





## 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:

 You have not visited the question yet.

 You have not answered the question.

 You have answered the question.

 You have NOT answered the question, but have marked the question for review.

 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.

### Answering a Question :

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.

### Choosing a Section :

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 of  $\frac{1}{3}$  marks for a 1-mark question and  $\frac{2}{3}$  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 Choose the most appropriate word from the options given below to complete the following sentence.

A person suffering from Alzheimer's disease \_\_\_\_\_ short-term memory loss.

- (A) experienced (B) has experienced  
(C) is experiencing (D) experiences

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

\_\_\_\_\_ is the key to their happiness; they are satisfied with what they have.

- (A) Contentment (B) Ambition (C) Perseverance (D) Hunger

Q.3 Which of the following options is the closest in meaning to the sentence below?

“As a woman, I have no country.”

- (A) Women have no country.  
(B) Women are not citizens of any country.  
(C) Women's solidarity knows no national boundaries.  
(D) Women of all countries have equal legal rights.

Q.4 In any given year, the probability of an earthquake greater than Magnitude 6 occurring in the Garhwal Himalayas is 0.04. The average time between successive occurrences of such earthquakes is \_\_\_\_ years.

Q.5 The population of a new city is 5 million and is growing at 20% annually. How many years would it take to double at this growth rate?

- (A) 3-4 years (B) 4-5 years (C) 5-6 years (D) 6-7 years

**Q. 6 – Q. 10 carry two marks each.**

Q.6 In a group of four children, Som is younger to Riaz. Shiv is elder to Ansu. Ansu is youngest in the group. Which of the following statements is/are required to find the eldest child in the group?

**Statements**

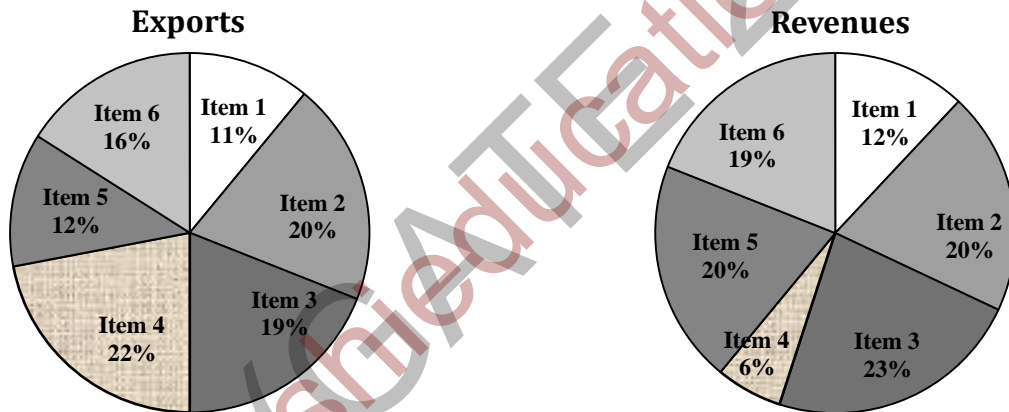
1. Shiv is younger to Riaz.
2. Shiv is elder to Som.

- (A) Statement 1 by itself determines the eldest child.  
(B) Statement 2 by itself determines the eldest child.  
(C) Statements 1 and 2 are both required to determine the eldest child.  
(D) Statements 1 and 2 are not sufficient to determine the eldest child.

- Q.7 Moving into a world of big data will require us to change our thinking about the merits of exactitude. To apply the conventional mindset of measurement to the digital, connected world of the twenty-first century is to miss a crucial point. As mentioned earlier, the obsession with exactness is an artefact of the information-deprived analog era. When data was sparse, every data point was critical, and thus great care was taken to avoid letting any point bias the analysis.  
*From "BIG DATA" Viktor Mayer-Schonberger and Kenneth Cukier*

The main point of the paragraph is:

- (A) The twenty-first century is a digital world  
 (B) Big data is obsessed with exactness  
 (C) Exactitude is not critical in dealing with big data  
 (D) Sparse data leads to a bias in the analysis
- Q.8 The total exports and revenues from the exports of a country are given in the two pie charts below. The pie chart for exports shows the quantity of each item as a percentage of the total quantity of exports. The pie chart for the revenues shows the percentage of the total revenue generated through export of each item. The total quantity of exports of all the items is 5 lakh tonnes and the total revenues are 250 crore rupees. What is the ratio of the revenue generated through export of Item 1 per kilogram to the revenue generated through export of Item 4 per kilogram?



- (A) 1:2                      (B) 2:1                      (C) 1:4                      (D) 4:1

- Q.9 X is 1 km northeast of Y. Y is 1 km southeast of Z. W is 1 km west of Z. P is 1 km south of W. Q is 1 km east of P. What is the distance between X and Q in km?  
 (A) 1                      (B)  $\sqrt{2}$                       (C)  $\sqrt{3}$                       (D) 2
- Q.10 10% of the population in a town is HIV<sup>+</sup>. A new diagnostic kit for HIV detection is available; this kit correctly identifies HIV<sup>+</sup> individuals 95% of the time, and HIV<sup>-</sup> individuals 89% of the time. A particular patient is tested using this kit and is found to be positive. The probability that the individual is actually positive is \_\_\_\_\_

**END OF THE QUESTION PAPER**

**Q. 1 – Q. 25 carry one mark each.**

Q.1 A fair (unbiased) coin was tossed four times in succession and resulted in the following outcomes: (i) Head, (ii) Head, (iii) Head, (iv) Head. The probability of obtaining a 'Tail' when the coin is tossed again is

- (A) 0                      (B)  $\frac{1}{2}$                       (C)  $\frac{4}{5}$                       (D)  $\frac{1}{5}$

Q.2

The determinant of matrix  $\begin{bmatrix} 0 & 1 & 2 & 3 \\ 1 & 0 & 3 & 0 \\ 2 & 3 & 0 & 1 \\ 3 & 0 & 1 & 2 \end{bmatrix}$  is \_\_\_\_\_

Q.3

$z = \frac{2-3i}{-5+i}$  can be expressed as

- (A)  $-0.5 - 0.5i$                       (B)  $-0.5 + 0.5i$   
(C)  $0.5 - 0.5i$                       (D)  $0.5 + 0.5i$

Q.4

The integrating factor for the differential equation  $\frac{dP}{dt} + k_2 P = k_1 L_0 e^{-k_1 t}$  is

- (A)  $e^{-k_1 t}$                       (B)  $e^{-k_2 t}$                       (C)  $e^{k_1 t}$                       (D)  $e^{k_2 t}$

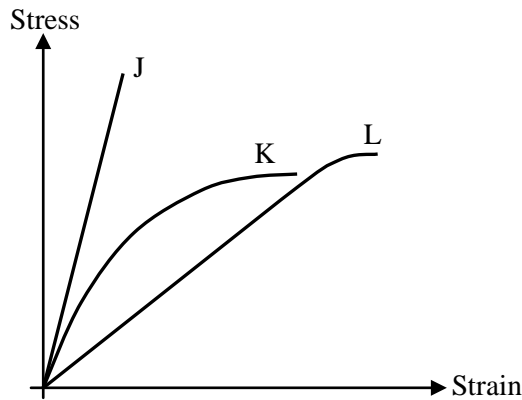
Q.5

If  $\{x\}$  is a continuous, real valued random variable defined over the interval  $(-\infty, +\infty)$  and its occurrence is defined by the density function given as:  $f(x) = \frac{1}{\sqrt{2\pi} * b} e^{-\frac{1}{2} \left(\frac{x-a}{b}\right)^2}$  where 'a' and 'b' are the statistical attributes of the random variable  $\{x\}$ . The value of the integral  $\int_{-\infty}^a \frac{1}{\sqrt{2\pi} * b} e^{-\frac{1}{2} \left(\frac{x-a}{b}\right)^2} dx$  is

- (A) 1                      (B) 0.5                      (C)  $\pi$                       (D)  $\frac{\pi}{2}$



- Q.6 Group I contains representative stress-strain curves as shown in the figure, while Group II gives the list of materials. Match the stress-strain curves with the corresponding materials.

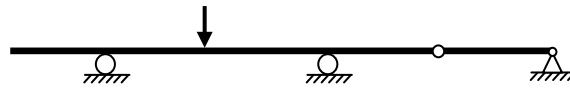


Group I	Group II
P. Curve J	1. Cement paste
Q. Curve K	2. Coarse aggregate
R. Curve L	3. Concrete

- (A) P - 1; Q - 3; R - 2  
(B) P - 2; Q - 3; R - 1  
(C) P - 3; Q - 1; R - 2  
(D) P - 3; Q - 2; R - 1
- Q.7 The first moment of area about the axis of bending for a beam cross-section is  
(A) moment of inertia  
(B) section modulus  
(C) shape factor  
(D) polar moment of inertia
- Q.8 Polar moment of inertia ( $I_p$ ), in  $\text{cm}^4$ , of a rectangular section having width,  $b = 2$  cm and depth,  $d = 6$  cm is \_\_\_\_\_
- Q.9 The target mean strength  $f_{cm}$  for concrete mix design obtained from the characteristic strength  $f_{ck}$  and standard deviation  $\sigma$ , as defined in IS:456-2000, is  
(A)  $f_{ck} + 1.35\sigma$   
(B)  $f_{ck} + 1.45\sigma$   
(C)  $f_{ck} + 1.55\sigma$   
(D)  $f_{ck} + 1.65\sigma$
- Q.10 The flexural tensile strength of M25 grade of concrete, in  $\text{N/mm}^2$ , as per IS:456-2000 is \_\_\_\_\_
- Q.11 The modulus of elasticity,  $E = 5000\sqrt{f_{ck}}$  where  $f_{ck}$  is the characteristic compressive strength of concrete, specified in IS:456-2000 is based on  
(A) tangent modulus  
(B) initial tangent modulus  
(C) secant modulus  
(D) chord modulus



Q.12 The static indeterminacy of the two-span continuous beam with an internal hinge, shown below, is \_\_\_\_\_



Q.13 As per Indian Standard Soil Classification System (IS: 1498 - 1970), an expression for **A-line** is

- (A)  $I_p = 0.73 (w_L - 20)$  (B)  $I_p = 0.70 (w_L - 20)$   
 (C)  $I_p = 0.73 (w_L - 10)$  (D)  $I_p = 0.70 (w_L - 10)$

Q.14 The clay mineral primarily governing the swelling behavior of Black Cotton soil is

- (A) Halloysite (B) Illite (C) Kaolinite (D) Montmorillonite

Q.15 The contact pressure for a rigid footing resting on clay at the centre and the edges are respectively

- (A) maximum and zero (B) maximum and minimum  
 (C) zero and maximum (D) minimum and maximum

Q.16 A certain soil has the following properties:  $G_s = 2.71$ ,  $n = 40\%$  and  $w = 20\%$ . The degree of saturation of the soil (rounded off to the nearest percent) is \_\_\_\_\_

Q.17 A plane flow has velocity components  $u = \frac{x}{T_1}$ ,  $v = -\frac{y}{T_2}$  and  $w = 0$  along  $x$ ,  $y$  and  $z$  directions respectively, where  $T_1 (\neq 0)$  and  $T_2 (\neq 0)$  are constants having the dimension of time. The given flow is incompressible if

- (A)  $T_1 = -T_2$  (B)  $T_1 = -\frac{T_2}{2}$  (C)  $T_1 = \frac{T_2}{2}$  (D)  $T_1 = T_2$

Q.18 Group I lists a few devices while Group II provides information about their uses. Match the devices with their corresponding use.

Group I

Group II

- P. Anemometer  
 Q. Hygrometer  
 R. Pitot Tube  
 S. Tensiometer

1. Capillary potential of soil water
2. Fluid velocity at a specific point in the flow stream
3. Water vapour content of air
4. Wind speed

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

- Q.19 An isolated 3-h rainfall event on a small catchment produces a hydrograph peak and point of inflection on the falling limb of the hydrograph at 7 hours and 8.5 hours respectively, after the start of the rainfall. Assuming, no losses and no base flow contribution, the time of concentration (in hours) for this catchment is approximately
- (A) 8.5                      (B) 7.0                      (C) 6.5                      (D) 5.5
- Q.20 The Muskingum model of routing a flood through a stream reach is expressed as  $O_2 = K_0 I_2 + K_1 I_1 + K_2 O_1$ , where  $K_0$ ,  $K_1$  and  $K_2$  are the routing coefficients for the concerned reach,  $I_1$  and  $I_2$  are the inflows to the reach, and  $O_1$  and  $O_2$  are the outflows from the reach corresponding to time steps 1 and 2 respectively. The sum of  $K_0$ ,  $K_1$  and  $K_2$  of the model is
- (A) -1                      (B) -0.5                      (C) 0.5                      (D) 1
- Q.21 The dominating microorganisms in an activated sludge process reactor are
- (A) aerobic heterotrophs                      (B) anaerobic heterotrophs  
(C) autotrophs                      (D) phototrophs
- Q.22 The two air pollution control devices that are usually used to remove very fine particles from the flue gas are
- (A) Cyclone and Venturi Scrubber  
(B) Cyclone and Packed Scrubber  
(C) Electrostatic Precipitator and Fabric Filter  
(D) Settling Chamber and Tray Scrubber
- Q.23 The average spacing between vehicles in a traffic stream is 50 m, then the density (in veh/km) of the stream is \_\_\_\_\_
- Q.24 A road is being designed for a speed of 110 km/hr on a horizontal curve with a super elevation of 8%. If the coefficient of side friction is 0.10, the minimum radius of the curve (in m) required for safe vehicular movement is
- (A) 115.0                      (B) 152.3                      (C) 264.3                      (D) 528.5
- Q.25 The survey carried out to delineate natural features, such as hills, rivers, forests and man-made features, such as towns, villages, buildings, roads, transmission lines and canals is classified as
- (A) engineering survey                      (B) geological survey  
(C) land survey                      (D) topographic survey

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

Q.26 The expression  $\lim_{\alpha \rightarrow 0} \frac{x^\alpha - 1}{\alpha}$  is equal to

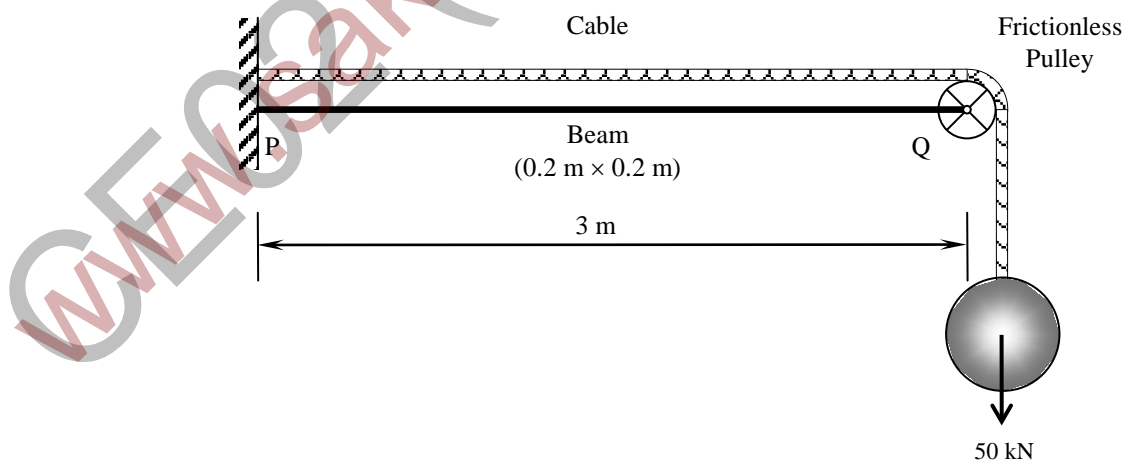
- (A)  $\log x$                       (B) 0                      (C)  $x \log x$                       (D)  $\infty$

Q.27 An observer counts 240 veh/h at a specific highway location. Assume that the vehicle arrival at the location is Poisson distributed, the probability of having one vehicle arriving over a 30-second time interval is \_\_\_\_\_

Q.28 The rank of the matrix  $\begin{bmatrix} 6 & 0 & 4 & 4 \\ -2 & 14 & 8 & 18 \\ 14 & -14 & 0 & -10 \end{bmatrix}$  is \_\_\_\_\_

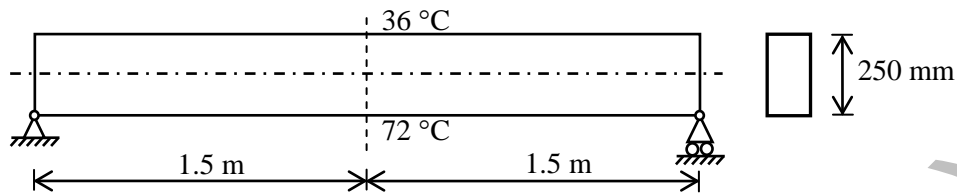
Q.29 Water is flowing at a steady rate through a homogeneous and saturated horizontal soil strip of 10 m length. The strip is being subjected to a constant water head ( $H$ ) of 5 m at the beginning and 1 m at the end. If the governing equation of flow in the soil strip is  $\frac{d^2 H}{dx^2} = 0$  (where  $x$  is the distance along the soil strip), the value of  $H$  (in m) at the middle of the strip is \_\_\_\_\_

Q.30 The values of axial stress ( $\sigma$ ) in  $\text{kN/m}^2$ , bending moment ( $M$ ) in  $\text{kNm}$ , and shear force ( $V$ ) in  $\text{kN}$  acting at point P for the arrangement shown in the figure are respectively

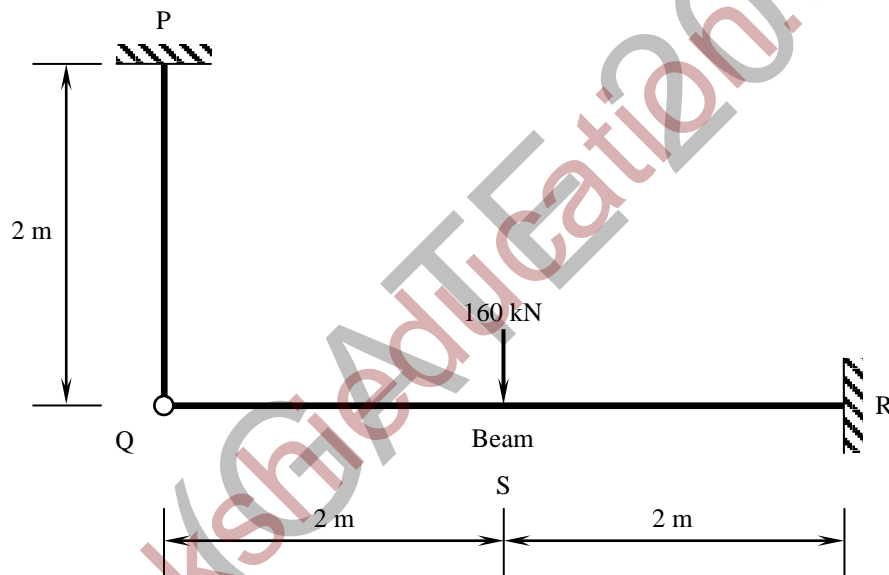


- (A) 1000, 75 and 25                      (B) 1250, 150 and 50  
 (C) 1500, 225 and 75                      (D) 1750, 300 and 100

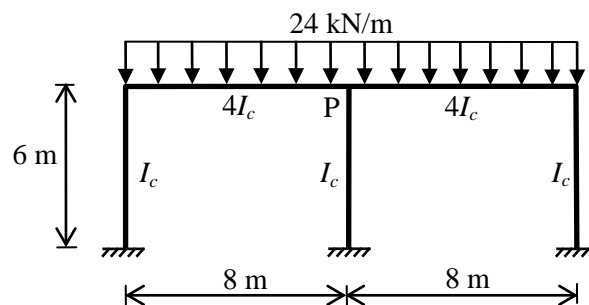
- Q.31 The beam of an overall depth 250 mm (shown below) is used in a building subjected to two different thermal environments. The temperatures at the top and bottom surfaces of the beam are  $36^{\circ}\text{C}$  and  $72^{\circ}\text{C}$  respectively. Considering coefficient of thermal expansion ( $\alpha$ ) as  $1.50 \times 10^{-5}$  per  $^{\circ}\text{C}$ , the vertical deflection of the beam (in mm) at its mid-span due to temperature gradient is \_\_\_\_\_



- Q.32 The axial load (in kN) in the member PQ for the arrangement/assembly shown in the figure given below is \_\_\_\_\_

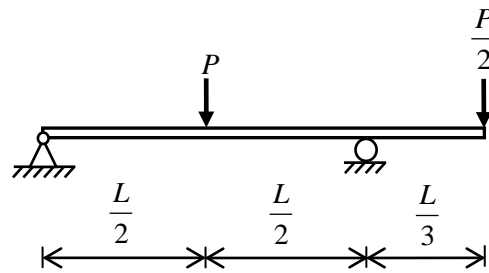


- Q.33 Considering the symmetry of a rigid frame as shown below, the magnitude of the bending moment (in kNm) at P (preferably using the moment distribution method) is



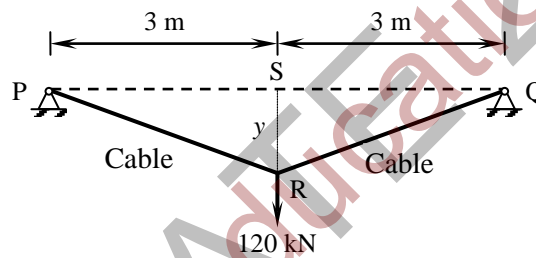
- (A) 170                      (B) 172                      (C) 176                      (D) 178

- Q.34 A prismatic beam (as shown below) has plastic moment capacity of  $M_p$ , then the collapse load  $P$  of the beam is



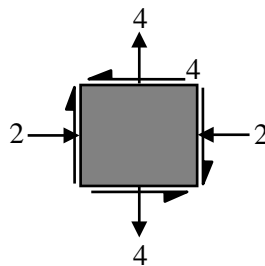
- (A)  $\frac{2M_p}{L}$       (B)  $\frac{4M_p}{L}$       (C)  $\frac{6M_p}{L}$       (D)  $\frac{8M_p}{L}$

- Q.35 The tension (in kN) in a 10 m long cable, shown in the figure, neglecting its self-weight is



- (A) 120      (B) 75      (C) 60      (D) 45

- Q.36 For the state of stresses (in MPa) shown in the figure below, the maximum shear stress (in MPa) is \_\_\_\_\_



- Q.37 An infinitely long slope is made up of a  $c-\phi$  soil having the properties: cohesion ( $c$ ) = 20 kPa, and dry unit weight ( $\gamma_d$ ) = 16 kN/m<sup>3</sup>. The angle of inclination and critical height of the slope are 40° and 5 m, respectively. To maintain the limiting equilibrium, the angle of internal friction of the soil (in degrees) is \_\_\_\_\_

- Q.38 Group I enlists in-situ field tests carried out for soil exploration, while Group II provides a list of parameters for sub-soil strength characterization. Match the type of tests with the characterization parameters.

## Group I

- P. Pressuremeter Test (PMT)  
 Q. Static Cone Penetration Test (SCPT)  
 R. Standard Penetration Test (SPT)  
 S. Vane Shear Test (VST)

## Group II

1. Menard's modulus ( $E_m$ )  
 2. Number of blows ( $N$ )  
 3. Skin resistance ( $f_c$ )  
 4. Undrained cohesion ( $c_u$ )

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

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

- Q.39 A single vertical friction pile of diameter 500 mm and length 20 m is subjected to a vertical compressive load. The pile is embedded in a homogeneous sandy stratum where: angle of internal friction ( $\phi$ ) =  $30^\circ$ , dry unit weight ( $\gamma_d$ ) =  $20 \text{ kN/m}^3$  and angle of wall friction ( $\delta$ ) =  $2\phi/3$ . Considering the coefficient of lateral earth pressure ( $K$ ) = 2.7 and the bearing capacity factor ( $N_q$ ) = 25, the ultimate bearing capacity of the pile (in kN) is \_\_\_\_\_

- Q.40 A circular raft foundation of 20 m diameter and 1.6 m thick is provided for a tank that applies a bearing pressure of 110 kPa on sandy soil with Young's modulus,  $E_s' = 30 \text{ MPa}$  and Poisson's ratio,  $\nu_s = 0.3$ . The raft is made of concrete ( $E_c = 30 \text{ GPa}$  and  $\nu_c = 0.15$ ). Considering the raft as rigid, the elastic settlement (in mm) is

- (A) 50.96                      (B) 53.36                      (C) 63.72                      (D) 66.71

- Q.41 A horizontal nozzle of 30 mm diameter discharges a steady jet of water into the atmosphere at a rate of 15 litres per second. The diameter of inlet to the nozzle is 100 mm. The jet impinges normal to a flat stationary plate held close to the nozzle end. Neglecting air friction and considering the density of water as  $1000 \text{ kg/m}^3$ , the force exerted by the jet (in N) on the plate is \_\_\_\_\_

- Q.42 A venturimeter having a throat diameter of 0.1 m is used to estimate the flow rate of a horizontal pipe having a diameter of 0.2 m. For an observed pressure difference of 2 m of water head and coefficient of discharge equal to unity, assuming that the energy losses are negligible, the flow rate (in  $\text{m}^3/\text{s}$ ) through the pipe is approximately equal to

- (A) 0.500                      (B) 0.150                      (C) 0.050                      (D) 0.015

- Q.43 A rectangular channel of 2.5 m width is carrying a discharge of  $4 \text{ m}^3/\text{s}$ . Considering that acceleration due to gravity as  $9.81 \text{ m/s}^2$ , the velocity of flow (in m/s) corresponding to the critical depth (at which the specific energy is minimum) is \_\_\_\_\_

- Q.44 Irrigation water is to be provided to a crop in a field to bring the moisture content of the soil from the existing 18% to the field capacity of the soil at 28%. The effective root zone of the crop is 70 cm. If the densities of the soil and water are  $1.3 \text{ g/cm}^3$  and  $1.0 \text{ g/cm}^3$  respectively, the depth of irrigation water (in mm) required for irrigating the crop is \_\_\_\_\_
- Q.45 With reference to a standard Cartesian (x, y) plane, the parabolic velocity distribution profile of fully developed laminar flow in x-direction between two parallel, stationary and identical plates that are separated by distance, h, is given by the expression

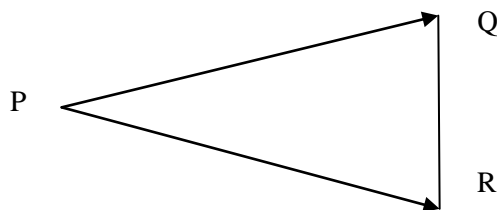
$$u = -\frac{h^2}{8\mu} \frac{dp}{dx} \left[ 1 - 4 \left( \frac{y}{h} \right)^2 \right]$$

In this equation, the  $y = 0$  axis lies equidistant between the plates at a distance  $h/2$  from the two plates,  $p$  is the pressure variable and  $\mu$  is the dynamic viscosity term. The maximum and average velocities are, respectively

- (A)  $u_{max} = -\frac{h^2}{8\mu} \frac{dp}{dx}$  and  $u_{average} = \frac{2}{3} u_{max}$
- (B)  $u_{max} = \frac{h^2}{8\mu} \frac{dp}{dx}$  and  $u_{average} = \frac{2}{3} u_{max}$
- (C)  $u_{max} = -\frac{h^2}{8\mu} \frac{dp}{dx}$  and  $u_{average} = \frac{3}{8} u_{max}$
- (D)  $u_{max} = \frac{h^2}{8\mu} \frac{dp}{dx}$  and  $u_{average} = \frac{3}{8} u_{max}$
- Q.46 A suspension of sand like particles in water with particles of diameter 0.10 mm and below is flowing into a settling tank at  $0.10 \text{ m}^3/\text{s}$ . Assume  $g = 9.81 \text{ m/s}^2$ , specific gravity of particles = 2.65, and kinematic viscosity of water =  $1.0105 \times 10^{-2} \text{ cm}^2/\text{s}$ . The minimum surface area (in  $\text{m}^2$ ) required for this settling tank to remove particles of size 0.06 mm and above with 100% efficiency is \_\_\_\_\_
- Q.47 A surface water treatment plant operates round the clock with a flow rate of  $35 \text{ m}^3/\text{min}$ . The water temperature is  $15^\circ\text{C}$  and jar testing indicated an alum dosage of 25 mg/l with flocculation at a  $Gt$  value of  $4 \times 10^4$  producing optimal results. The alum quantity required for 30 days (in kg) of operation of the plant is \_\_\_\_\_
- Q.48 An effluent at a flow rate of  $2670 \text{ m}^3/\text{d}$  from a sewage treatment plant is to be disinfected. The laboratory data of disinfection studies with a chlorine dosage of 15 mg/l yield the model  $N_t = N_o e^{-0.145t}$  where  $N_t$  = number of micro-organisms surviving at time  $t$  (in min.) and  $N_o$  = number of micro-organisms present initially (at  $t = 0$ ). The volume of disinfection unit (in  $\text{m}^3$ ) required to achieve a 98% kill of micro-organisms is \_\_\_\_\_



- Q.49 A waste water stream (flow =  $2 \text{ m}^3/\text{s}$ , ultimate BOD =  $90 \text{ mg/l}$ ) is joining a small river (flow =  $12 \text{ m}^3/\text{s}$ , ultimate BOD =  $5 \text{ mg/l}$ ). Both water streams get mixed up instantaneously. Cross-sectional area of the river is  $50 \text{ m}^2$ . Assuming the de-oxygenation rate constant,  $k = 0.25/\text{day}$ , the BOD (in  $\text{mg/l}$ ) of the river water, 10 km downstream of the mixing point is
- (A) 1.68                      (B) 12.63                      (C) 15.46                      (D) 1.37
- Q.50 In a Marshall sample, the bulk specific gravity of mix and aggregates are 2.324 and 2.546 respectively. The sample includes 5% of bitumen (by total weight of mix) of specific gravity 1.10. The theoretical maximum specific gravity of mix is 2.441. The void filled with bitumen (VFB) in the Marshall sample (in %) is \_\_\_\_\_
- Q.51 A student riding a bicycle on a 5 km one-way street takes 40 minutes to reach home. The student stopped for 15 minutes during this ride. 60 vehicles overtook the student (assume the number of vehicles overtaken by the student is zero) during the ride and 45 vehicles while the student stopped. The speed of vehicle stream on that road (in  $\text{km/hr}$ ) is
- (A) 7.5                      (B) 12                      (C) 40                      (D) 60
- Q.52 On a section of a highway the speed-density relationship is linear and is given by  $v = [80 - \frac{2}{3}k]$ ; where  $v$  is in  $\text{km/h}$  and  $k$  is in  $\text{veh/km}$ . The capacity (in  $\text{veh/h}$ ) of this section of the highway would be
- (A) 1200                      (B) 2400                      (C) 4800                      (D) 9600
- Q.53 A pre-timed four phase signal has critical lane flow rate for the first three phases as 200, 187 and 210  $\text{veh/hr}$  with saturation flow rate of 1800  $\text{veh/hr/lane}$  for all phases. The lost time is given as 4 seconds for each phase. If the cycle length is 60 seconds, the effective green time (in seconds) of the fourth phase is \_\_\_\_\_
- Q.54 A tacheometer was placed at point P to estimate the horizontal distances PQ and PR. The corresponding stadia intercepts with the telescope kept horizontal, are 0.320 m and 0.210 m, respectively. The  $\angle QPR$  is measured to be  $61^\circ 30' 30''$ . If the stadia multiplication constant = 100 and stadia addition constant = 0.10 m, the horizontal distance (in m) between the points Q and R is \_\_\_\_\_



- Q.55 The chainage of the intersection point of two straights is 1585.60 m and the angle of intersection is  $140^\circ$ . If the radius of a circular curve is 600.00 m, the tangent distance (in m) and length of the curve (in m), respectively are
- (A) 418.88 and 1466.08                      (B) 218.38 and 1648.49  
(C) 218.38 and 418.88                      (D) 418.88 and 218.38

**END OF THE QUESTION PAPER**

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