The degree of static indeterminacy of a rigid jointed frame PQR supported as shown in the figure is

(A) zero   (B) one   (C) two   (D) unstable

Q.12   In a beam of length L, four possible influence line diagrams for shear force at a section located at a distance of $\frac{L}{4}$ from the left end support (marked as P, Q, R and S) are shown below. The correct influence line diagram is

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

Q.13   The degree of disturbance of the sample collected by the sampler is expressed by a term called the "area ratio". If the outer diameter and inner diameter of the sampler are D_o and D_i respectively, the area ratio is given by

(A) $\dfrac{D_o^2 - D_i^2}{D_i^2}$ (B) $\dfrac{D_i^2 - D_o^2}{D_i^2}$ (C) $\dfrac{D_o^2 - D_i^2}{D_o^2}$ (D) $\dfrac{D_i^2 - D_o^2}{D_o^2}$

Q.14   For a saturated cohesive soil, a triaxial test yields the angle of internal friction (φ) as zero. The conducted test is

(A) Consolidated Drained (CD) test   (B) Consolidated Undrained (CU) test

(C) Unconfined Compression (UC) test   (D) Unconsolidated Undrained (UU) test

Q.15   The action of negative skin friction on the pile is to

(A) increase the ultimate load on the pile

(B) reduce the allowable load on the pile

(C) maintain the working load on the pile

(D) reduce the settlement of the pile

Q.16   A long slope is formed in a soil with shear strength parameters: $c' = 0$ and $\phi' = 34°$. A firm stratum lies below the slope and it is assumed that the water table may occasionally rise to the surface, with seepage taking place parallel to the slope. Use $\gamma_{sat} = 18$ kN/m^3 and $\gamma_w = 10$ kN/m^3. The maximum slope angle (in degrees) to ensure a factor of safety of 1.5, assuming a potential failure surface parallel to the slope, would be

(A) 45.3   (B) 44.7   (C) 12.3   (D) 11.3

Q.17   An incompressible homogeneous fluid is flowing steadily in a variable diameter pipe having the large and small diameters as 15 cm and 5 cm, respectively. If the velocity at a section at the 15 cm diameter portion of the pipe is 2.5 m/s, the velocity of the fluid (in m/s) at a section falling in 5 cm portion of the pipe is _____

Q.18   A conventional flow duration curve is a plot between

(A) Flow and percentage time flow is exceeded

(B) Duration of flooding and ground level elevation

(C) Duration of water supply in a city and proportion of area receiving supply exceeding this duration

(D) Flow rate and duration of time taken to empty a reservoir at that flow rate

Q.19   In reservoirs with an uncontrolled spillway, the peak of the plotted outflow hydrograph

(A) lies outside the plotted inflow hydrograph

(B) lies on the recession limb of the plotted inflow hydrograph

(C) lies on the peak of the inflow hydrograph

(D) is higher than the peak of the plotted inflow hydrograph
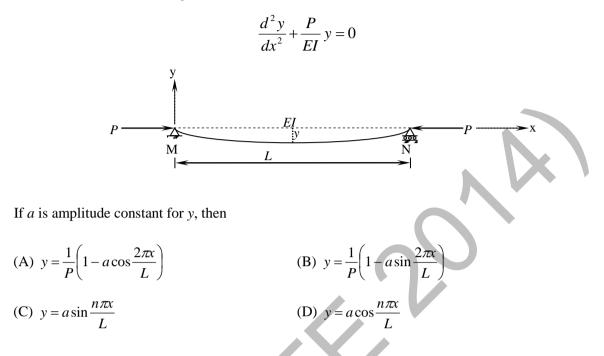
Q.20　The dimension for kinematic viscosity is

(A) $\dfrac{L}{MT}$　　　　(B) $\dfrac{L}{T^2}$　　　　(C) $\dfrac{L^2}{T}$　　　　(D) $\dfrac{ML}{T}$

Q.21　Some of the nontoxic metals normally found in natural water are

(A) arsenic, lead and mercury　　　　(B) calcium, sodium and silver

(C) cadmium, chromium and copper　　　　(D) iron, manganese and magnesium

Q.22　The amount of CO_2 generated (in kg) while completely oxidizing one kg of CH_4 to the end products is _____

Q.23　The minimum value of 15 minute peak hour factor on a section of a road is

(A) 0.10　　　　(B) 0.20　　　　(C) 0.25　　　　(D) 0.33

Q.24　The following statements are related to temperature stresses developed in concrete pavement slabs with free edges (without any restraint):

P.　　The temperature stresses will be zero during both day and night times if the pavement slab is considered weightless

Q.　　The temperature stresses will be compressive at the bottom of the slab during night time if the self-weight of the pavement slab is considered

R.　　The temperature stresses will be compressive at the bottom of the slab during day time if the self-weight of the pavement slab is considered

The TRUE statement(s) is(are)

(A) P only　　　　(B) Q only　　　　(C) P and Q only　　　　(D) P and R only

Q.25　The Reduced Levels (RLs) of the points P and Q are +49.600 m and +51.870 m respectively. Distance PQ is 20 m. The distance (in m from P) at which the +51.000 m contour cuts the line PQ is

(A) 15.00　　　　(B) 12.33　　　　(C) 3.52　　　　(D) 2.27

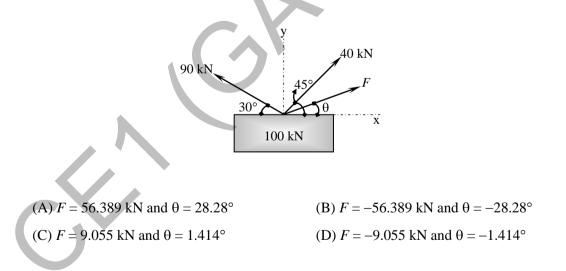## Q. 26 – Q. 55 carry two marks each.

Q.26　If the following equation establishes equilibrium in slightly bent position, the mid-span deflection of a member shown in the figure is
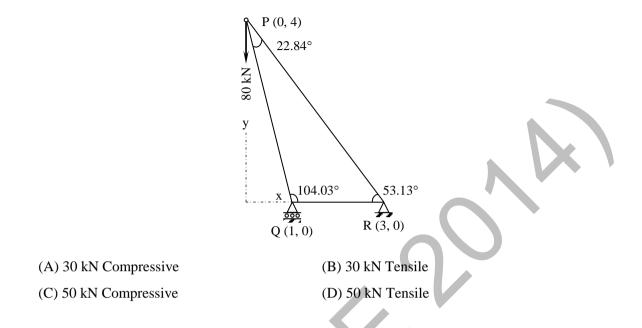
$$\frac{d^2 y}{dx^2} + \frac{P}{EI}\, y = 0$$

If a is amplitude constant for y, then

(A) $y = \dfrac{1}{P}\left(1 - a\cos\dfrac{2\pi x}{L}\right)$　　　　　(B) $y = \dfrac{1}{P}\left(1 - a\sin\dfrac{2\pi x}{L}\right)$

(C) $y = a\sin\dfrac{n\pi x}{L}$　　　　　(D) $y = a\cos\dfrac{n\pi x}{L}$

Q.27　A box of weight 100 kN shown in the figure is to be lifted without swinging. If all forces are coplanar, the magnitude and direction (θ) of the force (F) with respect to x-axis should be

(A) $F = 56.389$ kN and $\theta = 28.28°$　　　　　(B) $F = -56.389$ kN and $\theta = -28.28°$

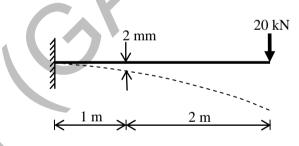(C) $F = 9.055$ kN and $\theta = 1.414°$　　　　　(D) $F = -9.055$ kN and $\theta = -1.414°$

Q.28　A particle moves along a curve whose parametric equations are: $x = t^3 + 2t$, $y = -3e^{-2t}$ and $z = 2\sin(5t)$, where x, y and z show variations of the distance covered by the particle (in cm) with time t (in s). The magnitude of the acceleration of the particle (in cm/s^2) at $t = 0$ is _____

Q.29　A traffic office imposes on an average 5 number of penalties daily on traffic violators. Assume that the number of penalties on different days is independent and follows a Poisson distribution. The probability that there will be less than 4 penalties in a day is _____
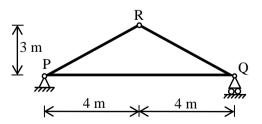
Q.30 Mathematical idealization of a crane has three bars with their vertices arranged as shown in the figure with a load of 80 kN hanging vertically. The coordinates of the vertices are given in parentheses. The force in the member QR, F_{QR} will be

(A) 30 kN Compressive　　　　　　　　　(B) 30 kN Tensile

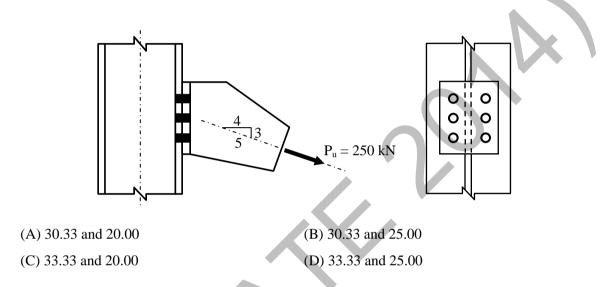(C) 50 kN Compressive　　　　　　　　　(D) 50 kN Tensile

Q.31 For the cantilever beam of span 3 m (shown below), a concentrated load of 20 kN applied at the free end causes a vertical displacement of 2 mm at a section located at a distance of 1 m from the fixed end. If a concentrated vertically downward load of 10 kN is applied at the section located at a distance of 1 m from the fixed end (with no other load on the beam), the maximum vertical displacement in the same beam (in mm) is _____
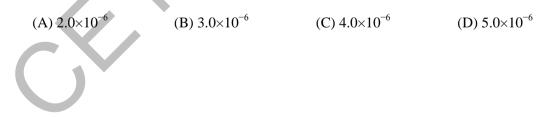

Q.32 For the truss shown below, the member PQ is short by 3 mm. The magnitude of vertical displacement of joint R (in mm) is _____
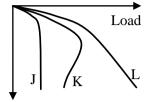
Q.33 A rectangular beam of width (*b*) 230 mm and effective depth (*d*) 450 mm is reinforced with four bars of 12 mm diameter. The grade of concrete is M20 and grade of steel is Fe500. Given that for M20 grade of concrete the ultimate shear strength, $\tau_{uc} = 0.36$ N/mm^2 for steel percentage, $p = 0.25$, and $\tau_{uc} = 0.48$ N/mm^2 for $p = 0.50$. For a factored shear force of 45 kN, the diameter (in mm) of Fe500 steel two legged stirrups to be used at spacing of 375 mm, should be

(A) 8   (B) 10   (C) 12   (D) 16

Q.34 The tension and shear force (both in kN) in each bolt of the joint, as shown below, respectively are

(A) 30.33 and 20.00   (B) 30.33 and 25.00

(C) 33.33 and 20.00   (D) 33.33 and 25.00

Q.35 For a beam of cross-section, width = 230 mm and effective depth = 500 mm, the number of rebars of 12 mm diameter required to satisfy minimum tension reinforcement requirement specified by IS:456-2000 (assuming grade of steel reinforcement as Fe500) is _____

Q.36 In a reinforced concrete section, the stress at the extreme fibre in compression is 5.80 MPa. The depth of neutral axis in the section is 58 mm and the grade of concrete is M25. Assuming linear elastic behavior of the concrete, the effective curvature of the section (in per mm) is

(A) 2.0×10^{-6} (B) 3.0×10^{-6} (C) 4.0×10^{-6} (D) 5.0×10^{-6}

Q.37 Group I contains representative load-settlement curves for different modes of bearing capacity failures of sandy soil. Group II enlists the various failure characteristics. Match the load-settlement curves with the corresponding failure characteristics.

Group I	Group II
P. Curve J	1. No apparent heaving of soil around the footing
Q. Curve K	2. Rankine's passive zone develops imperfectly
R. Curve L	3. Well defined slip surface extends to ground surface

(A) P - 1, Q - 3, R - 2   (B) P - 3, Q - 2, R - 1

(C) P - 3, Q - 1, R - 2   (D) P - 1, Q - 2, R - 3

Q.38 A given cohesionless soil has $e_{max} = 0.85$ and $e_{min} = 0.50$. In the field, the soil is compacted to a mass density of 1800 kg/m^3 at a water content of 8%. Take the mass density of water as 1000 kg/m^3 and G_s as 2.7. The relative density (in %) of the soil is
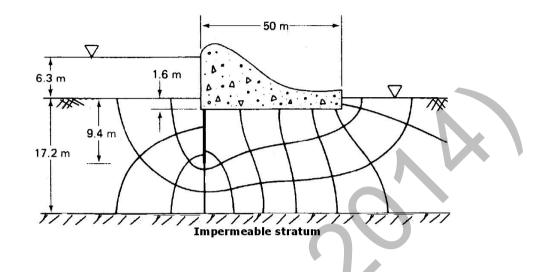
(A) 56.43   (B) 60.25   (C) 62.87   (D) 65.71

Q.39 The following data are given for the laboratory sample.

$$\sigma_o^{'} = 175 \text{ kPa} ; \quad e_o = 1.1 ; \quad \sigma_o^{'} + \Delta\sigma_o^{'} = 300 \text{ kPa} ; \quad e = 0.9$$
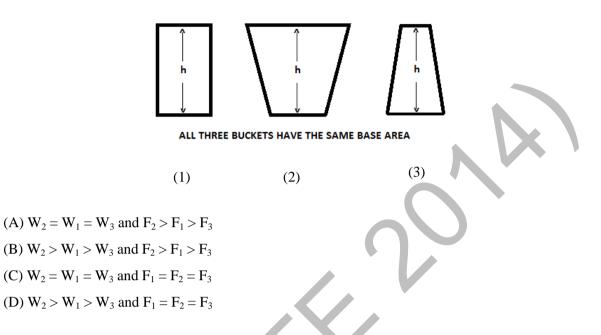
If thickness of the clay specimen is 25 mm, the value of coefficient of volume compressibility is _____ $\times 10^{-4}$ m^2/kN

Q.40   The flow net constructed for the dam is shown in the figure below. Taking the coefficient of permeability as 3.8×10^{-6} m/s, the quantity of flow (in cm^3/s) under the dam per meter of dam is _____

Q.41   A horizontal jet of water with its cross-sectional area of 0.0028 m^2 hits a fixed vertical plate with a velocity of 5 m/s. After impact the jet splits symmetrically in a plane parallel to the plane of the plate. The force of impact (in N) of the jet on the plate is

(A) 90   (B) 80   (C) 70   (D) 60

Q.42   A venturimeter, having a diameter of 7.5 cm at the throat and 15 cm at the enlarged end, is installed in a horizontal pipeline of 15 cm diameter. The pipe carries an incompressible fluid at a steady rate of 30 litres per second. The difference of pressure head measured in terms of the moving fluid in between the enlarged and the throat of the venturimeter is observed to be 2.45 m. Taking the acceleration due to gravity as 9.81 m/s^2, the coefficient of discharge of the venturimeter (correct up to two places of decimal) is _____

Q.43   A rectangular channel having a bed slope of 0.0001, width 3.0 m and Manning's coefficient 'n' 0.015, carries a discharge of 1.0 m^3/s. Given that the normal depth of flow ranges between 0.76 m and 0.8 m. The minimum width of a throat (in m) that is possible at a given section, while ensuring that the prevailing normal depth is not exceeded along the reach upstream of the contraction, is approximately equal to (assume negligible losses)

(A) 0.64   (B) 0.84   (C) 1.04   (D) 1.24

Q.44 Three rigid buckets, shown as in the figures (1), (2) and (3), are of identical heights and base areas. Further, assume that each of these buckets have negligible mass and are full of water. The weights of water in these buckets are denoted as W_1, W_2, and W_3 respectively. Also, let the force of water on the base of the bucket be denoted as F_1, F_2, and F_3 respectively. The option giving an accurate description of the system physics is

ALL THREE BUCKETS HAVE THE SAME BASE AREA

(1)   (2)   (3)

(A) $W_2 = W_1 = W_3$ and $F_2 > F_1 > F_3$

(B) $W_2 > W_1 > W_3$ and $F_2 > F_1 > F_3$

(C) $W_2 = W_1 = W_3$ and $F_1 = F_2 = F_3$

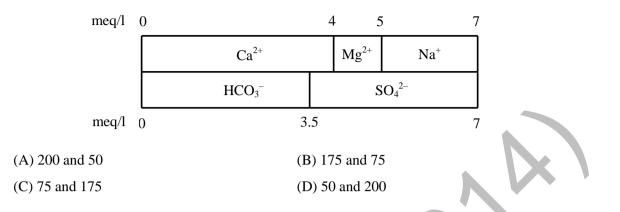(D) $W_2 > W_1 > W_3$ and $F_1 = F_2 = F_3$

Q.45 An incompressible fluid is flowing at a steady rate in a horizontal pipe. From a section, the pipe divides into two horizontal parallel pipes of diameters d_1 and d_2 (where $d_1 = 4d_2$) that run for a distance of L each and then again join back to a pipe of the original size. For both the parallel pipes, assume the head loss due to friction only and the Darcy-Weisbach friction factor to be the same. The velocity ratio between the bigger and the smaller branched pipes is _____

Q.46 16 MLD of water is flowing through a 2.5 km long pipe of diameter 45 cm. The chlorine at the rate of 32 kg/d is applied at the entry of this pipe so that disinfected water is obtained at the exit. There is a proposal to increase the flow through this pipe to 22 MLD from 16 MLD. Assume the dilution coefficient, n = 1. The minimum amount of chlorine (in kg per day) to be applied to achieve the same degree of disinfection for the enhanced flow is

(A) 60.50   (B) 44.00   (C) 38.00   (D) 23.27

Q.47 The potable water is prepared from turbid surface water by adopting the following treatment sequence.

(A) Turbid surface water → Coagulation → Flocculation → Sedimentation → Filtration → Disinfection → Storage & Supply

(B) Turbid surface water → Disinfection → Flocculation → Sedimentation → Filtration → Coagulation → Storage & Supply

(C) Turbid surface water → Filtration → Sedimentation → Disinfection → Flocculation → Coagulation → Storage & Supply

(D) Turbid surface water → Sedimentation → Flocculation → Coagulation → Disinfection → Filtration → Storage & Supply

Q.48 For a sample of water with the ionic composition shown in the figure below, the carbonate and non-carbonate hardness concentrations (in mg/l as $CaCO_3$), respectively are:

meq/l	0	4	5	7
	Ca^{2+}	Mg^{2+}	Na^+	
	HCO_3^-	SO_4^{2-}		
meq/l	0	3.5	7	

(A) 200 and 50   (B) 175 and 75

(C) 75 and 175   (D) 50 and 200

Q.49 A straight 100 m long raw water gravity main is to carry water from an intake structure to the jack well of a water treatment plant. The required flow through this water main is 0.21 m^3/s. Allowable velocity through the main is 0.75 m/s. Assume f = 0.01, g = 9.81 m/s^2. The minimum gradient (in cm/100 m length) to be given to this gravity main so that the required amount of water flows without any difficulty is _____

Q.50 A traffic survey conducted on a road yields an average daily traffic count of 5000 vehicles. The axle load distribution on the same road is given in the following table:

Axle load (tonnes)	Frequency of traffic (%)
18	10
14	20
10	35
8	15
6	20

The design period of the road is 15 years, the yearly traffic growth rate is 7.5% and the load safety factor (LSF) is 1.3. If the vehicle damage factor (VDF) is calculated from the above data, the design traffic (in million standard axle load, MSA) is _____

Q.51 The perception-reaction time for a vehicle travelling at 90 km/h, given the coefficient of longitudinal friction of 0.35 and the stopping sight distance of 170 m (assume $g = 9.81$ m/s^2), is _____ seconds.

Q.52 The speed-density ($u-k$) relationship on a single lane road with unidirectional flow is $u = 70 - 0.7k$, where u is in km/hr and k is in veh/km. The capacity of the road (in veh/hr) is _____

Q.53 An isolated three-phase traffic signal is designed by Webster's method. The critical flow ratios for three phases are 0.20, 0.30, and 0.25 respectively, and lost time per phase is 4 seconds. The optimum cycle length (in seconds) is _____

Q.54 A levelling is carried out to establish the Reduced Levels (RL) of point R with respect to the Bench Mark (BM) at P. The staff readings taken are given below.

Staff Station	BS	IS	FS	RL
P	1.655 m			100.000 m
Q	-0.950 m		-1.500 m	
R			0.750 m	?

If RL of P is +100.000 m, then RL (in m) of R is

(A) 103.355   (B) 103.155   (C) 101.455   (D) 100.355

Q.55 Group I lists tool/instrument while Group II lists the method of surveying. Match the tool/instrument with the corresponding method of surveying.

Group I   Group II

P. Alidade   1. Chain surveying
Q. Arrow   2. Levelling
R. Bubble tube   3. Plain table surveying
S. Stadia hair   4. Theodolite surveying

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

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

END OF THE QUESTION PAPER