

GATE 2008 CIVIL ENGINEERING¹

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Q.1 – Q.20 CARRY ONE MARK EACH.

1) The product of matrices $(PQ)^{-1}P$ is (GATE CE 2008)

- a) P^{-1}
- b) Q^{-1}
- c) $P^{-1}Q^{-1}P$
- d) PQ^{-1}

2) The general solution of

$$\frac{d^2y}{dx^2} + y = 0 \quad (1)$$

is (GATE CE 2008)

- a) $y = P \cos x + Q \sin x$
- b) $y = P \cos x$
- c) $y = P \sin x$
- d) $y = P \sin^2 x$

3) A mild steel specimen is under uni-axial tensile stress. Young's modulus and yield stress for mild steel are 2×10^5 MPa and 250 MPa respectively. The maximum amount of strain energy per unit volume that can be stored in this specimen without permanent set is (GATE CE 2008)

- a) 156 Nmm/mm³
- b) 15.6 Nmm/mm³
- c) 1.56 Nmm/mm³
- d) 0.156 Nmm/mm³

4) A reinforced concrete structure has to be constructed along a sea coast. The minimum grade of concrete to be used as per IS:456 - 2000 is (GATE CE 2008)

- a) M 15
- b) M 20
- c) M 25
- d) M 30

5) In the design of a reinforced concrete beam, the requirement for bond is not getting satisfied. The economical option to satisfy the requirement for bond is by (GATE CE 2008)

- a) bundling of bars
- b) providing smaller diameter bars more in number
- c) providing larger diameter bars less in number
- d) providing same diameter bars more in number

6) The shape of the cross-section, which has the largest shape factor, is (GATE CE 2008)

$$\begin{aligned} \text{a) } \frac{b}{H} &= \frac{1}{\sqrt{G-K}} \\ \text{b) } \frac{b}{H} &= \sqrt{G-K} \end{aligned}$$

$$\begin{aligned} \text{c) } \frac{b}{H} &= \frac{1}{G-K} \\ \text{d) } \frac{b}{H} &= \frac{1}{K\sqrt{G-K}} \end{aligned}$$

14) Two primary air pollutants are: (GATE CE 2008)

- | | |
|--|-----------------------------------|
| a) sulphur oxide and ozone | c) sulphur oxide and hydrocarbon |
| b) nitrogen oxide and peroxyacetyl nitrate | d) ozone and peroxyacetyl nitrate |

15) Two biodegradable components of municipal solid waste are: (GATE CE 2008)

- | | |
|------------------------|-------------------------------------|
| a) plastics and wood | c) leather and tin cans |
| b) cardboard and glass | d) food wastes and garden trimmings |

16) The specific gravity of paving bitumen as per IS:73 – 1992 lies between: (GATE CE 2008)

- | | |
|------------------|------------------|
| a) 1.10 and 1.06 | c) 1.02 and 0.97 |
| b) 1.06 and 1.02 | d) 0.97 and 0.92 |

17) A combined value of flakiness and elongation index is to be determined for a sample of aggregates. The sequence in which the two tests are conducted is: (GATE CE 2008)

- elongation index test followed by flakiness index test on the whole sample
- flakiness index test followed by elongation index test on the whole sample
- flakiness index test followed by elongation index test on non-flaky aggregates
- elongation index test followed by flakiness index test on non-elongated aggregates

18) The capacities of One-way 1.5 m wide sidewalk per-sons per hour and One-way 2-lane urban road (PCU per hour, with no frontage access, no standing vehicles and very little cross tra- are respectively: (GATE CE 2008)

- | | |
|------------------|------------------|
| a) 1.10 and 1.06 | c) 1.02 and 0.97 |
| b) 1.06 and 1.02 | d) 0.97 and 0.92 |

19) The shape of the STOP sign according to IRC:67-2001 is: (GATE CE 2008)

- | | |
|---------------|----------------|
| a) circular | c) octagonal |
| b) triangular | d) rectangular |

20) The type of surveying in which the curvature of the earth is taken into account is called: (GATE CE 2008)

- a) Geodetic surveying
b) Plane surveying

- c) Preliminary surveying
d) Topographical surveying

Q.21 – Q.75 CARRY TWO MARKS EACH.

21) The equation

$$k_x \frac{\partial^2 h}{\partial x^2} + k_z \frac{\partial^2 h}{\partial z^2} = 0 \quad (2)$$

can be transformed to

$$\frac{\partial^2 h}{\partial x_t^2} + \frac{\partial^2 h}{\partial z^2} = 0 \quad (3)$$

by substituting: (GATE CE 2008)

a) $x_t = x \frac{k_z}{k_x}$
b) $x_t = x \frac{k_x}{k_z}$

c) $x_t = x \sqrt{\frac{k_x}{k_z}}$
d) $x_t = x \sqrt{\frac{k_z}{k_x}}$

22) The value of

$$\int_0^3 \int_0^{3-x} (6 - x - y) dx dy \quad \text{is} \quad (4)$$

(GATE CE 2008)

- a) 13.5
b) 27.0

- c) 40.5
d) 54.0

23) Three values of x and y are to be fitted in a straight line in the form $y = a + bx$ by the method of least squares. Given: $\sum x = 6$, $\sum y = 21$, $\sum x^2 = 14$ and $\sum xy = 46$, the values of a and b are respectively: (GATE CE 2008)

- a) 2 and 3
b) 1 and 2

- c) 2 and 1
d) 3 and 2

24) Solution of

$$\frac{dy}{dx} = \frac{-x}{y} \quad (5)$$

at $x = 1$ and $y = \sqrt{3}$ is: (GATE CE 2008)

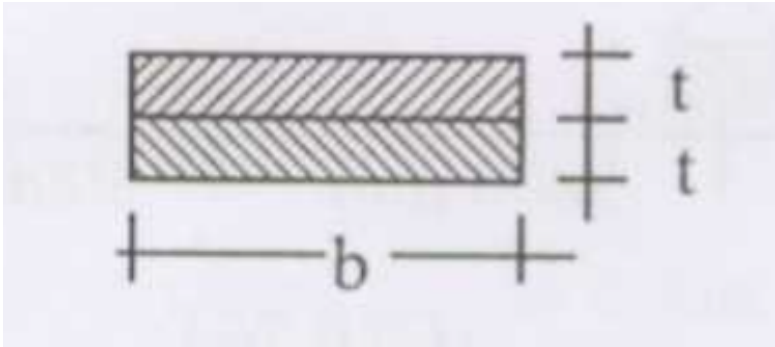
- a) $x^2 - y^2 = -2$
b) $x^2 + y^2 = 4$

- c) $x^2 - y^2 = -2$
d) $x^2 + y^2 = 4$

- a) 0
b) 30

- c) 90
d) 120

- 30) Cross-section of a column consisting of two steel strips, each of thickness t and width b is shown in the figure below. The critical loads of the column with perfect bond and without bond between the strips are P and P_0 respectively. The ratio P/P_0 is: (GATE CE 2008)



- a) 2
b) 4

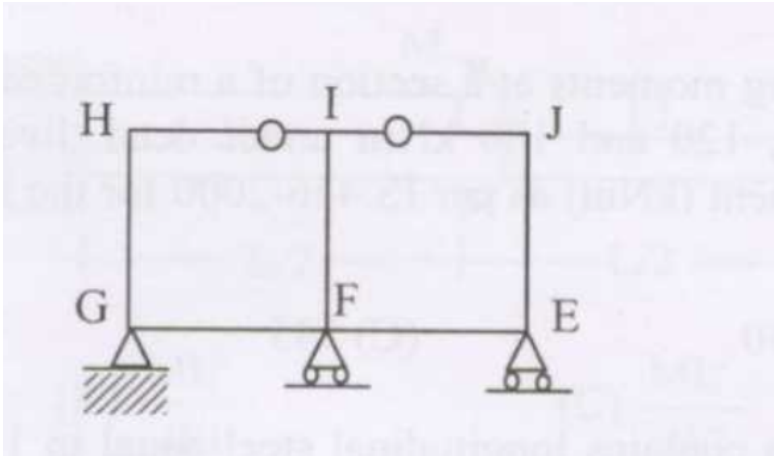
- c) 6
d) 8

- 31) A rigid bar GH of length L is supported by a hinge and a spring of stiffness K as shown in the figure below. The buckling load, P_{Cr} , for the bar will be (GATE CE 2008)

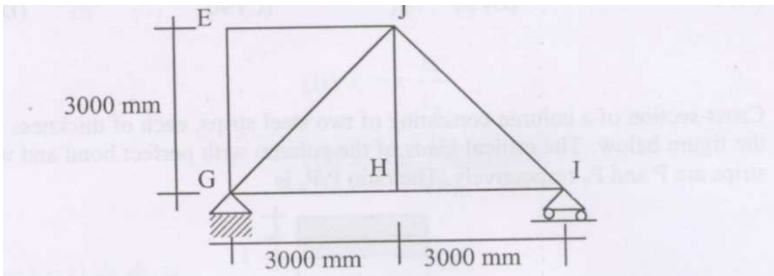
- a) $0.5KL$
b) $0.8KL$

- c) $1.0KL$
d) $1.2KL$

- 32) The degree of static indeterminacy of the rigid frame having two internal hinges as shown in the figure below, is (GATE CE 2008)



- a) 8
b) 7
c) 6
d) 5
- 33) The members EJ and IJ of a steel truss shown in the figure below are subjected to a temperature rise of 30°C . The coefficient of thermal expansion of steel is 0.000012 per $^{\circ}\text{C}$ per unit length. The displacement (mm) of joint E relative to joint H along the direction HE of the truss, is (GATE CE 2008)



- a) 0.1
- b) 1
- c) 1.1
- d) 10

39) A pre-tensioned concrete member of section 200 mm x 250 mm contains tendons of area 500 mm^2 at centre of gravity of the section. The prestress in the tendons is 1000 N/mm^2 . Assuming modular ratio as 10, the stress N/mm^2 in concrete is (GATE CE 2008)

- a) 11
- b) 9
- c) 7
- d) 5

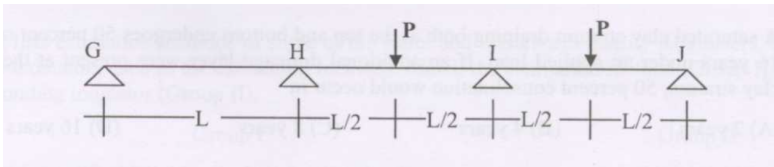
40) Rivets and bolts subjected to both shear stress $\tau_{vf, \text{ cal}}$ and axial tensile stress ($\sigma_{tf, \text{ cal}}$) shall be so proportioned that the stresses do not exceed the respective allowable stresses τ_{vf} and σ_{tf} and the value of

$$\left(\frac{\tau_{vf, \text{ cal}}}{\tau_{vf}} + \frac{\sigma_{tf, \text{ cal}}}{\sigma_{tf}} \right) \quad (11)$$

does not exceed (GATE CE 2008)

- a) 1.0
- b) 1.2
- c) 1.4
- d) 1.8

41) A continuous beam is loaded as shown in the figure below. Assuming a plastic moment capacity equal to M_p , the minimum load at which the beam would collapse is (GATE CE 2008)



- | | |
|------------------------------------|-------------------------------------|
| a) $\left(\frac{4M_p}{L} \right)$ | c) $\left(\frac{8M_p}{L} \right)$ |
| b) $\left(\frac{6M_p}{L} \right)$ | d) $\left(\frac{10M_p}{L} \right)$ |

42) The maximum tensile stress at the section X-X shown in the figure below is (GATE CE 2008)

- | | |
|-----------------------------------|-----------------------------------|
| a) $\left(\frac{8P}{bd} \right)$ | c) $\left(\frac{4P}{bd} \right)$ |
| b) $\left(\frac{6P}{bd} \right)$ | d) $\left(\frac{2P}{bd} \right)$ |

- a) 6.48 m c) 3.24 m
b) 5.24 m d) 2.24 m
- 53) The flow of water (mass density = 1000 kg/m^3 and kinematic viscosity = $10^{-6} \text{ m}^2/\text{s}$) in a commercial pipe, having equivalent roughness k_s , as 0.12 mm, yields an average shear stress at the pipe boundary = 600 N/m^2 . The value of k_s/δ (δ being the thickness of laminar sub-layer) for this pipe is (GATE CE 2008)
- a) 0.25 m c) 6.0 m
b) 0.50 m d) 8.0 m
- 54) A river reach of 2.0 km long with maximum flood discharge of $10000 \text{ m}^3/\text{s}$ is to be physically modeled in the laboratory where maximum available discharge is $0.20 \text{ m}^3/\text{s}$. For a geometrically similar model based on equality of Froude number, the length of the river reach (m) in the model is (GATE CE 2008)
- a) 26.4 m c) 20.5 m
b) 25.0 m d) 18.0 m
- 55) An outlet irrigates an area of 20 ha . The discharge (l/s) required at this outlet to meet the evapo-transpiration requirement of 20 mm occurring uniformly in 20 days neglecting other field losses is (GATE CE 2008)
- a) 2.52 m c) 2.01 m
b) 2.31 m d) 1.52 m
- 56) A wastewater sample contains $10^{-5.6} \text{ mmol/l}$ of OH^- ions at 25°C . The pH of this sample is (GATE CE 2008)
- a) 8.6 c) 5.6
b) 8.4 d) 5.4
- 57) Group I lists estimation methods of some of the water and wastewater quality parameters. Group II lists the indicators used in the estimation methods. Match the estimation method (Group I) with the corresponding indicator (Group II). (GATE CE 2008)
- | Group I | Group II |
|--|-----------------------|
| P Azide modified Winkler method for dissolved oxygen | 1. Eriochrome Black T |
| Q Dichromate method for chemical oxygen demand | 2. Ferrion |
| R EDTA titrimetric method for hardness | 3. Potassium chromate |
| S Mohr or Argentometric method for chlorides | 4. Starch |

Options:

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

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

- 58) Determine the correctness or otherwise of the following Assertion [a] and the Reason [r]

Assertion: The crown of the outgoing larger diameter sewer is always matched with the crown of incoming smaller diameter sewer.

Reason: It eliminates backing up of sewage in the incoming smaller diameter sewer. (GATE CE 2008)

- a) Both [a] and [r] are true and [r] is the correct reason for [a]
 - b) Both [a] and [r] are true but [r] is not the correct reason for [a]
 - c) Both [a] and [r] are false
 - d) Assertion [a] is true but Reason [r] is false
- 59) The 5-day BOD of a wastewater sample is obtained as 190 mg/l (with $k = 0.01 \text{ h}^{-1}$). The ultimate oxygen demand (mg/l) of the sample will be (GATE CE 2008)
- a) 3800
 - b) 475
 - c) 271
 - d) 190
- 60) A water treatment plant is required to process $28800 \text{ m}^3/\text{d}$ of raw water (density = 1000 kg/m^3 , kinematic viscosity = 10 ms). The rapid mixing tank imparts a velocity gradient of 900 s^{-1} to blend 35 mg/l of alum with the flow for a detention time of 2 minutes. The power input (W) required for rapid mixing is (GATE CE 2008)
- a) 3800
 - b) 475
 - c) 271
 - d) 190

- 61) Match Group I (*Terminology*) with Group II (*Definition/Brief Description*) for wastewater treatment systems (GATE CE 2008)

Group I

- P. Primary treatment
- Q. Secondary treatment
- R. Unit operation
- S. Unit process

Group II

- 1. Contaminant removal by physical forces
- 2. Involving biological and/or chemical reaction
- 3. Conversion of soluble organic matter to biomass
- 4. Removal of solid materials from incoming wastewater

Options:

- (A) P-4, Q-3, R-1, S-2
 - (B) P-4, Q-3, R-2, S-1
 - (C) P-3, Q-4, R-2, S-1
 - (D) P-1, Q-2, R-3, S-4
- 62) A roundabout is provided with an average entry width of 8.4 m, width of weaving section as 14 m, and length of the weaving section between channelizing islands

- a) 8000 vehicles per hour and 80 km per hour c) 2000 vehicles per hour and 80 km per hour
 b) 8000 vehicles per hour and 25 km per hour d) 2000 vehicles per hour and 40 km per hour

66) The plan of a survey plotted to a scale of 10 m to 1 cm is reduced in such a way that a line originally 10 cm long now measures 9 cm. The area of the reduced plan is measured as 81 cm^2 . The actual area m^2 of the survey is (*GATE CE 2008*)

- a) 10000 c) 1000
 b) 6561 d) 656

67) The lengths and bearings of a closed traverse PQRSP are given below.

Line	Length (m)	Bearing (WCB)
PQ	200	0°
QR	1000	45°
RS	907	180°
SP	?	?

The missing length and bearing, respectively, of the line SP are (*GATE CE 2008*)

- (A) 207 m and 270°
 (B) 707 m and 270°
 (C) 707 m and 180°
 (D) 907 m and 270°
- 68) The focal length of the object glass of a tacheometer is 200 mm, the distance between the vertical axis of the tacheometer and the optical centre of the object glass is 100 mm and the spacing between the upper and lower line of the diaphragm axis is 4 mm. With the line of collimation perfectly horizontal, the staff intercepts are 1 m (*top*), 2 m (*middle*), and 3 m (*bottom*). The horizontal distance (m) between the staff and the instrument station is (*GATE CE 2008*)

- a) 100.3 c) 150.0
 b) 103.0 d) 153.0

69) A road is provided with a horizontal circular curve having deflection angle of 55° and centre line radius of 250 m. A transition curve is to be provided at each end of the circular curve of such a length that the rate of gain of radial acceleration is 0.3 m/s at a speed of 50 km per hour. Length of the transition curve required at each of the ends is (*GATE CE 2008*)

- a) 2.57 c) 35.73
 b) 33.33 d) 1666.67

- 70) A light house of 120 m height is just visible above the horizon from a ship. The correct distance (m) between the ship and the light house considering combined correction for curvature and refraction, (GATE CE 2008)
- a) 39.098 c) 39098
b) 42.226 d) 42226

Statement for Linked Answer Questions 71 and 72:

A rectangular channel 6.0 m wide carries a discharge of 16.0 m³/s under uniform flow condition with normal depth of 1.60 m. Manning n is 0.015.

- 71)** The longitudinal slope of the channel is (*GATE CE 2008*)
- (A) 0.000585
(B) 0.000485
(C) 0.000385
(D) 0.000285
- 72)** A hump is to be provided on the channel bed. The maximum height of the hump without affecting the upstream flow condition is (*GATE CE 2008*)
- (A) 0.50 m
(B) 0.40 m
(C) 0.30 m
(D) 0.20 m
- 73)** The channel width is to be contracted. The minimum width to which the channel can be contracted without affecting the upstream flow condition is (*GATE CE 2008*)
- (A) 3.0 m
(B) 3.8 m
(C) 4.1 m
(D) 4.5 m

Statement for Linked Answer Questions 74 and 75:

A reinforced concrete beam of rectangular cross section of breadth 230 mm and effective depth 400 mm is subjected to a maximum factored shear force of 120 kN. The grades of concrete, main steel and stirrup steel are M20, Fe415 and Fe250 respectively. For the area of main steel provided, the design shear strength τ_c as per IS:456 – 2000 is 0.48 N/mm². The beam is designed for collapse limit state.

- 74)** The spacing (mm) of 2-legged 8 mm stirrups to be provided is (GATE CE 2008)
- (A) 40

- (B) 115
- (C) 250
- (D) 400

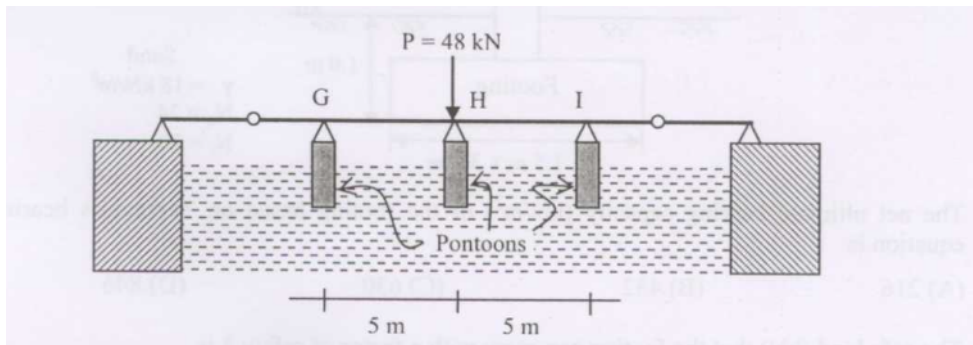
75) In addition, the beam is subjected to a torque whose factored value is 10.90 kNm. The stirrups have to be provided to carry a shear kN equal to (GATE CE 2008)

- (A) 50.42
- (B) 130.56
- (C) 151.67
- (D) 200.23

LINKED ANSWER QUESTIONS: Q.76 TO Q.85 CARRY TWO MARKS EACH

Statement for Linked Answer Questions 76 and 77:

Beam GHI is supported by three pontoons as shown in the figure below. The horizontal cross-sectional area of each pontoon is 8 m^2 , the flexural rigidity of the beam is 10000 kN-m^2 and the unit weight of water is 10 kN/m^3 .



76) When the middle pontoon is removed, the deflection at H will be (GATE CE 2008)

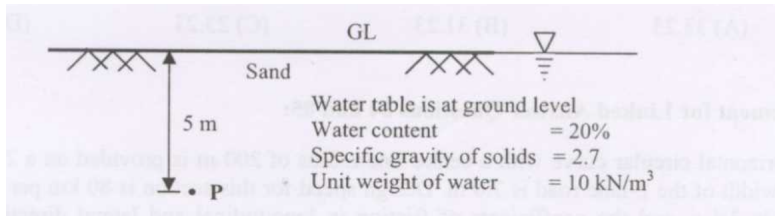
- (A) 0.2 m
- (B) 0.4 m
- (C) 0.6 m
- (D) 0.8 m

77) When the middle pontoon is brought back to its position as shown in the figure above, the reaction at H will be (GATE CE 2008)

- (A) 8.6 kN
- (B) 15.7 kN
- (C) 19.2 kN
- (D) 24.2 kN

Statement for Linked Answer Questions 78 and 79:

The ground conditions at a site are shown in the figure below.



78) The saturated unit weight of the sand (kN/m^3) is (GATE CE 2008)

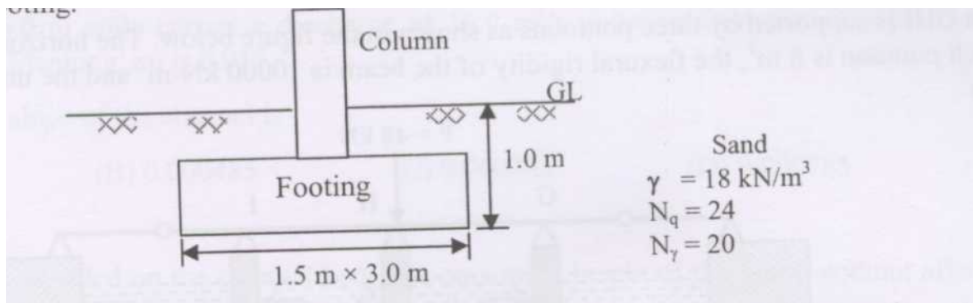
- (A) 15
- (B) 18
- (C) 21
- (D) 24

79) The total stress, pore water pressure and effective stress (kN/m^2) at the point P are, (GATE CE 2008)

- (A) 75, 50 and 25
- (B) 90, 50 and 40
- (C) 105, 50 and 55
- (D) 120, 50 and 70

Statement for Linked Answer Questions 80 and 81:

A column is supported on a footing as shown in the figure below. The water table is at a depth of 10 m below the base of the footing.



80) The net ultimate bearing capacity (kN/m^2) of the footing based on Terzaghi's bearing capacity equation is (GATE CE 2008)

- (A) 216
- (B) 432
- (C) 630
- (D) 846

81) The safe load (kN) that the footing can carry with a factor of safety 3 is (GATE CE 2008)

- (A) 282
- (B) 648
- (C) 945
- (D) 1269

Statement for Linked Answer Questions 82 and 83:

An automobile with projected area 2.6 m^2 is running on a road with a speed of 120 km per hour. The mass density and the kinematic viscosity of air are 1.2 kg/m^3 and $1.5 \times 10^{-5} \text{ m}^2/\text{s}$, respectively. The drag coefficient is 0.30.

82) The drag force on the automobile is (*GATE CE 2008*)

- (A) 620 N
- (B) 600 N
- (C) 580 N
- (D) 520 N

83) The metric horse power required to overcome the drag force is (*GATE CE 2008*)

- (A) 33.23
- (B) 31.23
- (C) 23.23
- (D) 20.23

Statement for Linked Answer Questions 84 and 85:

A horizontal circular curve with a centre line radius of 200 m is provided on a 2-lane, 2-way SH section. The width of the 2-lane road is 7.0 m. Design speed for this section is 80 km per hour. The brake reaction time is 2.4 s, and the coefficients of friction in longitudinal and lateral directions are 0.355 and 0.15, respectively.

84) The safe stopping sight distance on the section is (*GATE CE 2008*)

- (A) 221 m
- (B) 195 m
- (C) 125 m
- (D) 65 m

85) The set-back distance from the center line of the inner lane is (*GATE CE 2008*)

- (A) 7.93 m
- (B) 8.10 m
- (C) 9.60 m
- (D) 9.77 m