CIVIL ENGINEERING

GATE SOLUTION

Subject-wise descriptive Solution

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GATE-2016
Civil Engineering (SET-1)

Q. 1 – Q. 5 carry one mark each.

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.

2. A rewording of something written or spoken is a _____.

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

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

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

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.

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

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.

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

(A) **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)

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) $(x + 1)$

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

Q. 11 – Q. 35 carry one mark each

11. 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*)

12. 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

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

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

14. 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

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

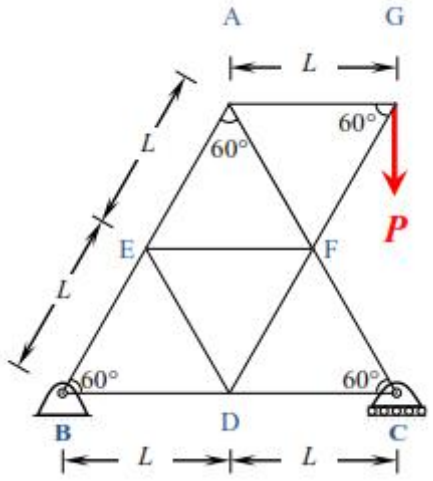
(A) $C\cos(kt)\left[C_1 e^{(\sqrt{k/\sim})x} + C_2 e^{-(\sqrt{k/\sim})x}\right]$

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

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

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

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

17. 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

18. 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

_____

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

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

20. 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

21. 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

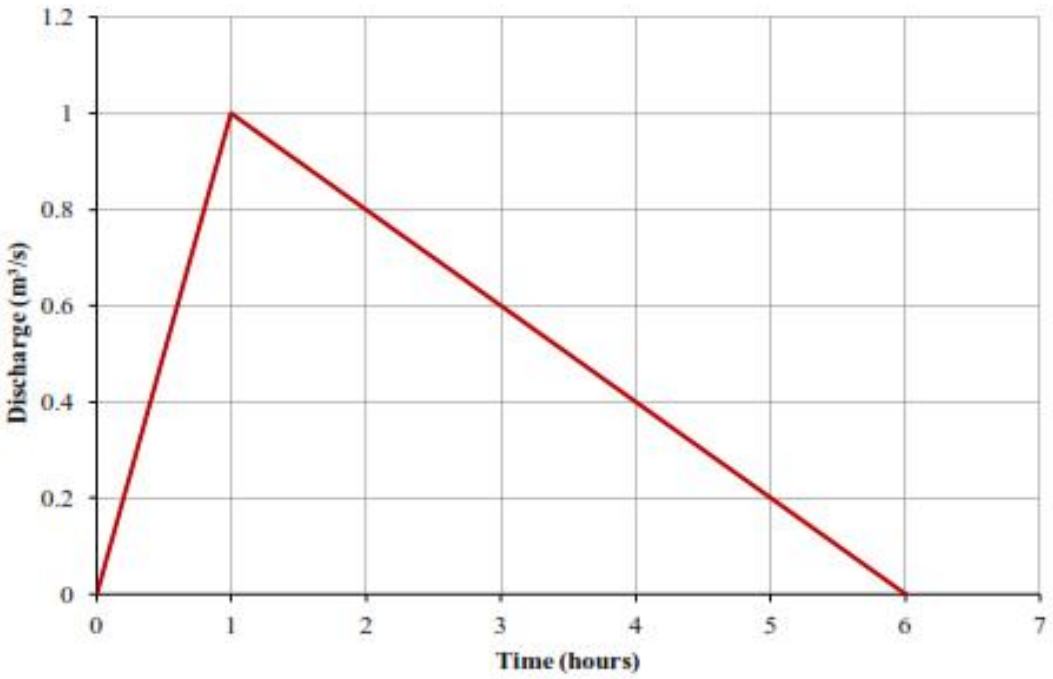
22. A fine grained soil is found to be plastic in the water content range of 26-48%. As per Indian Standard Classification System, the soil is classified as

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

23. A vertical cut is to be made in a soil mass having cohesion c, angle of internal friction ¨ , 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) $\frac{4c}{¥\sqrt{K_p}}$ (B) $\frac{2c\sqrt{K_p}}{¥}$ (C) $\frac{4c\sqrt{K_a}}{¥}$ (D) $\frac{4c}{¥\sqrt{K_a}}$

24. 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_____



25. 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

26. 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 _____

27. 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

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

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

29. 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

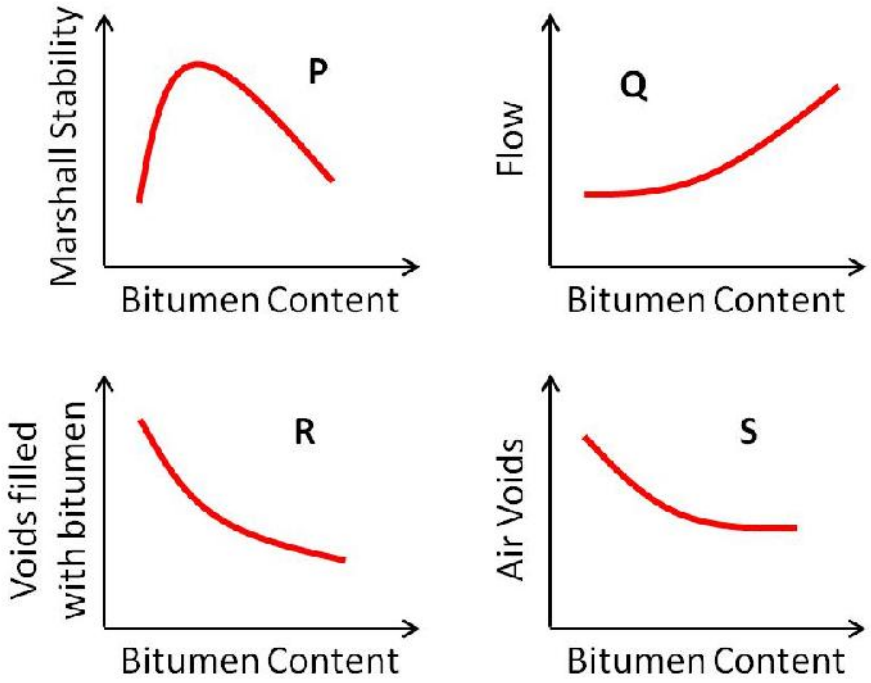
(A) 27 (B) 29 (C) 31 (D) 32

30. 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

31. 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

32. 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_____

33. The minimum number of satellites needed for a GPS to determine its position precisely is
(A) 2 (B) 3 (C) 4 (D) 24

34. 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

35. 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. 36 – Q. 65 carry two marks each

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

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

P(X≤4) is

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

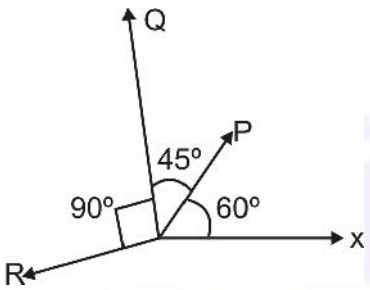
37. The value of $\int_0^{\infty}\frac{1}{1+x^2}dx+\int_0^{\infty}\frac{\sin x}{x}dx$ is

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

38. 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) $\frac{7}{6}$

39. 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°

40. 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

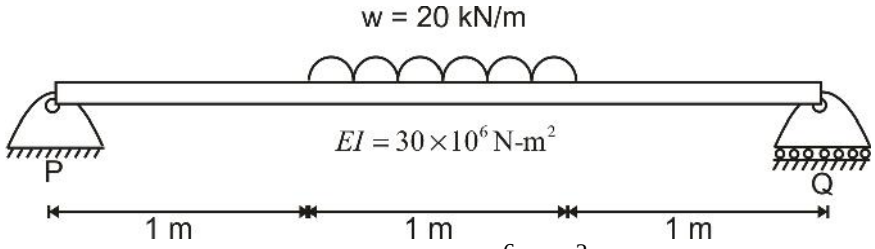
(A) $\left[c_1+c_2x+c_3\sin\sqrt{3}x+c_4\cos\sqrt{3}x\right]$ and $\left[3x^4-12x^2+c\right]$

(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 $\left[5x^4-12x^2+c\right]$

41. 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}

42. 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.

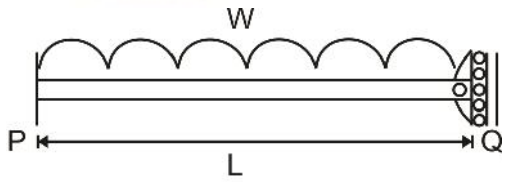


Figure-I

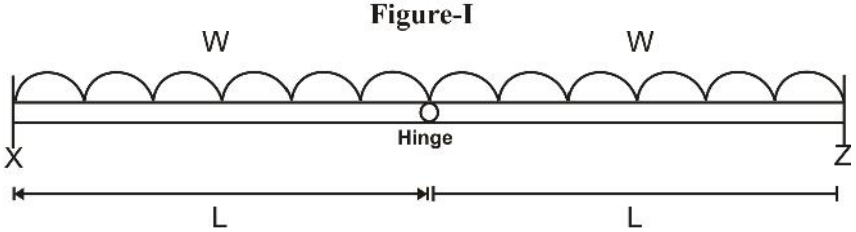
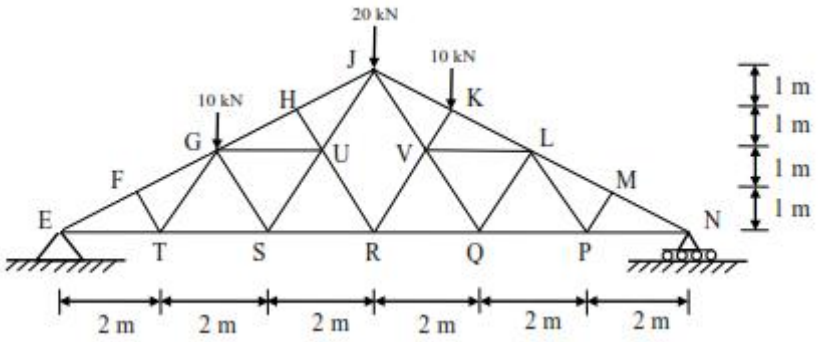


Figure-II

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 $\theta_{max1} = \theta_{max2}$

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

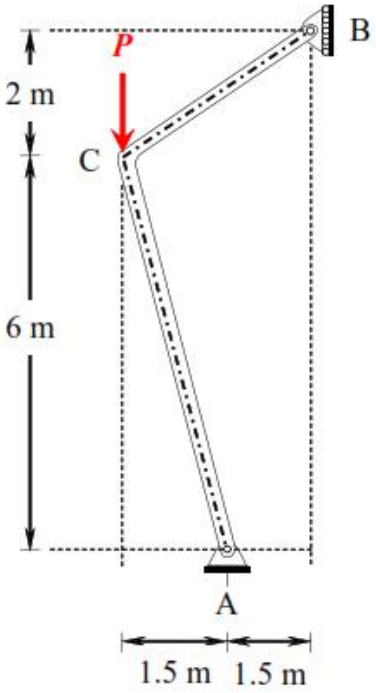


The members which do not carry any force are

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

(C) FT, GS, HU, MP, QL (D) MP, PL, HU, FT, UR

44. 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) $R_{Av} = 0$; $R_{Bh} = \frac{1}{3}P$; and $R_{Ab} = \frac{2}{3}P$

(B) $R_{Av} = 0$; $R_{Bh} = \frac{2}{3}P$; and $R_{Ab} = \frac{1}{3}P$

(C) $R_{Av} = P$; $R_{Bh} = \frac{3}{8}P$; and $R_{Ab} = \frac{1.5}{8}P$

(D) $R_{Av} = P$; $R_{Bh} = \frac{1.5}{8}P$; and $R_{Ab} = \frac{1.5}{8}P$

45. 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

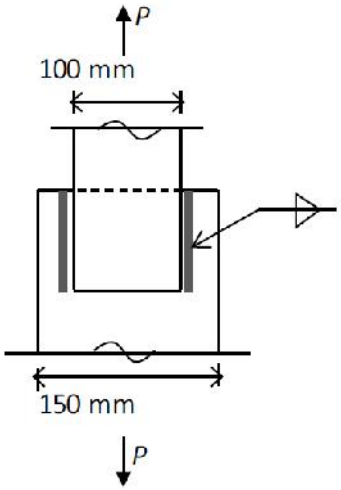
(C) 270 and 2000 (D) 300 and 2500

46. 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 _____

47. 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) $\frac{2M_p}{L}$

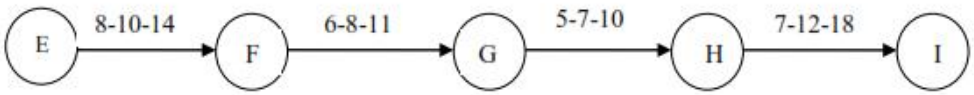
48. Two plates are connected by fillet welds of size 10 mm and subjected to tension, as shown in the figure. The thickness of each plate is 12 mm. The yield stress and the ultimate tensile stress of steel are 250 MPa and 410 MPa, respectively. The welding is done in the workshop (γ_{mw} = 1.25).



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

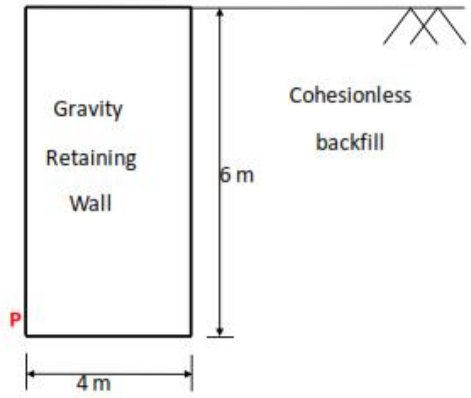
49. The Optimistic Time (O), Most likely Time (M) and Pessimistic Time (P) (in days) of the activities in the critical path are given below in the format O-M-P.



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

50. 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 _____

51. 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.



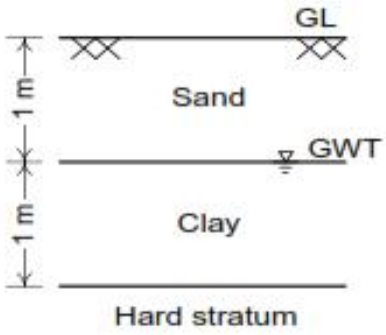
The minimum weight of the wall (expressed in kN per m length) required to prevent it from overturning about its toe (Point **P**) is

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

52. 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:

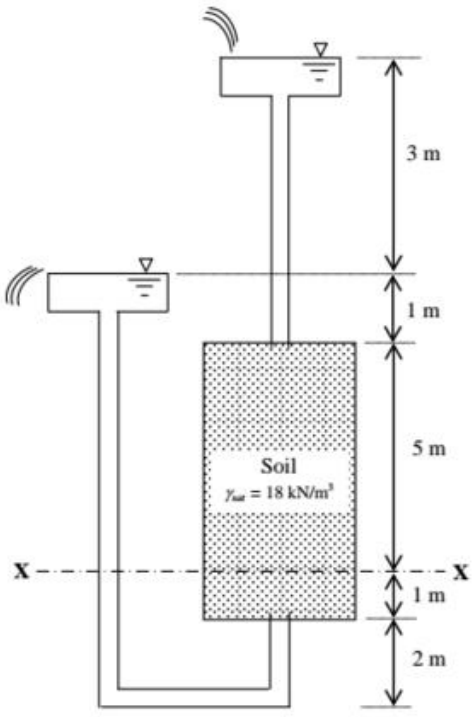
Natural water content of clay	:	25%
Preconsolidation pressure of clay	:	60 kPa
Compression index of clay	:	0.50
Recompression index of clay	:	0.50
Specific gravity of clay	:	2.70
Bulk unit weight of sand	:	17 kN/m^3

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



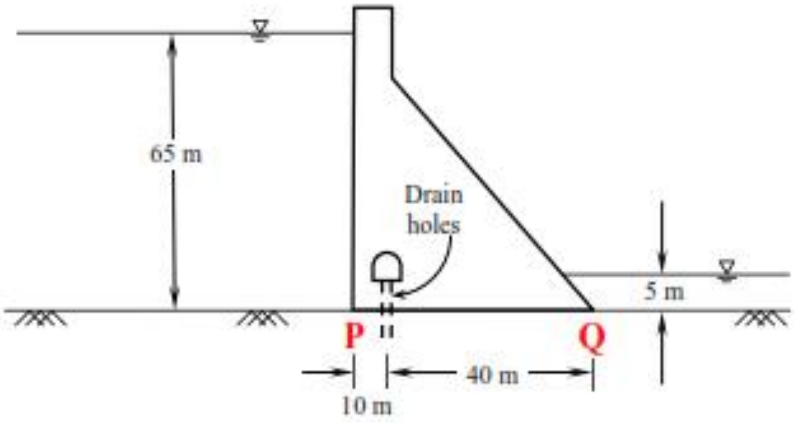
Assuming unit weight of water as10 kN/m^3, the ultimate consolidation settlement (expressed in mm) of the clay layer is _____

53. 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 _____

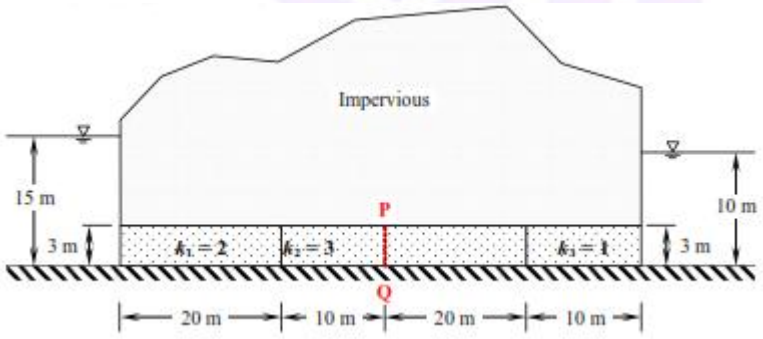


54. A drained triaxial compression test on a saturated clay yielded the effective shear strength parameters as $c' = 15$ kPa and $\phi' = 22^o$. Consolidated Undrained triaxial test on an identical sample of this clay at a cell pressure of 200 kPa developed a pore water pressure of 150 kPa at failure.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

55. 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 _____



56. 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.



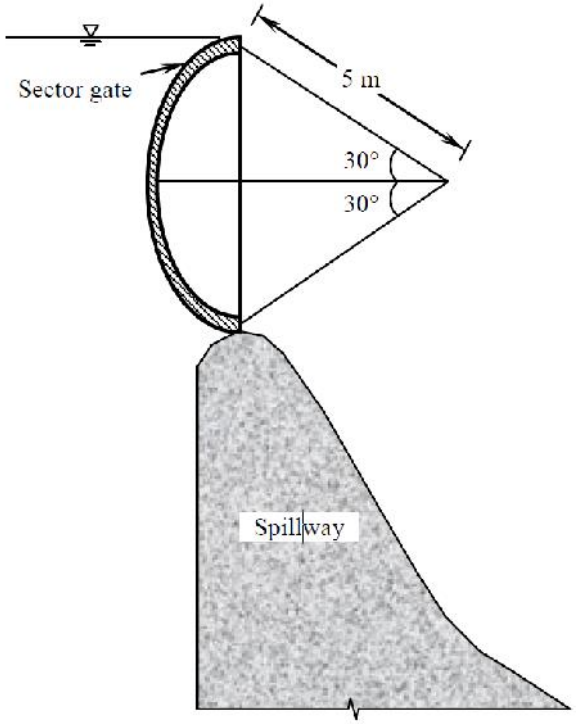
The seepage discharge (m^3/day per m) through the porous media at section PQ is

(A) 12 (B) 2 (C) 16 (D) 4

57. 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

58. 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 _____



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

60. 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 _____

61. 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 _____

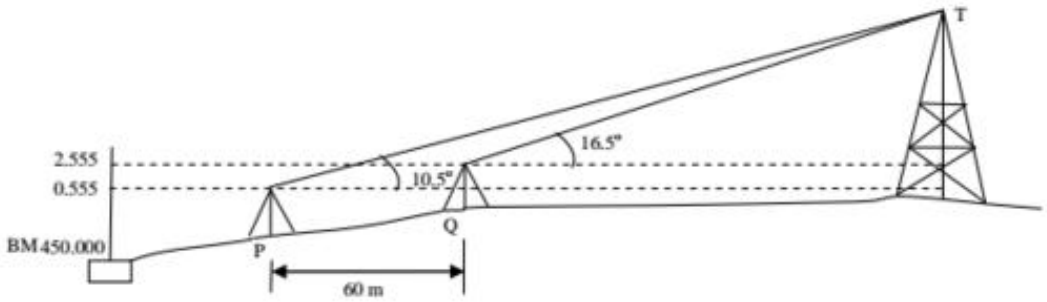
62. The 2-day and 4-day BOD values of a sewage sample are 100 mg/L and 155 mg/L,respectively. The value of BOD rate constant (expressed in per day) is _____

63. 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 $w_{me,60}$ and $w_{ps,60}$, $w_{me,80}$, $w_{ps,80}$, 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

64. 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 _____

65. 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 _____



GATE-2016 SET-1 SOLUTIONS

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
D	**A**	**A**	**C**	**D**	**B**	**D**	**D**	**B**	**B**
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
0.355 to 0.365	**C**	**D**	**A**	**B**	**A**	**D**	**99.9 TO 100.1**	**C**	**B**
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	**D**	**D**	**21.5 to 21.7**	**B**	**13.6 TO 13.7**	**A**	**A**	**B**	**A**
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	**1199 TO 1201**	**C**	**C**	**A**	**A**	**B**	**B**	**C**	**A**
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	**D**	**A**	**D**	**B**	**9999 TO 10001**	**B**	**B**	**37 TO 38**	**41 TO 43**
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
A	**36 TO 38**	**65.3 TO 65.6**	**100 TO 110**	**10490 TO 10510**	**B**	**B**	**126 TO 128**	**2.29 TO 2.32**	**4.4 TO 4.6**
61	**62**	**63**	**64**	**65**					
8000 TO 8020	**0.29 TO 0.31**	**B**	**2.9 TO 3.1**	**476.500 TO 477.500**					

ONE MARK EACH

(1.) Ans. (d)

EXP: Here no need to use 'doesn't', 'until' conveys the same meaning.
Minister is singular, so use 'meets' as the correct form of verb.

(2.) Ans. (a)

EXP:

(3.) Ans. (a)

EXP: He doesn't actually want a Fulcrum. It is used just to convey the meaning.
Figurative language contains or uses figures of speech, especially metaphors. Here the sentence is a metaphor.

(4.) Ans. (c)

EXP: relftaga = care free
Otaga = carefull $\Rightarrow$ taga = care
fertaga = care less
$\Rightarrow$ After care = taga zen
As tagafer = less care

(5.) Ans. (d)

EXP: On removing the corner cube 3 faces will be removed while the same 3 new faces will be exposed. So the total area is still same as without removing cubes.

$\therefore$ Area = $6 \times (4 \times 4) = 96$

(6.) Ans. (b)

EXP: Revenue due to Elegance = $(27300 + 25222 + 28976 + 21012) \times 48$

$= 102510 \times 48 =$ Rs. 4920480

Revenue due to smooth = $(20009 + 19392 + 22429 + 18229) \times 63$

$= 80059 \times 63 =$ Rs. 5043717

Revenue due to soft = $(17602 + 18445 + 19544 + 16595) \times 78$

$= 72186 \times 78 =$ Rs. 5630508

Revenue due to executive = $(9999 + 8942 + 10234 + 10109) \times 173$

$= 39284 \times 173 =$ Rs. 6796132

$\Rightarrow$ Executive gives highest revenue

(7.) Ans. (d)

EXP: In 2nd sentence 'if this is not an indication of the nation' diversity, nothing else is', the underline part clearly shows (d) is correct.

(8.) Ans. (d)

EXP: Since S loses to P only sometimes. So, S is not the absolute worst player in the set. Thus P also not likely to beat all three other players.

Also this is logical because in players if P better than Q and Q better than R, it doesn't even mean P better than R.

(9.) Ans. (b)

EXP: $f(x) = 2x^7 + 3x - 5$

$f(1) = 2 \times (1)^7 + 3 \times (1) - 5 = 2 + 3 - 5 = 0$

$\Rightarrow$ $(x-1)$ is a factor of f(x)

(10.) Ans. (b)

EXP: Let N = no. of cycles

And P = load

$\therefore$ $N = c_1 e^{-C_2 p}$

$\therefore$ $100 = c_1 e^{-80c_2}$ …(1)

& $10000 = c_1 e^{-40c_2}$ …(2)

Divide (2) by (1)

$\therefore$ $100 = \dfrac{e^{-40c_2}}{e^{-80c_2}}$

Taking *ln* on both sides

$ln100 = -40c_2 + 80c_2 = 40c_2$

$\Rightarrow$ $c_2 = 0.1151$

GATE-2015 SET-1 with Solution

GENERAL APTITUDE

Q.1 to 5 carry 1 mark each & Q. 6 to Q. 10 carry 2 marks each.

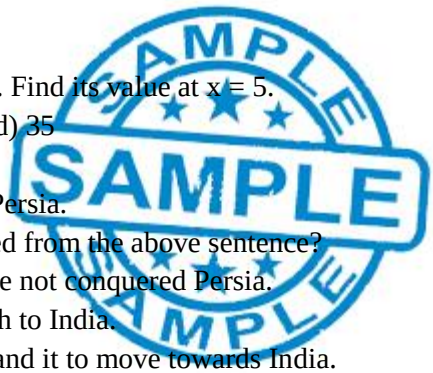
1. Extreme focus on syllabus and studying for tests has become such a dominant concern of Indian students that they close their minds to anything _____ to the requirements of the exam.
(a) related (b) extraneous (c) outside (d) useful

2. Select the pair that best expresses a relationship similar to that expressed in the pair.
Children : Pediatrician
(a) Adult: Orthopaedist (b) Females: Gynaecologist
(c) Kidney: Nephrologist (d) Skin: Dermatologist

3. The Tamil version of _____ John Abraham-starrer Madras Cafe _____ cleared by the Censor Board with no cuts last week, but the film's distributors _____ no takers among the exhibitors for a release in Tamil Nadu _____ this Friday.
(a) Mr., was, found, on (b) a, was, found, at
(c) the, was, found, on (d) a, being, find, at

4. If ROAD is written as URDG, then SWAN should be written as:
(a) VXDQ
(b) VZDQ
(c) VZDP
(d) UXDQ

5. A function f(x) is linear and has a value of 29 at x = –2 and 39 at x = 3. Find its value at x = 5.
(a) 59 (b) 45 (c) 43 (d) 35



6. Alexander turned his attention towards India, since he had conquered Persia.
Which one of the statements below is logically valid and can be inferred from the above sentence?
(a) Alexander would not have turned his attention towards India had he not conquered Persia.
(b) Alexander was not ready to rest on his laurels, and wanted to march to India.
(c) Alexander was completely in control of his army and could command it to move towards India.
(d) Since Alexander's kingdom extended to Indian borders after the conquest of Persia, he was keen to move further.

7. Most experts feel that in spite of possessing all the technical skills required to be a batsman of the highest order, he is unlikely to be so due to lack of requisite temperament. He was guilty of throwing away his wicket several times after working hard to lay a strong foundation. His critics pointed out that until he addressed this problem, success at the highest level will continue to elude him.
Which of the statement(s) below is/are logically valid and can be inferred from the above passage?
(i) He was already a successful batsman at the highest level
(ii) He has to improve his temperament in order to become a great batsman.

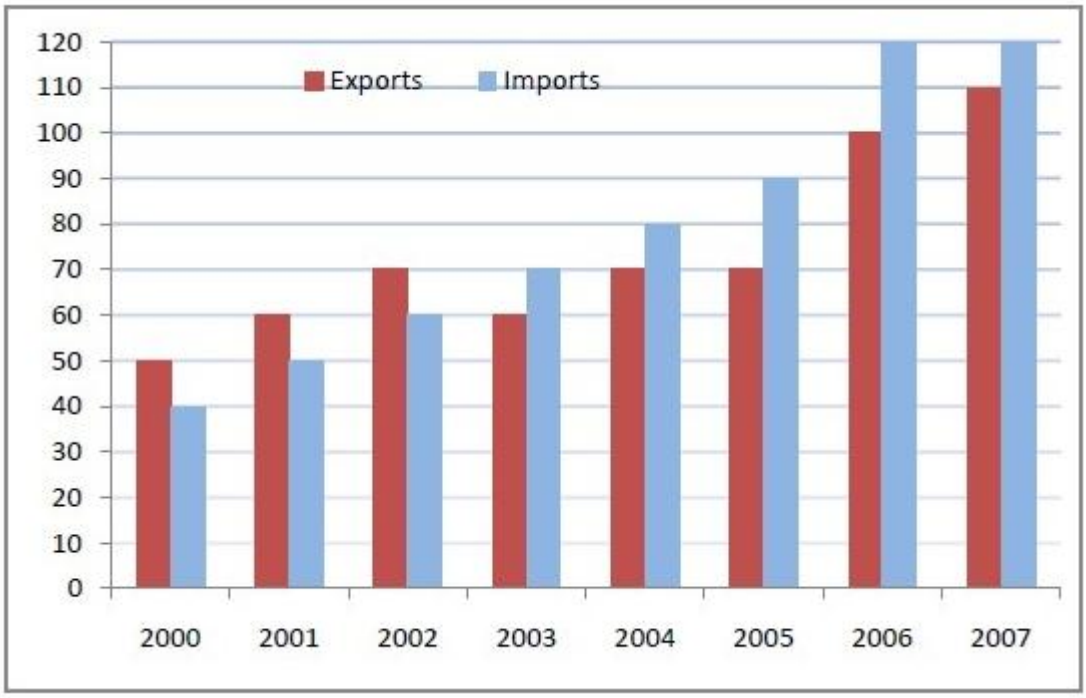
(iii) He failed to make many of his good starts count.

(iv) Improving his technical skills will guarantee success.

(a) (iii) and (iv) (b) (ii) and (iii)

(c) (i), (ii) and (iii) (d) (ii) only

8. The exports and imports (in crores of Rs.) of a country from the year 2000 to 2007 are given in the following bar chart. In which year is the combined percentage increase in imports and exports the highest?



9. Choose the most appropriate equation for the function drawn as a thick line, in the plot below.

(a) $x = y - |y|$ (b) $x = -(y - |y|)$ (c) $x = y + |y|$ (d) $x = -(y + |y|)$

10. The head of a newly formed government desires to appoint five of the six selected members P, Q, R, S, T and U to portfolios of Home, Power, Defense, Telecom, and Finance. U does not want any portfolio if S gets one of the five. R wants either Home or Finance or no portfolio. Q says that if S gets either Power or Telecom, then she must get the other one. T insists on a portfolio if P gets one. Which is the valid distribution of portfolios?

(a) P-Home, Q-power, R-Defense, S-Telecom, T-Finance

(b) R-Home, S-power, P-Defense, Q-Telecom, T-Finance

(c) P-Home, Q-power, T-Defense, S-Telecom, U-Finance

(d) Q-Home, U-power, T-Defense, R-Telecom, P-Finance

Engineering Mathematics : Linear Algebra

11. For what value of p the following set of equations will have no solution?

$2x + 3y = 5$

$3x + py = 10$

Engineering Mathematics : Numerical Methods

12. The integral $\int_{x1}^{x2} x^2 dx$ with $x_2 > x_1 > 0$ is evaluated analytically as well as numerically using a single application of the trapezoidal rule. If I is the exact value of the integral obtained analytically and J is the approximate value obtained using the trapezoidal rule, which of the following statements is correct about their relationship?

(a) J > I (b) J < I

(c) J = I (d) Insufficient data to determine the relationship

Engineering Mathematics :

13. Consider the following probability mass function (p.m.f) of a random variable X:

$$p(x,q) = \begin{cases} q & \text{if } X = 0 \\ 1-q & \text{if } X = 1 \\ 0 & \text{otherwise} \end{cases}$$

If q = 0.4, the variance of X is _____.

Concrete Technology: Workability

14. Workability of concrete can be measured using slump, compaction factor and Vebe time. Consider the following statements for workability of concrete.

(i) As the slump increases, the Vebe time increases

(ii) As the slump increases, the compaction factor increases

(a) Both (i) and (ii) are True (b) Both (i) and (ii) are False

(c) (i) is True and (ii) is False (d) (i) is False and (ii) is True

Concrete Technology: Admixtures

15. Consider the following statements for air-entrained concrete:

(i) Air-entrainment reduces the water demand for a given level of workability

(ii) Use of air-entrained concrete is required in environments where cyclic freezing and thawing is expected

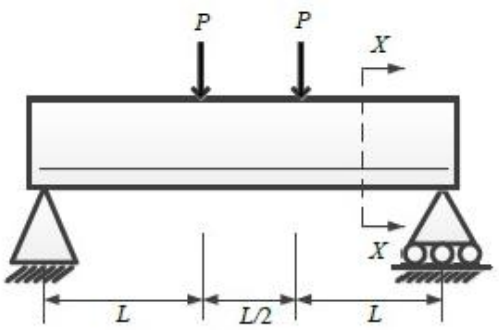
Which of the following is TRUE?

(a) Both (i) and (ii) are True (b) Both (i) and (ii) are False

(c) (i) is True and (ii) is False (d) (i) is False and (ii) is True

Concrete Technology: Admixtures

16. Consider the singly reinforced beam shown in the figure below:



At cross-section XX, which of the following statements is TRUE at the limit state?

(a) The variation of stress is linear and that of strain is non-linear

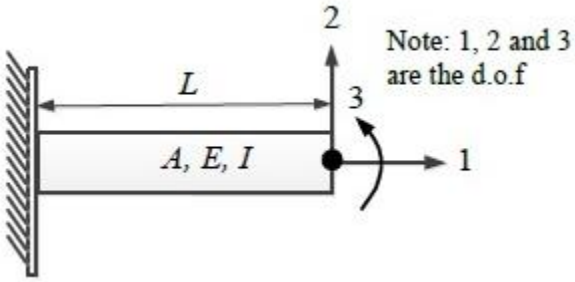
(b) The variation of strain is linear and that of stress is non-linear

(c) The variation of both stress and strain is linear

(d) The variation of both stress and strain is non-linear

Matrix Method of Structural Analysis

17. For the beam shown below, the stiffness coefficient K_{22} can be written as



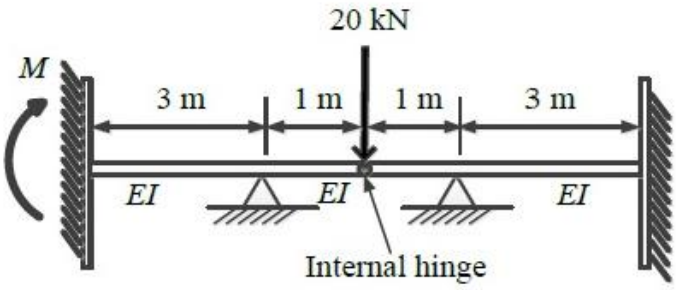
(a) $\frac{6EI}{L^2}$ (b) $\frac{12EI}{L^3}$ (c) $\frac{3EI}{L}$ (d) $\frac{EI}{6L^2}$

R.C.C.

18. The development length of a deformed reinforcement bar can be expressed as $(1/k)(\phi\,\sigma_s/\tau_{bd})$. From the IS: 456-2000, the value of k can be calculated as _____.

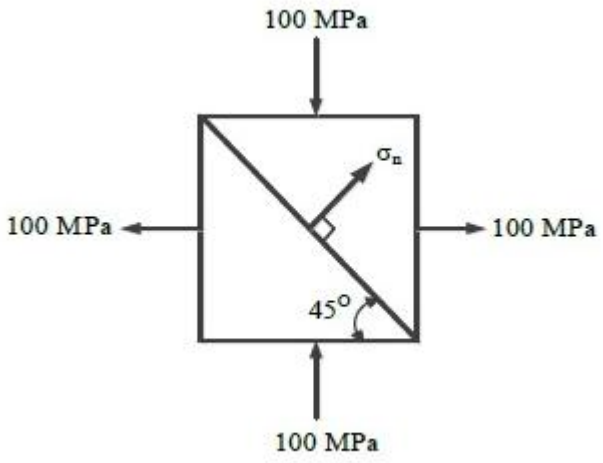
R.C.C.

19. For the beam shown below, the value of the support moment M is _____ kN-m.



SOM: Stress Calculations

20. Two triangular wedges are glued together as shown in the following figure. The stress acting normal to the interface, σ_n is _____ MPa.



Soil Mechanics

21. A fine-grained soil has 60% (by weight) silt content. The soil behaves as semi-solid when water content is between 15% and 28%. The soil behaves fluid-like when the water content is more than 40%. The 'Activity' of the soil is _____.

Soil Mechanics:

22. Which of the following statements is TRUE for the relation between discharge velocity and seepage velocity?

(a) Seepage velocity is always smaller than discharge velocity
(b) Seepage velocity can never be smaller than discharge velocity
(c) Seepage velocity is equal to the discharge velocity
(d) No relation between seepage velocity and discharge velocity can be established

Soil Mechanics

23. Which of the following state is TRUE for degree of disturbance of collected soil sample?

(a) Thinner the sampler wall, lower the degree of disturbance of collected soil sample
(b) Thicker the sampler wall, lower the degree of disturbance of collected soil sample
(c) Thickness of the sampler wall and the degree of disturbance of collected soil sample are unrelated
(d) The degree of disturbance of collected soil sample is proportional to the inner diameter of the sampling tube.

Soil Mechanics

24. In an unconsolidated undrained triaxial test, it is observed that an increase in cell pressure from 150 kPa to 250 kPa leads to a pore pressure increase of 80 kPa. It is further observed that, an increase of 50 kPa in deviatoric stress results in an increase of 25 kPa in the pore pressure. The value of Skempton's pore pressure parameter B is:

(a) 0.5 (b) 0.625 (c) 0.8 (d) 1.0

GATE-2014 SET-1 with Solution

Graduate Aptitude

Q.1 – Q.5 Carry one mark each.

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

The work closest in meaning to comprehension is

(a.) Understanding (b.) meaning (c.) concentration (d.) stability

2. Choose the most appropriate work form 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

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

(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.

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

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?

6. Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK

(a.) ALRVX (b.) EPVZB (c.) ITZDF (d.) OYEIK

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?

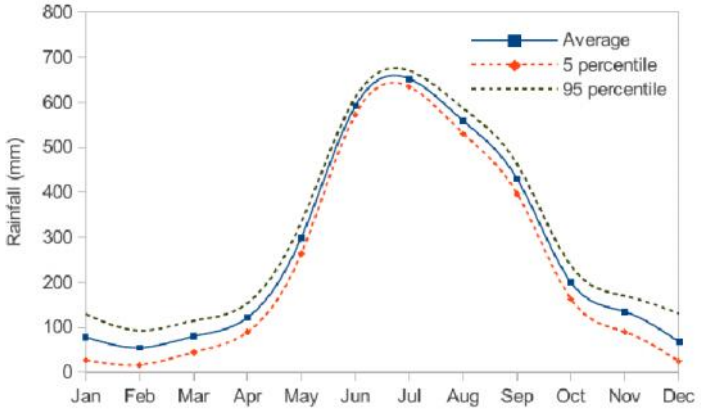
	Anuj	Bhola	Chandn	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

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?

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

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)

Civil Engineering – CE

Q.11 – Q.35 carry one mark each.

ENGINEERING MATH

11. $\lim_{x\to\infty}\left(\frac{x+\sin x}{x}\right)$ equals to

(a.) $-\infty$ (b.) 0 (c.) 1 (d.) ∞

ENGINEERING MATH

12. 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 _____

ENGINEERING MATH

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

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

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

ENGINEERING MATH

14. 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

ENGINEERING MATH

15. 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.) 3/2 (b.) ¾ (c.) 4/5 (d.) 5/2

16. Match the information given in Group – I with those in Group – II.

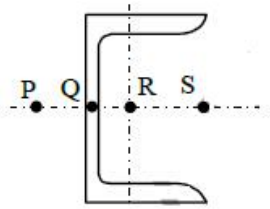
Group – I		Group – II	
P	Factor to decrease ultimate strength to design strength	1	Upper bound on ultimate load
Q	Factor to increase working load to ultimate load for design	2	Lower bound on ultimate load
R	Statical method of ultimate load analysis	3	Material partial safety factor
S	Kinematical mechanism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

SOM

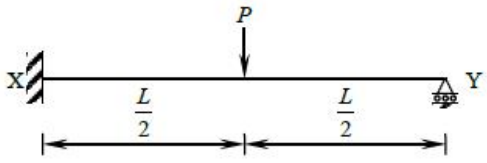
17. The possible location of shear centre of the channel section, shown below, is



(a.) P (b.) Q (c.) R (d.) S

Steel structural

18. 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.) $P = \frac{2M_p}{L}$ (b.) $P = \frac{4M_p}{L}$ (c.) $P = \frac{6M_p}{L}$ (d.) $P = \frac{8M_p}{L}$

RCC

19. 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/mm2) in limit state method of design as per IS: 456 – 2000 is _____

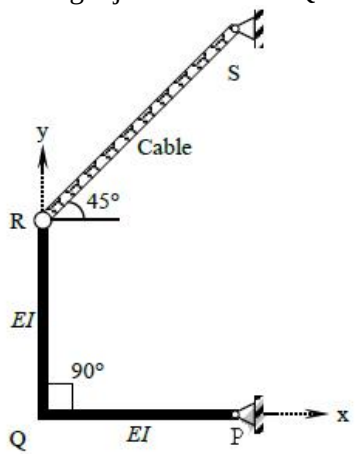
Steel structural

20. A steel section is subjected to a combination of shear and bending actions. The applied shear force is V and 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.) $V > 0.9V_s$

Structure Analysis

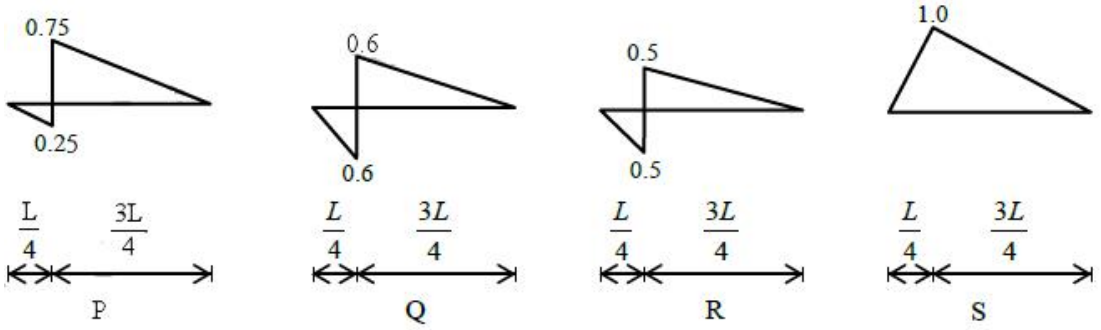
21. The degree of static indeterminacy of a rigid jointed frame PQR supported as shown in the figure is



(a.) Zero (b.) one (c.) two (d.) unstable

Structure Analysis

22. 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

Soil Mechanics

23. 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 *Do* and *Di* respectively, the area ratio is given by

(a.) $\frac{D_o^2 - D_i^2}{D_i^2}$ (b.) $\frac{D_i^2 - D_o^2}{D_i^2}$ (c.) $\frac{D_o^2 - D_i^2}{D_o^2}$ (d.) $\frac{D_i^2 - D_o^2}{D_o^2}$

Soil Mechanics

24. 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 compressions (UC) test (d.) Unconsolidated Undrained (UU) test

Soil Mechanics

25. 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

Soil Mechanics

26. A long slope is formed in a soil with shear strength parameters: c' = 0 and $\phi = 34^o$. 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 $¥_{sat} = 18kN/m^3$ and $¥_w = 10kN/m^3$. 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

Fluid mechanics

27. 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 _____

Hydrology

28. 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

Hydrology

29. 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

Fluid Mechanics

30. The dimension for kinematic viscosity is

(a.) $\frac{L}{MT}$ (b.) $\frac{L}{T^2}$ (c.) $\frac{L^2}{T}$ (d.) $\frac{ML}{T}$

Environmental Engineering

31. 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

Environmental Engineering

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

Transportation

33. 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

Highway

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

P. The temperature stress 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 stress 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

Surveying

35. 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

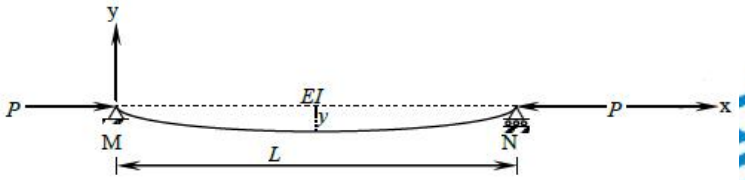
(a.) 15.00 (b.) 12.33 (c.) 3.52 (d.) 2.27

Q.36 – Q.65 Carry two marks each.

Math

36. If the following equation establishes equilibrium in slightly bend position, the mid – span deflection of a member shown in the figure is

$$\frac{d^2y}{dx^2}+\frac{P}{EI}y=0$$



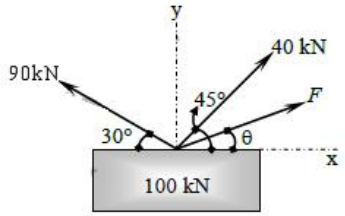
If a is amplitude constant for y, then

(a.) $y=\frac{1}{P}\left(1-a\cos\frac{2\pi x}{L}\right)$ (b.) $y=\frac{1}{P}\left(1-a\sin\frac{2\pi x}{L}\right)$

(c.) $y=a\sin\frac{n\pi x}{L}$ (d.) $y=a\cos\frac{n\pi x}{L}$

SOM

37. 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 = 56.389kN and θ = 28.28º (b.) F = – 56.398kN and θ = – 28.28º

(c.) F = 9.055kN and θ = 1.414º (d.) F = - 9.055kN and θ = – 1.414º

Fluid Mechanics

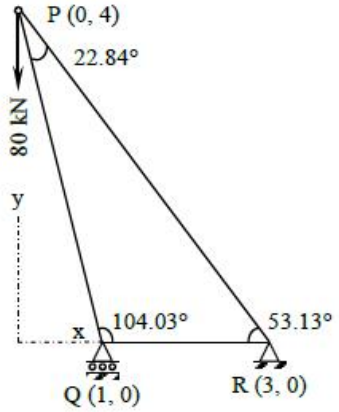
38. A particle moves along a curve whose parametric equations are: $x = t^3 + 2t$, $y = -3e^{-2t}$ and $z = 2\sin(5t)$, where x, y and z show variations of the distance covered by the particle (in cm) with time t (in s). The magnitude of the acceleration of the particle (in cm/s^2) at t = 0 is _____

Highway

39. 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 _____

Structure analysis

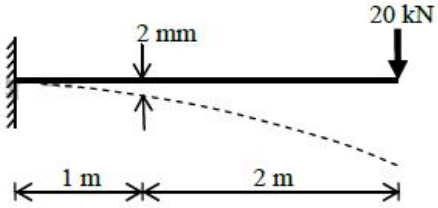
40. Mathematical idealization of a crane has three bars with their vertices arranged as shown in the figure with a load of 80kN hanging vertically. The coordinates of the vertices are given in parentheses. The force in the member QR, *F*QR will be



(a.) 30kN compressive (b.) 30kN tensile
(c.) 50kN compressive (d.) 50kN tensile

SOM

41. For the cantilever beam of span 3 m (shown below), a concentrated load of 20kN 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 10kN 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 _____



Structure analysis

42. For the truss shown below, the member PQ is short by 3mm. The magnitude of vertical displacement of joint R (in mm) is _____

1. REINFORCED CEMENT CONCRETE-RCC

(GATE Previous Papers)

All Questions has been arranged as per this booklet (Chapter).

1. Properties of Steel & Concrete

GATE-2013(1-Mark)

1. Maximum possible value of Compacting Factor for fresh (green) concrete is:

(*a*) 0.5 (*b*) 1.0 (*c*) 1.5 (*d*) 2.0

GATE-2011(1-Mark)

2. The cross-section of a thermo mechanically treated (TMT) reinforcing bar has

(*a*) soft ferrite-pearlite throughout

(*b*) hard martensite throughout

(*c*) a soft ferrite-pearlite core with a hard martensitic rim

(*d*) a hard martensitic core with a soft pearlite-bainitic rim

GATE-2009(2-Marks)

3. Consider a reinforcing bar embedded in concrete. In a marine environment this bar undergoes uniform corrosion, which leads to the deposition of corrosion products on its surface and an increase in the apparent volume of the bar. This subjects the surrounding concrete to expansive pressure. As a result, corrosion induced cracks appear at the surface of concrete. Which of the following statements is TRUE?

(*a*) Corrosion causes circumferential tensile stresses in concrete and the cracks will be parallel to the corroded reinforcing bar.

(*b*) Corrosion causes radial tensile stresses in concrete and the cracks will be parallel to the corroded reinforcing bar.

(*c*) Corrosion causes circumferential tensile stresses in concrete and the cracks will be perpendicular to the direction of the corroded reinforcing bar.

(*d*) Corrosion causes radial tensile stresses in concrete and the cracks will be perpendicular to the direction of the corroded reinforcing bar.

4. Match List-I (List of test methods for evaluating properties of concrete) with List-II(List of properties) and select the correct answer using the codes given below the lists:

List-I	**List-II**
A. Resonant frequency test	**1.** Tensile strength
B. Rebound hammer test	**2.** Dynamic modulus of elasticity
C. Split cylinder test	**3.** Workability
D. Compacting factor test	**4.** Compressive strength

Codes:

	A	**B**	**C**	**D**
(*a*)	2	4	1	3
(*b*)	2	1	4	3
(*c*)	2	4	3	1
(*d*)	4	3	1	2

GATE-2009(1-Mark)

5. For limit state of collapse, the partial safety factors recommended by IS 456 : 2000 for estimating the design strength of concrete and reinforcing steel are respectively

(*a*) 1.15 and 1.5 (*b*) 1.0 and 1.0

(*c*) 1.5 and 1.15 (*d*) 1.5 and 1.0

6. The modulus of rupture of concrete in terms of its characteristic cube compressive strength (f_{ck}) in MPa according to IS 456 : 2000 is

(*a*) $5000\ f_{ck}$ (*b*) $0.7\ f_{ck}$

(*c*) $5000\sqrt{f_{ck}}$ (*d*) $0.7\sqrt{f_{ck}}$

GATE-2008(2-Marks)

7. Un-factored maximum bending moments at a section of a reinforced concrete beam resulting from a frame analysis are 50, 80, 120 and 180 kN-m under dead, live, wind and earthquake loads respectively. The design moment(kNm) as per IS : 456-2000 for the limit state of collapse(flexure) is

(*a*) 195 (*b*) 250

(*c*) 345 (*d*) 372

GATE-2008(1-Mark)

8. 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

(*a*) M 15 (*b*) M 20

(*c*) M 25 (*d*) M 30

GATE-2007(2-Marks)

9. Consider the following statements:

1. Modulus of elasticity of concrete increases with increase in compressive strength of concrete.
2. Brittleness of concrete increases with decrease in compressive strength of concrete.
3. Shear strength of concrete increase with increase in compressive strength of concrete.

The TRUE statements are

(*a*) 2 and 3 (*b*) 1, 2 and 3

(*c*) 1 and 2 (*d*) 1 and 3

GATE-2007(1-Mark)

10. Consider the following statements:

1. The compressive strength of concrete decreases with increase in water-cement ratio of the concrete mix.
2. Water is added to the concrete mix for hydration of cement and workability.
3. Creep and shrinkage of concrete are independent of the water-cement ratio in the concrete mix.

The TRUE statements are

(*a*) 1 and 2 (*b*) 1, 2 and 3

(*c*) 2 and 3 (*d*) only 2

GATE-2006(1-Mark)

11. If the characteristic strength of concrete f_{ck} is defined as the strength below which not more than 50% of the test results are expected to fall, the expression for f_{ck} in terms of mean strength f_m and standard deviation S would be

(*a*) $f_m - 0.1645\text{S}$ (*b*) $f_m - 1.645\text{S}$

(*c*) f_m (*d*) $f_m + 1.645\text{S}$

GATE-2005(1-Mark)

12. In a random sampling procedure for cube strength of concrete, one sample consists of X number of specimens. These specimens are tested at 28 days and average strength of these X specimens is considered as test result of the sample, provided the individual variation in the strength of specimens is not more than ± Y per cent of the average strength. The values of X and Y as per IS : 456-2000 are

(*a*) 4 and 10 respectively (*b*) 3 and 10 respectively

(*c*) 4 and 15 respectively (*d*) 3 and 15 respectively

13. The flexural strength of M30 concrete as per IS : 456-2000 is
(*a*) 3.83 MPa (*b*) 5.47 MPa (*c*) 21.23 MPa (*d*) 30.0 MPa

14. The partial factor of safety for concrete as per IS : 456-2000 is
(*a*) 1.50 (*b*) 1.15 (*c*) 0.87 (*d*) 0.446

GATE-2004(1-Mark)

15. For avoiding the limit state of collapse, the safety of RC structures is checked for appropriate combinations of Dead Load(DL), imposed Load or Live Load(IL), Wind Load (WL) and Earthquake Load (EL). Which of the following load combinations is NOT considered?
(*a*) 0.9 DL + 1.5 WL (*b*) 1.5 DL + 1.5 WL
(*c*) 1.5 DL + 1.5 WL + 1.5 EL (*d*) 1.2 DL + 1.2 IL + 1.2 WL

GATE-2003(1-Mark)

16. List-I contains some properties of concrete/cement and List-II contains list of some tests on concrete/cement. Match the property with the corresponding test.

List-I	**List-II**
A. Workability of concrete	**1.** Cylinder splitting test
B. Direct tensile strength of concrete	**2.**Vee-Bee test
C. Bond between concrete and steel	**3.** Surface area test
D. Fineness of cement	**4.** Fineness modulus test
	5. Pull out test

Codes:

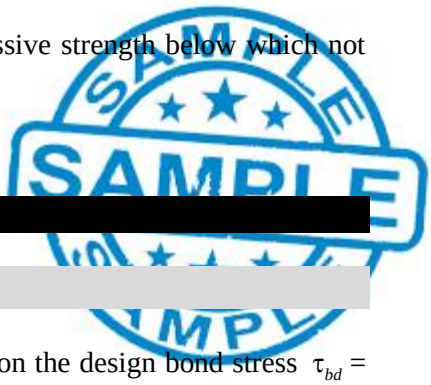
	A	**B**	**C**	**D**
(*a*)	2	1	5	3
(*b*)	4	5	1	3
(*c*)	2	1	5	4
(*d*)	2	5	1	4

GATE-2002(1-Mark)

17. Modulus of elasticity of M25 grade concrete in MPa is
(*a*) 25000 (*b*) 36000 (*c*) 45600 (*d*) 54000

GATE-1999 (1-Mark)

18. The characteristic strength of concrete is defined as that compressive strength below which not more than
(*a*) 10% of results fall (*b*) 5% of results fall
(*c*) 2% of results fall (*d*) None of these



2. Bond, Shear & Torsion

Bond & Shear

GATE-2013 (1-Mark)

19. As per IS 456:2000 for M20 grade concrete and plain basin tension the design bond stress τ_{bd} = 1.2 MPa. Further, IS 456 : 2000 permits this design bond stress value to be increased by 60% for HSD bars. The stress in the HSD reinforcing steel barsin tension, σ_s = 360 MPa. Find the required development length, L_d, for HSD barsin terms of the bar diameter, ϕ.....

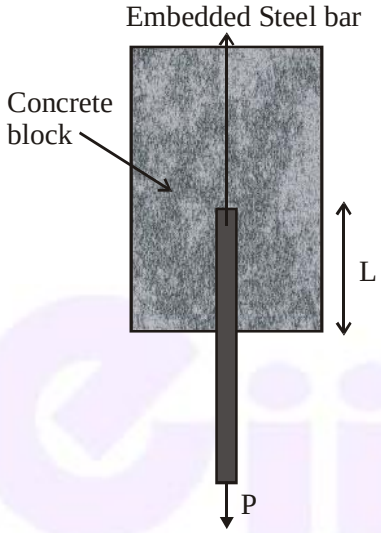
GATE-2011 (2-Marks)

20. Consider two RCC beams, P and Q, each having the section 400 mm × 750 mm (effective depth, *d* = 750 mm) made with concrete having a $\tau_{c\max} = 2.1\ \text{N/mm}^2$. For the reinforcement provided and the grade of concrete used, it may be assumed that the $\tau_c = 0.75\ \text{N/mm}^2$. The design shear in beam P is 400 kN and in beam Q is 750 kN. Considering the provisions of IS 456-2000, which of the following statements is TRUE?

(*a*) Shear reinforcement should be designed for 175 kN for beam P and the section for beam Q should be revised.
(*b*) Nominal shear reinforcement is required for beam P and the shear reinforcement should be designed for 120 kN for beam Q.
(*c*) Shear reinforcement should be designed for 175 kN for beam P and the shear reinforcement should be designed for 525 kN for beam Q
(*d*) The sections for both beams P and Q need to be revised.

GATE-2011 (2-Marks)

21. Consider a bar of diameter 'D' embedded in a large concrete block as shown in the adjoining figure, with a pull out force P being applied. Let σ_b and σ_{st}, be the bond strength (between the bar and concrete) and the tensile strength of the bar, respectively. If the block is held in position and it is assumed that the material of the block does not fail, which of the following options represents the maximum value of P?



(*a*) Maximum of $\left(\frac{\pi}{4}D^2\ \sigma_b\right)$ and $(\pi\ DL\ \sigma_{st})$ (*b*) Maximum of $\left(\frac{\pi}{4}D^2\ \sigma_{st}\right)$ and $(\pi\ DL\ \sigma_b)$

(*c*) Minimum of $\left(\frac{\pi}{4}D^2\ \sigma_{st}\right)$ and $(\pi\ DL\ \sigma_b)$ (*d*) Minimum of $\left(\frac{\pi}{4}D^2\ \sigma_b\right)$ and $(\pi\ DL\ \sigma_{st})$

GATE-2008 (2-Marks) : Common data for Q. 22 and 23

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 $0.48\ N/mm^2$. The beam is designed for collapse limit state.

22. The spacing (mm) of 2-legged 8 mm stirrups to be provided is
(*a*) 40 (*b*) 115 (*c*) 250 (*d*) 400

23. In addition, the beam is subjected to a torque whose factored value is 10.90 kN-m. The stirrups have to be provided to carry a shear (kN) equal to
(*a*) 50.42 (*b*) 130.56 (*c*) 151.67 (*d*) 200.23

GATE-2008 (1-Mark)

24. 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
(*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

GATE-2006 (1-Mark)

25. As per IS : 456-2000, consider the following statements:

1. The modular ratio considered in the working stress method depends on the type of steel used.
2. There is an upper limit on the nominal shear stress in beams (even with shear reinforcement) due to the possibility of crushing of concrete in diagonal compression.
3. A rectangular slab whose length is equal to its width may not be a two-way slab for some support conditions.

The TRUE statements are

(*a*) 1 and 2 (*b*) 2 and 3 (*c*) 1 and 3 (*d*) 1, 2 and 3

26. Assuming concrete below the neutral axis to be cracked, the shear stress across the depth of a singly-reinforced rectangular beam section

(*a*) Increases parabolically to the neutral axis and then drops suddenly to zero value.

(*b*) Increases parabolically to the neutral axis and then remains constant over the remaining depth.

(*c*) Increases linearly to the neutral axis and then remains constant up to the tension steel.

(*d*) Increases parabolically to the neutral axis and then remains constant up to the tension steel.

GATE-2001 (2-Marks)

27. Consider the following two statements related to reinforced concrete design, and identify whether they are TRUE/FALSE:

I. Curtailment of bars in the flexural tension zone in beams reduces the shear strength at the cut-off locations.

II. When a rectangular column section is subject to will be eccentric compression, the neutral axis will be parallel to the resultant axis of bending.

(*a*) Both statements I and II are TRUE

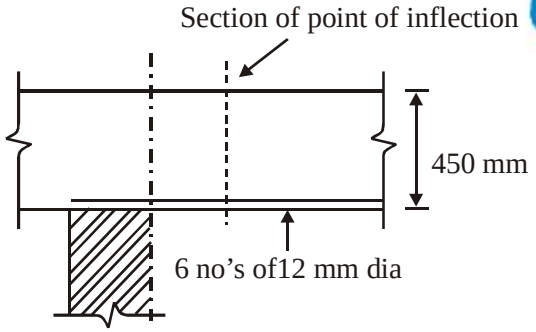
(*b*) Statement I is TRUE, and Statement II is FALSE

(*c*) Statement I is FALSE, and Statement II is TRUE

(*d*) Both Statements I and II are FALSE

GATE-2000 (5-Marks)

28. A continuous beam 250 mm × 450 mm carries 6 numbers of 12 mm diameter longitudinal bars as shown. The factored shear force at the point of inflection is 200kN. Check if the beam is safe in bond. Assume M15 mix with $\sigma_{ck} = 15\,\text{N/mm}^2$ and mild steel with $\sigma_y = 250\,\text{N/mm}^2$. A clear cover of 25 mm can be assumed. The design bond stress for mild steel bars in M15 concrete is specified to be $1.0\ \text{N/mm}^2$.



GATE-1999 (5-Marks)

29. The width and effective depth of a reinforced concrete beam is 250 mm and 440 mm respectively. The beam is provided with 4 numbers of 20 mm for bars in the tension zone. The beam is subjected to a shear force of 150 kN (Factored). Check the requirement of shear reinforcement and provide if required. Grade of concrete is M 20 and that of steel is Fe 415. The shear strength of concrete for different percentages of tensile steel are as below, 8 mm diameter vertical stirrups are available.

$$\left[V_{us} = 0.87\, f_y\, A_{sv}\, \frac{d}{S_v} \text{ and } \left(\frac{A_{sv}}{S_v}\right) \geq \frac{0.4b}{f_y} \text{ with the terms having usual meaning} \right]$$

% of Steel	Shear strength of concrete (τ_c) in N/ mm^2 k
1.0	0.62
1.25	0.67
1.50	0.72

Torsion

GATE- 2004 (2-Marks) : Common data for Questions 30 and 31

At the limit state of collapse, an RC beam is subjected to flexural moment 200 KN-m, shear force 20 KN and torque 9KN-m. The bream is 300 mm wide and has a gross depth of 425 mm, with an effective cover of 25 mm. The equivalent nominal shear stress (τ_{ve}) as calculated by using the design code turns out to the lesser than the design shear strength (τ_c) of the concrete.

30. The equivalent shear force (V_e) is

(*a*) 20 kN (*b*) 54 kN (*c*) 56 kN (*d*) 68 kN

31. The equivalent flexural moment (M_{el}) for designing the longitudinal tension steel is

(*a*) 187 kN-m (*b*) 200 kN-m (*c*) 209 kN-m (*d*) 213 kN-m

3. Limit State Method (LSM), Design of Beams & Slabs

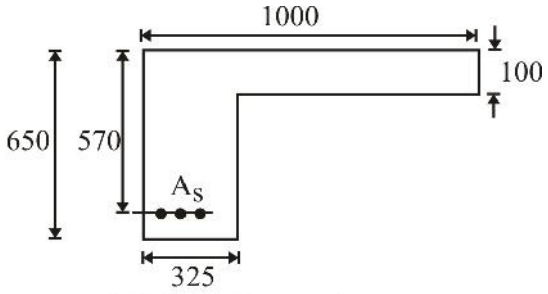
GATE-2013 (2-Marks)

32. A rectangular concrete beam 250 mm wide and 600 mm deep is pre-stressed by means of 16 high tensile wires, each of 7 mm diameter, located at 200 mm from the bottom face of the beamat a given section. If the effective pre-stress in the wires is 700 MPa, what is the maximum sagging bending moment (in kNm) (correct to 1-decimal place) due to live load that this section of the beam can with stand without causing tensile stress at the bottom face of the beam? Neglect the effect of dead load of beam.

GATE-2012 (2-Marks) :

Statement for linked answer questions 33 and 34

The cross-section at mid-span of a beam at the edge of a slab is shown in the sketch. A portion of the slab is considered as the effective flange width for the beam. The grades of concrete and reinforcing steel are M25 and Fe415, respectively. The total area of reinforcing bars (A), is 4000 mm^2. At the ultimate limit state, x_u denotes the depth of the neutral axis from the top fibre. Treat the section as under-reinforced and flanged $(x_u > 100 \text{ mm})$.



All dimensions are in mm.

33. The value of x_u (in mm) computed per the Limit State Method of IS 456 : 2000 is

(*a*) 200.0 (*b*) 223.3 (*c*) 236.3 (*d*) 273.6

2. SOIL MECHANICS
(GATE Previous Papers)

1. Properties of Soils

GATE – 2002 (2-Marks)

1. Soil has been compacted in an embankment at a bulk density of $2.15\,Mg/m^3$ and a water content of 12%. The value of specific gravity of soil solids is 2.65. The water table is well below the foundation level. Estimate the dry density, void ratio, degree of saturation and air content of the compacted soil.

(*a*) $1.92Mg/m^3$, 0.81 (*b*) 18.5, 0.30 (*c*) 19.4, 0.45 (*d*) 18.5, 0.45

GATE – 2007 (2-Marks)

2. The water content of a saturated soil and the specific gravity of soils solids were found to be 30% and 2.70, respectively. Assuming the unit weight of water to be $10\,kN/m^3$, the saturated unit weight (kN/m^3), and the void ratio of the soil are

(*a*) 19.4, 0.81 (*b*) 18.5, 0.30
(*c*) 19.4, 0.45 (*d*) 18.5, 0.45

GATE – 2005 (2-Marks)

3. A saturated soil mass has a total density of $22\,kN/m^3$ and a water content of 10%. The bulk density and dry density of this soil are

(*a*) $12\,kN/m^3$ and $20\,kN/m^3$ respectively
(*b*) $22\,kN/m^3$ and $20\,kN/m^3$ respectively
(*c*) $19.8\,kN/m^3$ and $19.8\,kN/m^3$ respectively
(*d*) $23.2\,kN/m^3$ and $19.8\,kN/m^3$ respectively

GATE – 2001 (2-Marks)

4. The void ratio and specific gravity of a soil are 0.65 and 2.72 respectively. The degree of saturation (in percent) corresponding to water content of 20% is

(*a*) 65.3 (*b*) 20.9 (*c*) 83.7 (*d*) 54.4

GATE – 1999 (2-Marks)

5. A soil sample in its natural state has mass of 2.290 kg and a volume of $1.15\times10^{-3}\,m^3$. After being oven dried, the mass of the sample is 2.035 kg. G_s for soil is 2.68. The void ratio of the natural soil is

(*a*) 0.40 (*b*) 0.45 (*c*) 0.55 (*d*) 0.53

GATE – 2013 (1-Mark)

6. In its natural condition, a soil sample has a mass of 1.980 kg and a volume of $0.001\,m^3$. After being completely dried in an oven, the mass of sample is 1.800 kg. Specific gravity G is 2.7. Unit weight of water is $10\,kN/m^3$. The degree of saturation of the soil is:

(*a*) 0.65 (*b*) 0.70 (*c*) 0.54 (*d*) 0.61

GATE – 2004 (1-Mark)

7. The ratio of saturated unit weight to dry unit weight of a soil is 1.25. If the specific gravity of solids (G_s) is 2.56, the void ratio of the soil is

(*a*) 0.625 (*b*) 0.663 (*c*) 0.944 (*d*) 1.325

GATE – 2000 (1-Mark)

8. A borrow pit soil has a dry density of $17\,kN/m^3$. How many cubic meters of this soil will be required to construct an embankment of $100\,m^3$ volume with a dry density of $16\,kN/m^3$.

(*a*) $94\,m^3$ (*b*) $106\,m^3$ (*c*) $100\,m^3$ (*d*) $90\,m^3$

9. A soil sample has a void ratio of 0.5 and its porosity will be close to

(*a*) 50% (*b*) 66% (*c*) 100% (*d*) 33%

GATE – 1999 (1-Mark)

10. Principle involved in the relationship between submerged unit weight and saturated weight of a soil is based on

(*a*) Equilibrium of floating bodies (*b*) Archimedes' principle

(*c*) Stokes' law (*d*) Darcy's law

GATE – 2008 (1-Mark)

11. The liquid limit (LL), plastic limit (PL) and shrinkage limit (SL) of a cohesive soil satisfy the relation

(*a*) LL > PL < SL (*b*) LL > PL > SL (*c*) LL < PL < SL (*d*) LL < PL > SL

GATE – 2002 (1-Mark)

12. The void ratios at the densest, loosest and the natural states of a sand deposit are 0.2, 0.6, and 0.4 respectively. The relative density of the deposit is

(*a*) 100% (*b*) 75% (*c*) 50% (*d*) 25%

GATE – 2002 (1-Mark)

13. The following data were obtained from a liquid limit test conducted on a soil sample

Number of blows	17	22	25	28	34
Water Content (%)	63.8	63.1	61.9	60.6	60.5

The liquid limit of the soil is:

(*a*) 63.1 (*b*) 62.8% (*c*) 61.9% (*d*) 60.6%

GATE – 1999 (1-Mark)

14. The toughness index of clayey soils is given by

(*a*) Plasticity index/Flow index (*b*) liquid limit/Plastic limit

(*c*) Liquidity index/plastic limit (*d*) Plastic limit/Liquidity index

2. Classification of Soils

GATE – 2009 (2-Marks)

15. The laboratory test results of a soil sample are given below:
Percentage finer than 4.75 mm = 60
Percentage finer than 0.075 mm = 30
Liquid limit = 35%
Plastic limit = 27%
The soil classification is
(*a*) GM (*b*) SM (*c*) GC (*d*) ML – MI

GATE – 2007 (2-Marks)

16. Sieve analysis on a dry soil sample of mass 1000 g showed that 980g and 270g of soil pass through 4.75 mm and 0.075 mm sieve, respectively. The liquid limit and plastic limits of the soil fraction passing through $425\,\mu$ sieves are 40% and 18% respectively. The soil may be classified as
(*a*) SC (*b*) MI (*c*) CI (*d*) SM

GATE – 2006 (2-Marks)

Common Data for Q. 17 and Q. 18

Laboratory sieve analysis was carried out on a soil sample using a complete set of standard IS sieves. Out of 500g of soil used in the test, 200g was retained on IS $600\,\mu$ sieve, 250g was retained on IS $500\,\mu$ sieve and the remaining 50g was retained on IS $425\,\mu$ sieve.

17. The coefficient of uniformity of the soil is
(*a*) 0.9 (*b*) 1.0 (*c*) 1.1 (*d*) 1.2

18. The classification of the soil is
(*a*) SP (*b*) SW (*c*) GP (*d*) GW

GATE – 2005 (2-Marks)

19. A soil mass contains 40% gravel, 50% sand and 10% silt. This soil can be classified as
(*a*) silty sandy gravel having coefficient of uniformity less than 60.
(*b*) silty gravelly sand having coefficient of uniformity equal to 10
(*c*) gravellysilty sand having coefficient of uniformity greater than 60
(*d*) gravellysilty sand and its coefficient uniformity cannot be determined.

GATE – 2012 (1-Mark)

20. As per the Indian Standard soil classification system, a sample of silty clay with liquid limit of 40% and plasticity index of 28% is classified as
(*a*) CH (*b*) CI (*c*) CL (*d*) CL – ML

GATE – 2010 (1-Mark)

21. A fine grained soil has liquid limit of 60 and plastic limit of 20. As per the plasticity chart, according to IS classification, the soil is represented by the letter symbols
(*a*) CL (*b*) C (*c*) CH (*d*) CL – ML

GATE – 2008 (1-Mark)

22. Group symbols assigned to silty sand and clayey sand are respectively
(*a*) SS and CS (*b*) SM and CS (*c*) SM and SC (*d*) MS and CS

GATE – 2002 (1-Mark)

23. Data from a sieve analysis conducted on a given sample of soil showed that 67% of the particles passed through 75 micron IS sieve. The liquid limit and plastic limit of the finer fraction was found to be 45 and 33 percent respectively. The group symbol of the given soil as per IS : 1498-1970 is

(*a*) SC (*b*) MI (*c*) CH (*d*) MH

3. Soil Structures & Clay Mineralogy

GATE – 2013(One Mark Questions)

24. Following statements are made on compacted soils, wherein DS stands for the soils compacted on dry side of optimum moisture content and WS stands for the soils compacted on wet side of optimum moisture content. Identify the incorrect statement.

(*a*) Soil structure is flocculated on DS and dispersed on WS

(*b*) Construction pore water pressure is low on DS and high on WS.

(*c*) On drying, shrinkage is high on DS and low on WS.

(*d*) On access to water, swelling is high on DS and low on WS

GATE – 2009(One Mark Questions)

25. Deposit with flocculated structure is formed when

(*a*) Clay particles settle on sea bed (*b*) Clay particles settle on fresh water lake bed

(*c*) Sand particles settle on river bed (*d*) Sand particles settle on sea bed

4. Soil Compaction

GATE – 2006 (2-Marks)

26. In a standard proctor test, 1.8 kg of moist soil was filling the mould (volume = 944 cc) after compaction. A soil sample weighing 23 g was taken from the mould and oven dried for 24 hours at a temperature of 110º C. Weight of the dry sample was found to be 20 g. Specific gravity of soil solids is G = 2.7. The theoretical maximum volume of the dry unit weight of the soil at that water content is equal to

(*a*) $4.67\ kN/m^3$ (*b*) $11.5\ kN/m^3$ (*c*) $16.26\ kN/m^3$ (*d*) $18.85\ kN/m^3$

GATE – 2003 (2-Marks)

27. Compaction of an embankment is carried out in 500 mm thick layers. The rammer used for compaction has a foot area of 0.05 sq.m. and the energy imparted in every drop of rammer is 400 Nm. Assuming 50% more energy in each pass over the compacted area due to overlap, the number of passes required to develop, compactive energy equivalent to Indian Standard light compaction for each layer would be

(*a*) 10 (*b*) 16 (*c*) 20 (*d*) 26

GATE – 2012 (1-Mark)

28. Two series of compaction tests were performed in the laboratory on an inorganic clayey soil employing two different levels of compaction energy per unit volume of soil. With regard to the above tests, the following two statements are made

I. The optimum moisture content is expected to be more for the tests with higher energy.
II. The maximum dry density is expected to be more for the tests with higher energy.
The correct option evaluating the above statements is
(*a*) Only I is true (*b*) Only II is true
(*c*) Both I and II are true (*d*) Neither I nor II is true

GATE – 2010 (1-Mark)

29. In a compaction test, G, w, S and e represent the specific gravity, water content, degree of saturation and void ratio of the soil sample, respectively. If γ_w represents the unit weight of water and γ_d represents the dry unit weight of the soil, the equation for zero air voids line is

(*a*) $\gamma_d = \frac{G\gamma_w}{1+Se}$ (*b*) $\gamma_d = \frac{G\gamma_w}{1+Gw}$ (*c*) $\gamma_d = \frac{Gw}{1+\gamma_w S}$ (*d*) $\gamma_d = \frac{Gw}{1+Se}$

GATE – 2008 (1-Mark)

30. Compaction by vibratory roller is the best method of compaction in case of
(*a*) moistslity sand (*b*) well graded dry sand
(*c*) clay of medium compressibility (*d*) silt of high compressibility

GATE – 2004 (1-Mark)

31. A clayey soil has a maximum dry density of $16\,kN/m^3$ and optimum moisture content of 12%. A contractor during the construction of core of an earth dam obtained the dry density $15.2\,kN/m^3$ and water content 11%. This construction is acceptable because
(*a*) the density is less than the maximum dry density and water content is on dry side of optimum
(*b*) the compaction density is very low and water content is less than 12%
(*c*) the compaction is done on the dry side of the optimum
(*d*) both the dry density and water content of the compacted soil are within the desirable limits

5. Principle of effective Stress, Capillarity & Permeability

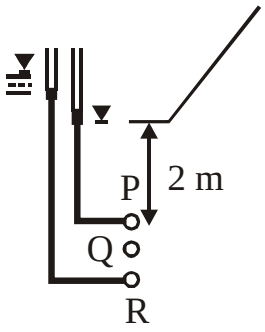
GATE – 1999 (5-Marks)

32. A layer of saturated clay 5 m thick is overlain by sand 4.0 m deep. The water table is 3 m below the top surface. The saturated unit weight of clay and sand are $18\,kN/m^3$ and $20\,kN/m^3$ respectively. Above the water table, the unit weight of sand is $17\,kN/m^3$. Calculate the effective pressure on a horizontal plane at a depth of 9m below the ground surface. What will be the increase in the effective pressure at 9m if the soil gets saturated by capillary, up to height of 1 m above the water table? $\gamma_w = 9.81\,kN/m^3$.

GATE-2012 (2-Marks)

33. Steady state seepage is taking place through a soil element at Q, 2m below the ground surface immediately downstream of the toe of an earthen dam as shown in the sketch. The water level in a piezometer installed at P, 500 mm above Q, is at the ground surface.

The water level in piezometer installed at R, 500mm below Q, is 100 mm above the ground surface. The bulk saturated unit weight of the soil is $18\,kN/m^3$ and the unit weight of water is $9.81\,kN/m^3$. The vertical effective stress (in kPa) at Q is



(*a*) 14.42 (*b*) 15.89 (*c*) 16.38 (*d*) 18.34

GATE – 2011 (2-Marks)

Common Data for Q. 34 and Q. 35

A sand layer found at sea floor under 20 m water depth is characterized with relative density = 40%, maximum void ratio = 1.0, minimum void ratio = 0.5, and specific gravity of soil solids = 2.67. Assume the specific gravity of sea water to be 1.03 and the unit weight of fresh water to be $9.81\,kN/m^3$.

34. What would be the effective stress (rounded off to the nearest integer value of kPa) at 30 m depth into the sand layer?

(*a*) 77 kPa (*b*) 273 kPa (*c*) 268 kPa (*d*) 281 kPa

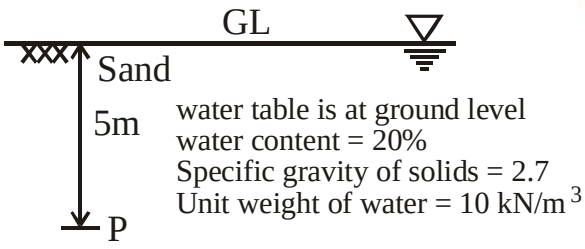
35. What would be the change in the effective stress (rounded off to the nearest integer value of kPa) at 30 m depth into the sand layer if the sea water level permanently rises by 2m?

(*a*) 19 kPa (*b*) 0 kPa (*c*) 21 kPa (*d*) 22 kPa

GATE-2008 (2-Marks)

Statement for linked Q. 36 and Q. 37

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



36. The saturated unit weight of the sand (kN/m^3) is

(*a*) 15 (*b*) 18 (*c*) 21 (*d*) 24

37. The total stress, pore water pressure and effective stress (kN/m^2) at the point P are, respectively

(*a*) 75, 50 and 25 (*b*) 90, 50 and 40 (*c*) 105, 50 and 55 (*d*) 120, 50 and 70

3. FOUNDATION ENGINEERING
(GATE Previous Papers)

1. Shallow Foundation

GATE – 2000 (5-Marks)

1. A footing 3 m square carries a gross pressure of $350\,kN/m^2$ at a depth of 1.2 m in sand. The saturated unit weight of sand is $20\,kN/m^3$ and the unit weight above the water table is $17\,kN/m^3$. The shear strength parameters are $c' = 0$ and $\phi' = 30^o$. (For $\phi' = 30^o$, $N_q = 22$ and $N_g = 20$). Determine the factor of safety with respect of shear failure for the following cases:

(*a*) water table is 5m below ground level
(*b*) water table is at 1.2 m below ground level

GATE – 1999 (5-Marks)

2. A footing 2.25 m square is located at a depth of 1.5 m in a sand of unit weight $18\,kN/m^3$. The shear strength parameters are $c' = 0$ and $\phi = 36^o$. Calculate the safe load carried by the footing against complete shear failure. Factor of safety against shear failure is 3. Use Terzahi's analysis, $(N_c = 65.4,\ N_q = 49.4,\ N_\gamma = 54.0)$

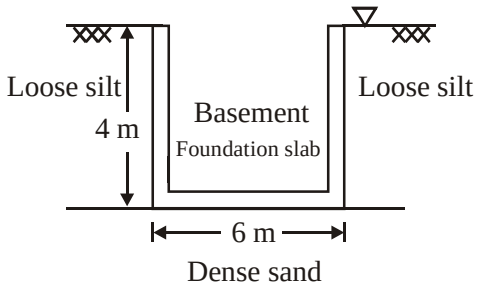
(*a*) 754KN (*b*) 3818KN
(*c*) 33318KN (*d*) 1818KN

GATE – 2013 (2-Marks)

Statement for linked answer questions Q. 3 and Q. 4

A multi-story building with a basement is to be constructed. The top 4 m consists of loose silt, below which dense sand layer is present up to a great depth. Ground water table is at the surface. The foundation consists of the basement slab of 6 m width which will rest on the top of dense sand as shown in the figure. For dense sand, saturated unit weight = $20\,kN/m^3$, and bearing capacity factors $N_q = 40$ and $N_\gamma = 45$. For loose silt, saturated unit weight = $18\,kN/m^3$, N_q = 15 and N_γ = 20. Effective cohesion c^1 is zero for both soils. Unit weight of water is $10\,kN/m^3$. Neglect shape factor and depth factor.

Average elastic modulus E and Poisson's ratio μ of dense sand is $60 \times 10^3\,kN/m^2$ and 0.3 respectively



3. Using factor of safety = 3, the net safe bearing capacity (in kN/m^2) of the foundation is:
(*a*) 610 (*b*) 320
(*c*) 866 (*d*) 693

4. The foundation slab is subjected to vertical downward stresses equal to net safe bearing capacity derived in the above question. Using influence factor $I_f = 2.0$, and neglecting embedment depth and rigidity corrections, the immediate settlement of the dense sand layer will be:
(*a*) 58 mm (*b*) 111 mm
(*c*) 126 mm (*d*) 157 mm

GATE – 2012 (2-Marks)

5. An embankment is to be constructed with a granular soil (bulk unit weight = $20\,\text{kN/m}^3$) on a saturated clayey silt deposit (undrained shear strength 25 kPa). Assuming undrained general shear failure and bearing capacity factor of 5.7, the maximum height (in m) of the embankment at the point of failure is
(*a*) 7.1 (*b*) 5.0
(*c*) 4.5 (*d*) 2.5

GATE – 2010 (2-Marks)
Statement for linked Q. 6 and Q. 7

6. The value of cohesion for the clay is
(*a*) Zero (*b*) 13.5 kPa
(*c*) 27 kPa (*d*) 54 kPa

7. If a square footing of size 4m × 4 m is resting on the surface of a deposit of the above clay, the ultimate bearing capacity of the footing (as per Terzaghi's equation) is
(*a*) 1600 kPa (*b*) 316 kPa
(*c*) 200 kPa (*d*) 100 kPa

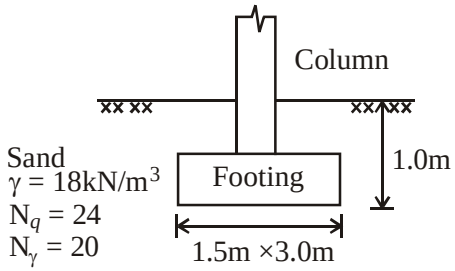
GATE – 2009 (2-Marks)

8. A plate load test is carried out on a 300 mm × 300 mm plate placed at 2 m below the ground level to determine the bearing capacity of a 2m × 2m footing placed at same depth of 2m on a homogeneous sand deposit extending 10 m below ground level. The ground water table is 3m below the ground level. Which of the following factors does not require a correction to the bearing capacity determined based on the load test?
(*a*) Absence of the overburden pressure during the test
(*b*) Size of the plate is much smaller than the footing size
(*c*) Influence of the ground water table
(*d*) Settlement is recorded only over a limited period of one or two days

GATE – 2008 (2-Marks)

Statement for linked Q. 8 and Q. 9

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.



9. The net ultimate bearing capacity (kN/m^2) of the footing based on Terzaghi's bearing capacity equations

(*a*) 216 (*b*) 432

(*c*) 630 (*d*) 846

10. The safe load (kN) that the footing can carry with a factor of safety 3 is

(*a*) 282 (*b*) 648

(*c*) 945 (*d*) 1269

11. A test plate 30 cm × 30 cm resting on a sand deposit settles by 10 mm under a certain loading intensity. A footing 150 cm × 200 cm resting on the same sand deposit and loaded to the same load intensity settles by

(*a*) 2.0 mm (*b*) 27.8 mm

(*c*) 3.02 mm (*d*) 50.0 mm

GATE – 2007 (2-Marks)

12. The bearing capacity of a rectangular footing of plan dimension 1.5 m × 3 m resting on the surface of a sand deposit was estimated as $600\ kN/m^2$ when the water table is far below the base of the footing. The bearing capacities in kN/m^2 when the water level rises to depths of 3 m, 1.5 m and 0.5 m below the base of the footing are

(*a*) 600, 600, 400 (*b*) 600, 450, 350

(*c*) 600, 500, 250 (*d*) 600, 400, 250

GATE – 2005 (2-Marks)

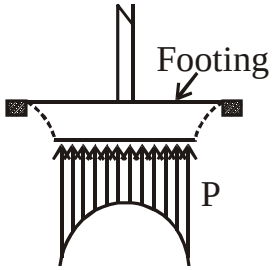
13. A strip footing (8 m wide) is designed for a total settlement of 40 mm. The safe bearing capacity (shear) was $150\ kN/m^2$ and safe allowable soil pressure was $100\ kN/m^2$. Due to importance of the structure, now the footing to be redesigned for total settlement of 25 mm. The new width of footings will be

(*a*) 5m (*b*) 8m

(*c*) 12m (*d*) 12.8

GATE – 2004 (2-Marks)

14. The figure given below represents the contact pressure distribution underneath a



(*a*) rigid footing on saturated only (*b*) rigid footing on sand
(*c*) flexible footing on saturated only (*d*) flexible footing on sand

GATE – 2001 (2-Marks)

15. A plate load test was conducted in sand on a 300 mm diameter plate. If the plate settlement was 5 mm at a pressure of 100 kPa, the settlement (in mm) of a 5m × 8m rectangular footing at the same pressure will be

(*a*) 9.4 (*b*) 18.6
(*c*) 12.7 (*d*) 17.8

GATE – 2000 (2-Marks)

16. Two footings, one circular and the other square, are founded on the surface of a purely cohesionless soil. The diameter of the circular footing is same as that of the side of the square footing. The ratio of their ultimate bearing capacities is

(*a*) $\frac{3}{4}$ (*b*) $\frac{4}{3}$
(*c*) 1.0 (*d*) 1.3

17. The ultimate bearing capacity of a soil is $300\,kN/m^2$. The depth of foundation is 1m and unit weight of soil is $20\,kN/m^3$. Choosing a factor of safety of 2.5. The net safe bearing capacity is

(*a*) $100\,kN/m^2$ (*b*) $112\,kN/m^2$
(*c*) $80\,kN/m^2$ (*d*) $100.5\,kN/m^2$

GATE – 2013 (1-Mark)

18. Four columns of a building are to be located within a plot size of 10 m × 10 m. The expected load on each column is 4000 kN. Allowable bearing capacity of the soil deposit is $100\,kN/m^2$. The type of foundation best suited is

(*a*) isolated footing (*b*) raft foundation
(*c*) Pile foundation (*d*) Combined footing

GATE – 2011 (1-Mark)

19. Likelihood of general shear failure for an isolated footing in sand decreases with
(*a*) Decreasing footing depth (*b*) Decreasing inter-granular packing of the sand
(*c*) Increasing footing width (*d*) Decreasing soil grain compressibility

GATE – 2004 (1-Mark)

20. Two circular footings of diameters D_1 and D_2 are resting on the surface of the same purely cohesive soil. The ratio of their gross ultimate bearing capacities is
(*a*) $\frac{D_1}{D_2}$ (*b*) 1.0 (*c*) $D_1^2\ D_2^2\ D$ (*d*) $\frac{D_2}{D_1}$

GATE – 2003 (1-Mark)

21. In a plate load test conducted on cohesion less soil, a 600 mm square test plate settles by 15 mm under a load intensity of $0.2\ N/mm^2$. All conditions remaining the same, settlement of a 1m square footing will be
(*a*) less than 15 mm (*b*) greater than 25 mm
(*c*) 15.60 mm (*d*) 20.50 mm

GATE – 2001 (1-Mark)

22. The following two statements are made with reference to the calculation of net bearing capacity of a footing in pure clay soil $(\phi = 0)$ using Terzaghi's bearing capacity theory. Identify if they are true or false.
I. Increase in footing width will result in increase in bearing capacity.
II. Increase in depth of foundation will result in higher bearing capacity
(*a*) Both statements are true (*b*) Both statements are false
(*c*) I is true but II is false (*d*) I is false but II is true

23. The width and depth of a footing are 2 and 1.5 m respectively. The water table at the site is at a depth of 3m below the ground level. The water table correction factor for the calculation of the bearing capacity of soil is
(*a*) 0.875 (*b*) 1.000 (*c*) 0.925 (*d*) 0.500

2. Pile Foundation

GATE – 2002 (5-Marks)

24. A group of 16 piles (diameter = 50 cm, length 14 m, center to center spacing = 1m) arranged in a square pattern passes through a recent fill (thickness = 3m) overlying a soft clay deposit (thickness = 5m) which is consolidating under the fill load and rest is a stiff clay strata. All the strata are saturated. The soil properties of different strata are

Type of Sole	Unit Weight $(\gamma)\ (kN/m^3)$	Strength Parameters		Adhesion Parameter (α)
		C_u (kPa)	ϕ_u	
Fill	16	50	0	0.60
Soft clay	17	20	0	0.40
Stiff clay	21	70	0	0.45

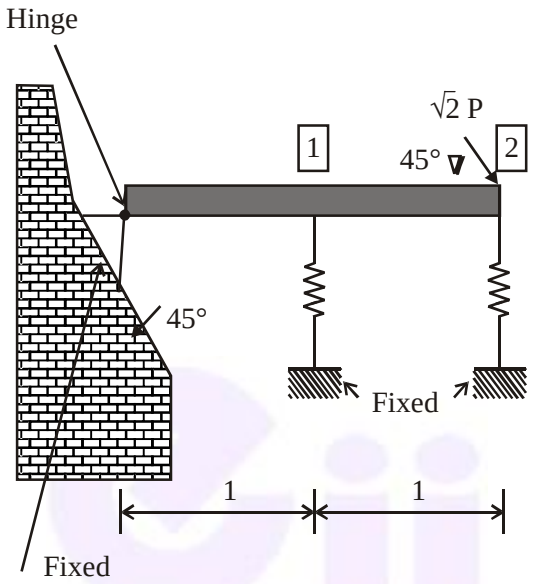
9. STRENGTH OF MATERIALS
(GATE-Previous Papers)

All Questions has been arranged as per this booklet (Chapter).

1. Simple Stresses

GATE-2011(2-Marks) : Data for Q. 1 and Q. 2 are given below

A rigid beam is hinged at one end and supported on linear elastic spring (both having a stiffness of '*k*') at points '1' and '2' an inclined load acts at '2' as shown



1. Which of the following options represents the deflections δ_1 and δ_2 at points '1' and '2'?

(*a*) $\delta_1 = \frac{2}{5}\left(\frac{2P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{2P}{k}\right)$

(*b*) $\delta_1 = \frac{2}{5}\left(\frac{P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{P}{k}\right)$

(*c*) $\delta_1 = \frac{2}{5}\left(\frac{P}{\sqrt{2k}}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{P}{k}\right)$

(*d*) $\delta_1 = \frac{2}{5}\left(\frac{\sqrt{2}P}{k}\right)$ and $\delta_2 = \frac{4}{5}\left(\frac{\sqrt{2}P}{k}\right)$

2. If the load P equals 100 kN, which of the following options represents forces R_1 and R_2 in the springs at points '1' and '2' ?

(*a*) $R_1 = 20$ kN and $R_2 = 40$ kN

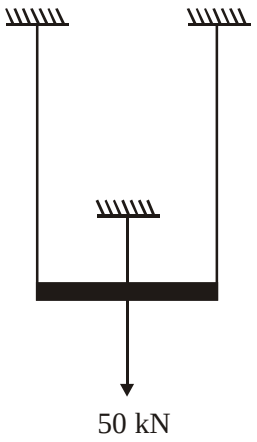
(*b*) $R_1 = 50$ kN and $R_2 = 50$ kN

(*c*) $R_1 = 30$ kN and $R_2 = 60$ kN

(*d*) $R_1 = 40$ kN and $R_2 = 80$ kN

GATE-2007(2-Marks)

3. A rigid bar is suspended by three rods made of the same material as shown in the figure. The area and length of the central rod are 3A and L, respectively while that of the two outer rods are 2A and 2L, respectively. If a downward force of 50 kN is applied to the rigid bar, the forces in the central and each of the outer rods will be



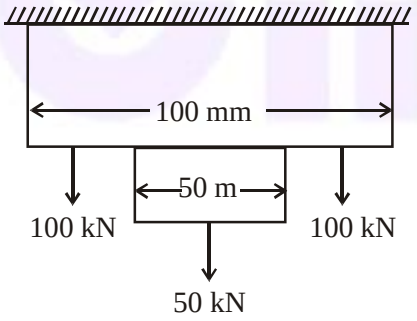
(*a*) 16.67 kN each (*b*) 30 kN and 15 kN
(*c*) 30 kN and 10 kN (*d*) 21.4 kN and 14.3 kN

4. A metal bar of length 100 mm is inserted between two rigid supports and its temperature is increased by 10° C. If the coefficient of thermal expansion is 12×10^{-6} per °C and the Young's modulus is 2×10^{5} MPa, the stress in the bar is

(*a*) zero (*b*) 12 MPa (*c*) 24 MPa (*d*) 2400 MPa

GATE-2003(2-Marks)

5. A bar of varying square cross-section is loaded symmetrically as shown in the figure. Loads shown are placed on one of the axes of symmetry of cross-section. Ignoring self weight, the maximum tensile stress in N/mm^2 anywhere is



(*a*) 16.0 (*b*) 20.0 (*c*) 25.0 (*d*) 30.0

GATE-2012(1-Mark)

6. The Poisson's ratio is defined as

(*a*) $\left|\frac{\text{axial stress}}{\text{lateral stress}}\right|$ (*b*) $\left|\frac{\text{lateral strain}}{\text{axial strain}}\right|$

(*c*) $\left|\frac{\text{lateral stress}}{\text{axial stress}}\right|$ (*d*) $\left|\frac{\text{axial strain}}{\text{lateral strain}}\right|$

GATE-2010(1-Mark)

7. The number of independent elastic constants for a linear elastic isotropic and homogeneous material is

(*a*) 4 (*b*) 3 (*c*) 2 (*d*) 1

GATE-2007(1-Mark)

8. For an isotropic material, the relationship between the young's modulus (E), shear modulus (G) and poison's ratio (μ) is given by

$(a)\ G = \frac{E}{(1+\mu)}$ $(b)\ G = \frac{E}{2(1+\mu)}$ $(c)\ G = \frac{E}{(1+2\mu)}$ $(d)\ G = \frac{E}{2(1+2\mu)}$

GATE-2002(1-Mark)

9. The shear modulus (G), modulus of elasticity (E) and the Poisson's ratio (v) of a material are related as,

$(a)\ G = \frac{E}{[2(1+v)]}$ $(b)\ E = \frac{G}{[2(1+v)]}$ $(c)\ G = \frac{E}{[2(1-v)]}$ $(d)\ G = \frac{E}{[2(v-1)]}$

GATE-2000(1-Mark)

10. Pick the incorrect statement from the following four statements

(a) On the plane which carries maximum normal stress, the shear stress is zero.

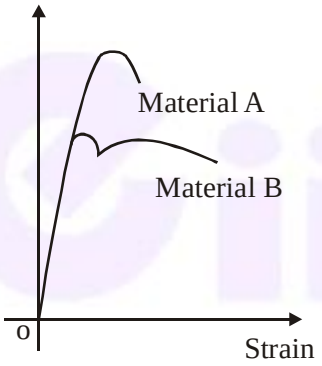
(b) Principal planes are mutually orthogonal

(c) On the plane which carries maximum shear stress, the normal stress is zero

(d) The principal stress axes and principal strain axes coincide for an isotropic material

GATE-2000(1-Mark)

11. The stress-strain diagram for two materials A and B is shown below:



The following statements are made based on this diagram

(I) Material A is more brittle than material B

(II) The ultimate strength of material B is more than that of A

With reference to the above statements, which of the following applies?

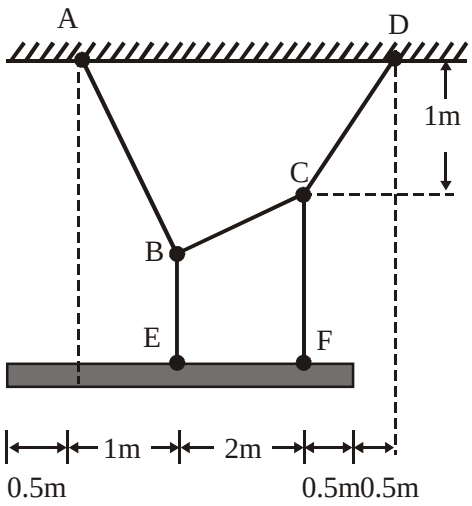
(a) Both the statements are false (b) Both the statements are true

(c) I is true but II is false (d) I is false but II is true

2. Complex Stresses

GATE-2013(2-Marks)

12. A uniform beam weighing 1800 N is supported at E and F by cable ABCD. Determine the tension (in N) in segment AB of this cable (correct to 1-decimal place). Assume the cables ABCD, BE and CF to be weightless.



13. The state of 2D-stress at a point is given by the following matrix of stresses:

$$\begin{bmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{xy} & \sigma_{yy} \end{bmatrix} = \begin{bmatrix} 100 & 30 \\ 30 & 20 \end{bmatrix} \text{MPa}$$

What is the magnitude of maximum shear stress in MPa?

(*a*) 50 (*b*) 75 (*c*) 100 (*d*) 110

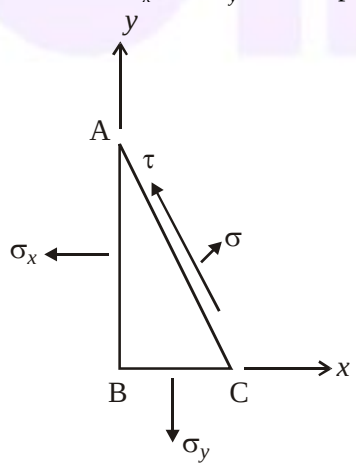
GATE-2004(2-Marks)

14. If principal stresses in a two-dimensional case are (–) 10 MPa and 20 MPa respectively, then maximum shear stress at the point is

(*a*) 10 MPa (*b*) 15 MPa (*c*) 20 MPa (*d*) 30 MPa

15. In a two dimensional analysis, the state of stress at a point is shown below.

If $\sigma = 120$ MPa and $\tau_{xy} = 70$ MPa, σ_x and σ_y, are respectively



(*a*) 26.7 MPa and 172.5 MPa (*b*) 54 MPa and 128 MPa

(*c*) 67.5 MPa and 213.3 MPa (*d*) 16 MPa and 138 MPa

GATE-2012(1-Mark)

16. If a small concrete cube is submerged deep in still water in such a way that the pressure exerted on all faces of the cube is ρ, then the maximum shear stress developed inside the cube is

(*a*) 0 (*b*) $\frac{p}{2}$ (*c*) p (*d*) $2p$

GATE-2010(1-Mark)

17. The major and minor principal stresses at a point are 3 MPa and 3 MPa respectively. The maximum shear stress at the point is

(*a*) zero (*b*) 3 MPa (*c*) 6 MPa (*d*) 9 MPa

GATE-2009(1-Mark)

18. Consider the following statements:

1. On a principal plane, only normal stress acts.
2. On a principal plane, both normal and shear stresses act.
3. On a principal plane, only shear stress acts.
4. Isotropic state of stress is independent of frame of reference.

Which of the above statements is/are correct?

(*a*) 1 and 4 (*b*) 2 only (*c*) 2 and 4 (*d*) 2 and 3

GATE-2007(1-Mark)

19. An axially loaded bar is subjected to a normal stress of 173 MPa. The shear stress in the bar is

(*a*) 75 MPa (*b*) 86.5 MPa (*c*) 100 MPa (*d*) 122.3 MPa

GATE-2006(1-Mark)

20. Mohr's circle for the state of stress defined by $\begin{bmatrix} 30 & 0 \\ 0 & 30 \end{bmatrix}$ MPa is a circle with

(*a*) center at (0, 0) and radius 30 MPa (*b*) center at (0, 0) and radius 60 MPa
(*c*) center at (30, 0) and radius 30 Mpa (*d*) center at (30, 0) and zero radius

GATE-2005(1-Mark)

21. The components of strain tensor at a point in the plane strain case can be obtained by measuring longitudinal strain in following directions

(*a*) A long any two arbitrary directions (*b*) Along any three arbitrary directions
(*c*) Along two mutually orthogonal directions (*d*) Along any arbitrary direction

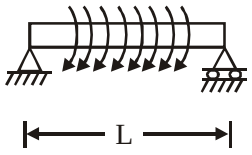
22. The symmetry of stress tensor at a point in the body under equilibrium is obtained from

(*a*) Conservation of mass (*b*) Force equilibrium equations
(*c*) Moment equilibrium equations (*d*) Conservation of energy

3. SFD and BMD

GATE-2010(2-Marks)

23. For the simply supported beam of length L, subjected to a uniformly distributed moment M kN-m per unit length as shown in the figure, the bending moment (in kN-m) at the mid-span of the beam is



(*a*) zero (*b*) M (*c*) ML (*d*) $\frac{M}{L}$

24. Two people weighing W each are sitting on a plank of length L floating on water at $\frac{L}{4}$ from either end. Neglecting the weight of the plank, the bending moment at the center of the plank is

(*a*) $\frac{WL}{8}$ (*b*) $\frac{WL}{16}$ (*c*) $\frac{WL}{32}$ (*d*) zero

10. SURVEYING
(GATE-Previous Papers)

SURVEYING

1. Fundamental Concepts about Surveying

GATE-2008(2-Marks)

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

(*a*) 10000 (*b*) 6561
(*c*) 1000 (*d*) 656

GATE-2008(1- Mark)

2. The survey in which the earth curvature is also considered is called

(*a*) Geodetic survey (*b*) plane survey
(*c*) Preliminary survey (*d*) topographical survey

GATE-2007(2-Marks)

3. The plan of a map was photo copied to a reduced size such that a line originally 100 mm, measures 90 mm. The original scale of the plan was 1: 1000. The revised scale is

(*a*) 1: 900 (*b*) 1 : 1111
(*c*) 1 : 1121 (*d*) 1 : 1221

2. Compass Surveying & Theodolite

GATE-2013(2-Marks)

4. Following bearings are observed while traversing with a compass

Line	Fore Bearing	Back Bearing
AB	126°45′	308°00′
BC	49°15′	227°30′
CD	340°30′	161°45′
DE	258°30′	78°30′
EA	212°30′	31°45′

After applying the correction due to local attraction, the corrected for bearing of line BC will be

(*a*) 48°15′ (*b*) 50°15′
(*c*) 49°45′ (*d*) 48°45′

GATE-2010(2-Marks)

5. The local mean time at a place located in Longitude 90°40′ E when the standard time is 6 hours and 30 minutes and the standard meridian is 82°30′ E is?

(*a*) 5 hrs, 2 min and 40 sec (*b*) 5 hrs, 57 min and 20 sec
(*c*) 6 hrs, and 30 min (*d*) 7 hrs, 02 min and 40 sec

GATE-2009(2-Marks)

6. The magnetic bearing of a line AB was N 59°30′ W in the year 1967, when the declination was 4°10′ E. If the resent declination is 3° W, the whole circle bearing of the line is

(*a*) 299º 20′ (*b*) 307º 40′
(*c*) 293º 20′ (*d*) 301º 40′

GATE-2009(1- Mark)

7. In quadrantal bearing system bearing of a line varies from
(*a*) 0º to 360º (*b*) 0º to 180º
(*c*) 0º to 90º (*d*) 0º N to 90º S

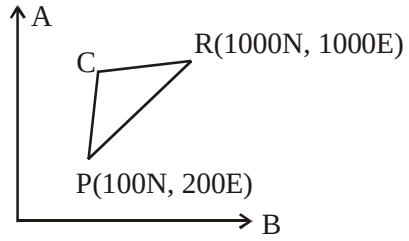
GATE-2008(2-Marks)

8. 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 is
(*a*) 39.098 (*b*) 42.226
(*c*) 39098 (*d*) 42226

GATE-2006(2-Marks)

9. The observed magnetic bearing of a line OE was found to be 185º. It was later discovered that station O had a local attraction of +1.5º. The true bearing of the line OE, considering declination of 3.5º E will be
(*a*) 180º (*b*) 187º
(*c*) 190º (*d*) 193º

10. In the figure shown, the length PQ (WCB 30º) and QR (WCB 45º) respectively up to three places of decimal are



(*a*) 273.505, 938.186 (*b*) 273.205, 551.815
(*c*) 551.815, 551.815 (*d*) 551.815, 938.186

11. The magnetic bearing of a line AB is S 45º E and the declination in 5º West. The true bearing of the line AB is
(*a*) S 45º E (*b*) S 40º E
(*c*) S 50º E (*d*) S 50º W

3. Traverse Surveying

GATE-2013(1-Mark)

12. The latitude and departure of a line AB are +78 m and –45.1 m, respectively. The whole circle bearing of the line AB is:
(*a*) 30º (*b*) 150º
(*c*) 120º (*d*) 330º

GATE-2012(1-Mark)

13. Which of the following errors can be eliminated by reciprocal measurements in differential leveling?
I. Error due to earth's curvature
II. Error due to atmospheric refraction
(*a*) Both I and II (*b*) I only
(*c*) II only (*d*) Neither I nor II

GATE-2011(2-Marks)

14. The observations from a closed loop traverse around an obstacle are

Segment	Observation from Station	Length(m)	Azimuth (clockwise from magnetic North)
PQ	P	Missing	33.7500º
QR	Q	300.00	86.3847º
RS	R	354.524	169.3819º
ST	S	450.000	243.9003º
TP	T	268.00	317.5000º

What is the value of the missing measurement (rounded off to the nearest 10 mm)?

(*a*) 396.86 m (*b*) 396.79 m

(*c*) 396.05 m (*d*) 396.94 m

GATE-2008(2-Marks)

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

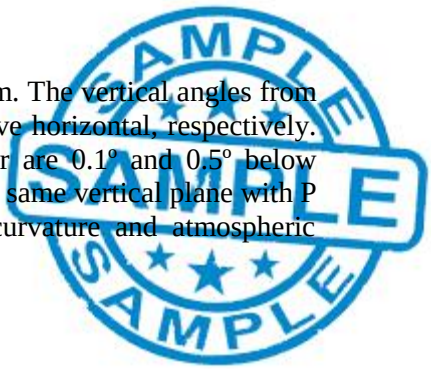
Line	Length (m)	Bearing (WCB)
PR	200	0º
QR	1000	45º
RS	907	180º
SP	?	?

The missing length and bearing, respectively of the line SP are

(*a*) 207 m and 270º (*b*) 707 and 270º

(*c*) 707 m and 180º (*d*) 907 and 270º

4. Leveling



GATE-2012(2-Marks)

16. The horizontal distance between two stations P and Q is 100 m. The vertical angles from P and Q to the top of a vertical tower at T are 3º and 5º above horizontal, respectively. The vertical angles from P and Q to the base of the tower are 0.1º and 0.5º below horizontal, respectively. Stations P, Q and the tower are in the same vertical plane with P and Q being on the same side of T. Neglecting earth's curvature and atmospheric refraction, the height (in m) of the tower is

(*a*) 6.972 (*b*) 12.387

(*c*) 12.540 (*d*) 128.745

GATE-2011(1-Mark)

17. Curvature correction to a staff reading in a differential leveling survey is

(*a*) always subtractive (*b*) always zero

(*c*) always additive (*d*) dependent on latitude

GATE-2010(2-Marks)

18. A bench mark was established at the soffit of an ornamental arch at the known elevation of 100, above m.s.l. The back sight used to establish height of instrument is an inverted staff reading of 2.105 m. A forward sight reading with normally held staff of 1.105 m is taken on a recently constructed plinth. The elevation of the plinth is

(*a*) 103.210 m (*b*) 101.00 m

(*c*) 99.00 m (*d*) 96.79 m

GATE-2009(2-Marks)

19. Consider the following statements:
Assertion (A): Curvature correction must be applied when the sights are long.
Reason (R): Line of collimation is not a level line but is tangential to the level line. Of these statements.
(*a*) both A and R are true and R is the correct explanation of A
(*b*) both A and R are true but R is not a correct explanation of A
(*c*) A is true but R is false
(*d*) A is false but R is true

GATE-2007(2-Marks)

20. The following observations are observed during testing a leveling instrument

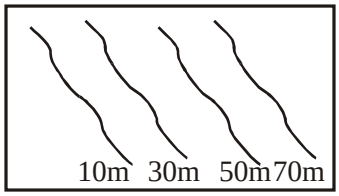
Instrument at	Staff reading at	
	P_1	Q_1
P	2.8000 m	1.7000 m
Q	2.7000 m	1.8000 m

P_1 is close to P and Q_1 is close to Q. If the reduced level of station P is 100.00 m, the reduced level of station Q is
(*a*) 99.000 m (*b*) 100.000 m
(*c*) 101.000 m (*d*) 102.000 m

21. A bench mark (BM) with reduced level (RL) 155.305 m has been established at the floor of a room. It is required to fine out the RL of the underside of the roof (R) of the room using spirit leveling. The back sight (BS) to the BM has been observed as 1.500 m where as the Fore sight (FS) to R has been observed as 0.575 m (staff held inverted). The RL (m) or R will be
(*a*) 155.880 (*b*) 156.320
(*c*) 157.380 (*d*) 157.860

GATE-2006(2-Marks)

22. Consider the following figure, which is an extract from a contour map (scale-1 : 20,000) of an area, an alignment of a road at ruling gradient of 4% is to be fixed from the point O and beyond. What should be the radius of the arc with O as the center to get the point of alignment of the next contour on the map?



GATE-2006(2-Marks)

23. During a leveling work along a falling gradient using a Dumpy Level and a Staff of 3m length, following successive readings were taken:
1.785, 2.935, 0.360, 1.320. What will be the correct order of booking these four readings in a level book? (BS : Back Sight, IS : Intermediate Sight, FS : Fore Sight)
(*a*) BS, FS, BS, FS (*b*) BS, IS, FS, FS
(*c*) BS, IS, IS, FS (*d*) BS, IS, BS, FS

11. HYDROLOGY ENGINEERING
(GATE-Previous Papers)

1. Precipitation, Frequency of Rain fall data

GATE-2013(1-Mark)

1. An isohyet is a line joining points of
(*a*) Equal temperature (*b*) Equal humidity
(*c*) Equal rainfall depth (*d*) Equal evaporation

2. A 1-h rainfall of 10 cm magnitude at a station has a return period of 50 years. The probability that a 1-h rainfall of magnitude 10 cm or more will occur in each of two successive years is:
(*a*) 0.04 (*b*) 0.2 (*c*) 0.02 (*d*) 0.0004

GATE-2005(1-Mark)

3. The intensity of rain fall and time interval of a typical storm are Time interval Intensity of rainfall

(Minutes)	**(mm / minute)**
0 – 10	0.7
10 – 20	1.1
20 – 30	2.2
30 – 40	1.5
40 – 50	1.2
50 – 60	1.3
60 – 70	0.9
70 – 80	0.4

The maximum intensity of rainfall for 20 minutes duration of the storm is
(*a*) 1.5 mm/minute (*b*) 1.85 mm/minute
(*c*) 2.2 mm/minute (*d*) 3.7 mm/minute

GATE-2003(1-Mark)

4. Match List-I with List-II and select the correct answers using the codes given below the lists:

List-I	**List-II**
P. Rainfall intensity	1. Isohyets
Q. Rainfall excess	2. Cumulative excess rainfall
R. Rainfall averaging	3. Hyetograph
S. Mass curve	4. Direct runoff hydrograph

Codes:

	P	**Q**	**R**	**S**
(*a*)	1	3	2	4
(*b*)	3	4	1	2
(*c*)	1	2	4	3
(*d*)	3	4	2	1

2. Evaporation and Transpiration

GATE-2003(2-Marks)

5. The plan area of a reservoir is $1\,km^2$. The water level in the reservoir is observed to decline by 20 cm in a certain period. During this period the reservoir receives a surface inflow of 10 hectare-meters, and 20 hectare-meters are abstracted from the reservoir for irrigation and power. The pan evaporation and rainfall recorded during the same period at a near by meteorological station are 12 cm and 3 cm respectively. The calibrated pan factor is 0.7. The seepage loss from the reservoir during this period in hectare-meters is

(*a*) 0.0 (*b*) 1.0 (*c*) 2.4 (*d*) 4.6

GATE-2002(2-Marks)

6. During a 6-hour storm the rainfall intensity was 0.8 cm/hr on a catchment of area $8.6\,km^2$. The measured runoff volume during this period was $2,56,000\,m^3$. The total rainfall was lost due to infiltration, evaporation and transpiration in cm/hr is

(*a*) 0.80 (*b*) 0.304 (*c*) 0.496

(*d*) Sufficient information and available

GATE-2012(1-Mark)

7. The ratio of actual evapo-transpiration to potential evapo-transpiration is in the range

(*a*) 0.0 to 0.4 (*b*) 0.6 to 0.9 (*c*) 0.0 to 1.0 (*d*) 1.0 to 2.0

3. Infiltration

GATE-2013(2-Marks) : Data for Q. 8 and Q. 9 are given below

At a station, Storm I of 5 hour duration with intensity 2 cm/h resulted in a runoff of 4 cm and Storm II of 8 hour duration resulted in a runoff of 8.4 cm. Assume that the ϕ- index is the same for both the storms.

8. The ϕ- index (in cm/h) is:

(*a*) 1.2 (*b*) 1.0 (*c*) 1.6 (*d*) 1.4

9. The intensity of storm II (in cm/h) is:

(*a*) 2.00 (*b*) 1.75 (*c*) 1.50 (*d*) 2.25

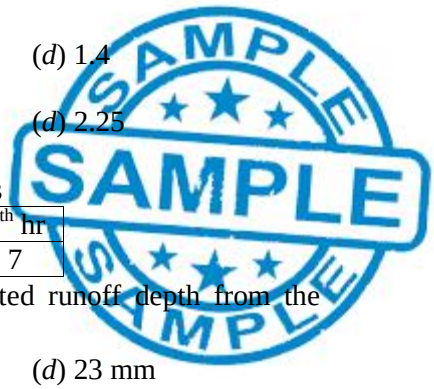
GATE-2007(2-Marks)

10. An isolated 4-hour storm occurred over a catchment as follows

Time	1st hr	2nd hr	3rd hr	4th hr
Rainfall (mm)	9	28	12	7

The ϕ- index for the catchment is 10 mm/hr. The estimated runoff depth from the catchment due to the above storm is

(*a*) 10 mm (*b*) 16 mm (*c*) 20 mm (*d*) 23 mm



GATE-2006(2-Marks)

11. During a 3 hour storm event, it was observed that all abstractions other than infiltration are negligible. The rainfall was idealized as 3 one hour storms of intensity 10 mm/hr, 20 mm/hr and 10 mm/hr respectively and the infiltration was idealized as a Horton curve, $f = 6.8 + 8.7 \exp(-t)$ (f in mm/hr and t in hr). What is the effective rainfall?

(*a*) 10.00 mm (*b*) 11.33 m (*c*) 12.43 mm (*d*) 13.63 mm

GATE-2004(2-Marks)

12. The rainfall during three successive 2 hour periods are 0.5, 2.8 and 1.6 cm. The surface runoff resulting from this storm is 3.2 cm. The ϕ- index value of this storm is

(*a*) 0.20 cm/hr (*b*) 0.28 cm/hr (*c*) 0.30 cm/hr (*d*) 0.80 cm/hr

GATE-2000(2-Marks)

13. The parameter in Horton's infiltration equation $[f(t) = f_c + (f_o - f_c)^{e-kt}]$ are given as, f_o = 7.62, cm/hour, f_c = 1.34 cm/hour and k = 4.182/hour. For assumed continuous ponding the cumulative infiltration at the end of 2 hours is

(*a*) 2.68 cm^3 (*b*) 1.50 cm^3 (*c*) 1.34 cm^3 (*d*) 4.18 cm^3

GATE-2003(1-Mark)

14. The vertical hydraulic conductivity of the top soil at certain stage is 0.2 cm/hr. A storm of intensity 0.5 cm/hr occurs over the soil for an indefinite period. Assuming the surface drainage to be adequate, the infiltration rate after the storm has lasted for a very long time, shall be

(*a*) Smaller than 0.2 cm/hr (*b*) 0.2 cm/hr

(*c*) Between 0.2 and 0.5 cm/hr (*d*) 0.5 cm/hr

GATE-2001(1-Mark)

15. Isopleths are lines on a map through points having equal depth of

(*a*) Rainfall (*b*) Infiltration (*c*) Evapo-transpiration (*d*) Total runoff

4. Hydrographs

GATE-2001(5-Marks)

16. The 4-hour unit hydrograph (UH) for a catchment having an area of 536 km^2 is shown in the Table below. Find the peak discharge when a 3-hour period of rainfall excess with intensity of 6 mm/hr was realized in the catchment. Assume that there is no base flow.

Time (hour)	UH ordinate (m^3/ sec)	Time (hour)	UH ordinate (m^3/ sec)
0	0	11	73
1	10	12	59
2	60	13	48
3	120	14	36
4	170	15	28
5	200	16	20
6	180	17	13
7	150	18	8
8	124	19	3
9	104	20	0
10	88	21	0

GATE-2000(5-Marks)

17. A 6 hour unit hydrograph of a watershed is given below. Calculated 18 hour unit hydrograph using S-curve method and tabulate the results.

Time (hour)	6hr unit hydrograph [m^3/ cm]
0	0
6	1.8
12	30.9
18	85.6
24	41.8
30	14.6
36	5.5
42	1.8

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GATE-2012(2-Marks) : Data for Q. 18 and Q. 19 are given below

The drainage area of a watershed is 50 km^2. The ϕ index is 0.5 cm/hour and the base flow at the outlet is 10 m^3/s. One hour unit hydrograph (unit depth = 1 cm) of the watershed is triangular in shape with a time base of 15 hours. The peak ordinate occurs at 5 hours.

18. The peak ordinate (in $(m^3/s/cm)$ of the unit hydrograph is

(*a*) 10.00 (*b*) 18.52 (*c*) 37.03 (*d*) 185.20

19. For a storm of depth of 5.5 cm and duration of 1 hour, the peak ordinate (in m^3/s) of the hydrograph is

(*a*) 55.00 (*b*) 82.60 (*c*) 92.60 (*d*) 102.60

GATE-2011(2-Marks) : Data for Q. 20 and Q. 21 are given below

The ordinates of 2-h unit hydrograph at 1 hour intervals starting from time t = 0 are 0, 3, 8, 6, 3, 2 and 0 m^3/s. Use trapezoidal rule for numerical integration, if required.

20. What is the catchment area represented by the unit hydrograph?

(*a*) 1.00 km^2 (*b*) 2.00 km^2 (*c*) 7.92 km^2 (*d*) 8.64 km^2

21. A storm of 6.6 cm occurs uniformly over the catchment in 3 hours. If ϕ index is equal to 2 mm/h and base flow is 5 m^3/s, what is the peak flow due to the storm?

(*a*) 41.0 m^3/s (*b*) 43.4 m^3/s (*c*) 53.0 m^3/s (*d*) 56.2 m^3/s

GATE-2009(2-Marks) : Data for Q. 22 and Q. 23 are given below

One hour triangular unit hydrograph of a watershed has the peak discharge of 60 $m^3/sec.cm$ at 10 hours and time base of 30 hours. The ϕ index is 0.4 cm per hour and base flow is 15 m^3 m/ sec.

22. The catchment area of the watershed is

(*a*) 3.24 km^2 (*b*) 32.4 km^2 (*c*) 324 km^2 (*d*) 3240 km^2

23. If these is rainfall of 5.4 cm in 1 hour, the ordinate of the flood hydrograph at 15^{th} hour is

(*a*) 225 m^3/sec (*b*) 240 m^3/sec (*c*) 249 m^3/sec (*d*) 258 m^3/sec

GATE-2007(2-Marks) : Data for Q. 24 and Q. 25 are given below

Ordinate of a 1-hour unit hydrograph at 1 hour intervals, staring from time t = 0, are 0, 2, 6, 4, 2, 1 and 0 m^3/s.

24. Catchment area represented by this unit hydrograph is

(*a*) 1.0 km^2 (*b*) 2.0 km^2 (*c*) 3.2 km^2 (*d*) 5.4 km^2

25. Ordinate of a 3-hour unit hydrograph for the catchment at t = 3 hour is

(*a*) 2.0 m^3/s (*b*) 3.0 m^3/s (*c*) 4.0 m^3/s (*d*) 5.0 m^3/s

GATE-2006(2-Marks) : Data for Q. 26 and Q. 27 are given below

For a catchment, the S-curve (or S-hydrograph) due to a rainfall of intensity 1 cm/hr is given by $Q = 1 - (1 + t)\exp(-t)$ (t in hr and Q in m^3/s).

26. What is the area of the catchment?

(*a*) 0.01 km^2 (*b*) 0.36 km^2 (*c*) 1.00 km^2 (*d*) 1.28 km^2

27. What will be the ordinate of a 2-hour unit hydrograph for this catchment at t = 3 hour?

(*a*) 0.13 m^3/s (*b*) 0.20 m^3/s (*c*) 0.27 m^3/s (*d*) 0.54 m^3/s

GATE-2005(2-Marks) : Data for Q. 28 and Q. 29 are given below

A four hour unit hydrograph of a catchment is triangular in shape with base of 80 hours. The area of the catchment is 720 kM^2. The base flow and ϕ index are 30 m^3/s and 1 mm/hr, respectively. A storm of a 4 cm occurs uniformly in 4 hours over the catchment

12. FLUID MECHANICS AND HYDRAULIC MACHINES (GATE-Previous Papers)

1. Properties of Fluids

GATE-2000(1-Mark)

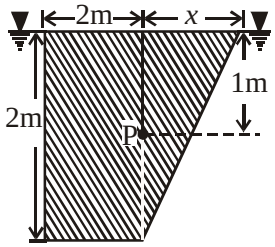
1. Cavitation if caused by

(*a*) High velocity (*b*) Low pressure (*c*) High pressure (*d*) High temperature

2. Fluid Statics

GATE-2005(2-Marks)

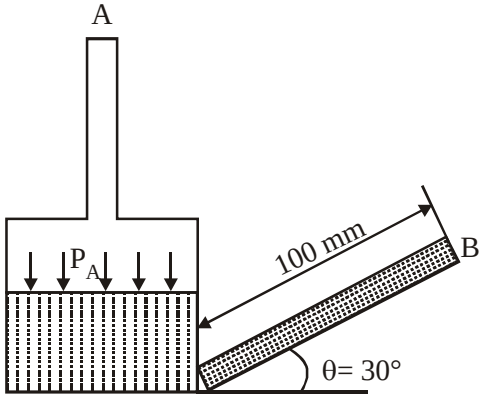
2. Cross section of an object (having same section normal to the paper) submerged into a fluid consists of a square of sides 2 m and triangle as shown in the figure. The object is hinged at point P that is one meter below the fluid free surface. If the object is to be kept in the position as shown in the figure, the value of '*x*' should be



(*a*) $2\sqrt{3}$ (*b*) $4\sqrt{3}$ (*c*) 4 m (*d*) 8 m

GATE-2004(2-Marks)

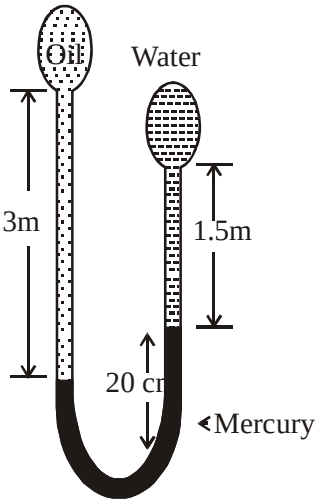
3. In the inclined manometer shown in the figure below, the reservoir is large. Its surface may be assumed to remain at a fixed elevation. A is connected to a gas pipeline and the deflection noted on the inclined glass tube is 100 mm. Assuming $\theta = 30°$ and the manometric fluid as oil with specific gravity of 0.86, the pressure at A is



(*a*) 43 mm water (vacuum) (*b*) 43 mm water (*c*) 86 mm water (*d*) 100 mm water

GATE-2003(2-Marks)

4. Two pipelines, one carrying oil (mass density 900 kg/m^3) and the other water are connected to a manometer as shown in figure. By what amount the pressure in the water pipe should be increased so that the mercury levels in both the limbs of the manometer become equal ? (Mass density of mercury = 13550 kg/m^3 and $g = 9.81\ m/s^2$)



(*a*) 24.7 kPa (*b*) 26.5 kPa (*c*) 26.7 kPa (*d*) 28.9 kPa

GATE-2001(2-Marks)

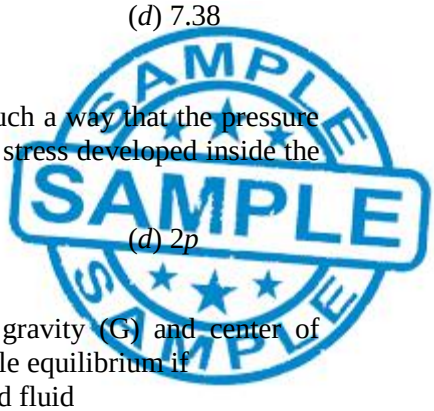
5. A 15 cm length of steel rod with relatively density of 7.4 is submerged in a two layer fluid. The bottom layer is mercury and the top layer is water. The height of top surface of the rod above the liquid interface in 'cm' is

(*a*) 8.24 (*b*) 7.82 (*c*) 7.64 (*d*) 7.38

GATE-2012(1-Mark)

6. If a small concrete cube is submerged deep in still water in such a way that the pressure exerted on all faces of the cube is *p*, then the maximum shear stress developed inside the cube is

(*a*) 0 (*b*) $\frac{p}{2}$ (*c*) p (*d*) $2p$



GATE-2011(1-Mark)

7. Fr a body completely submerged in a fluid, the center of gravity (G) and center of Buoyancy (O) are known. The body is considered to be in stable equilibrium if

(*a*) O does not coincide with the center of mass of the displaced fluid

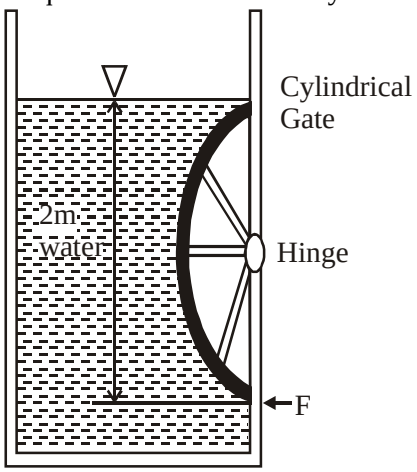
(*b*) G coincides with the center of mass of the displaced fluid

(*c*) O lies below G

(*d*) O lies above G

GATE-2002(1-Mark)

8. The force 'F' required at equilibrium on the semi-cylindrical gate shown below is



(*a*) 9.81 KN (*b*) 0.00 KN (*c*) 19.62 KN (*d*) None of these

GATE-1999(1-Mark)

9. In an iceberg, 15% of the volume projects above the sea surface. If the specific weight of sea water is 10.5 kN/ m^3, the specific weight of iceberg in kN/ m^3 is

(*a*) 12.52 (*b*) 9.81 (*c*) 8.93 (*d*) 7.83

3. Fluid Kinematics

GATE-2013(2-Marks)

10. Laplace equation for water flow in soils is given below.

$$\frac{\partial^2 H}{\partial x^2}+\frac{\partial^2 H}{\partial y^2}+\frac{\partial^2 H}{\partial z^2}=0$$

Head H does not vary in *y* and *z* directions. Boundary conditions are: at

$$x = 0,\ H = 5;\ \text{and}\ \frac{dH}{dx}=-1$$

What is the value of H at $x = 1.2$ ……

GATE-2006(2-Marks)

11. The velocity field for a flow is given by:

$\bar{V}=(5x+6y+7z)\,\hat{i}+(6x+5y+9z)\,\hat{j}+(3x+2y+\lambda z)\,\hat{k}$ and the density varies as $\rho=\rho_0.e^{-2t}$. In order that the mass is conserved, the value of λ should be

(*a*) –12 (*b*) –10 (*c*) –8 (*d*) 10

GATE-2005(2-Marks)

12. The circulation 'Γ' around a circle of radius 2 units for the velocity field $u = 2x + 3y$ and $v = -2y$ is

(*a*) -6π units (*b*) -12π units (*c*) -18π units (*d*) -24π units

13. A stream function is given by:

$\psi=2x^2y+(x+1)y^2$. The flow rate across a line joining points A(3, 0) and B(0, 2) is

(*a*) 0.4 units (*b*) 1.1 units (*c*) 4 units (*d*) 5 units

GATE-2004(2-Marks)

14. The velocity in m/s at a point in a two dimensional flow is given as $v = 2\hat{i} + 3\hat{j}$. The equation of the stream line passing through the point (x, y) is

(*a*) $3dx - 2dy = 0$ (*b*) $2x + 3y = 0$ (*c*) $3dx + 2dy = 0$ (*d*) $xy = 6$

15. A velocity field is given as $\bar{v} = 2y\hat{i} + 3x\hat{j}$ where x and y are in meters. The acceleration of a fluid particle at $(x, y) = (1, 1)$ in the x-direction is

(*a*) 0 (*b*) $5.00\ \text{m/s}^2$ (*c*) $6.00\ \text{m/s}^2$ (*d*) $8.48\ \text{m/s}^2$

GATE-2013(1-Mark)

16. For a two dimensional flow field, the stream function ψ is given as $\psi = \frac{3}{2}(y^2 - x^2)$. The magnitude of discharge occurring between the stream lines passing through points (0, 3) and (3, 4) is

(*a*) 6 (*b*) 3 (*c*) 1.5 (*d*) 2

GATE-2005(1-Mark)

17. An inert tracer is injected continuously from a point in an unsteady flow field. The locus of locations of all the tracer particles at an instance of time represents

(*a*) Stream line (*b*) Path line (*c*) Stream tube (*d*) Streak line

GATE-2004(1-Mark)

18. The x component of velocity in a two dimensional incompressible flow is given by $u = 1.5\,x$. At the point $(x, y) = (1, 0)$, the y-component of 'y' velocity $v = 0$. The equation for the component of velocity is

(*a*) $v = 0$ (*b*) $v = 1.5\,y$ (*c*) $v = -1.5\,x$ (*d*) $v = -1.5\,y$

GATE-2003(1-Mark)

19. For a two dimensional irrotational flow, the velocity potential is defined as $\phi = \log_e(x^2 + y^2)$. Which of the following is a possible stream function, ψ for this flow?

(*a*) $\frac{1}{2}\tan^{-1}\left(\frac{y}{x}\right)$ (*b*) $\tan^{-1}\left(\frac{y}{x}\right)$ (*c*) $2\tan^{-1}\left(\frac{y}{x}\right)$ (*d*) $2\tan^{-1}\left(\frac{x}{y}\right)$

GATE-2000(1-Mark)

20. The relation that must holds good for the flow to be irrotational is

(*a*) $\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x} = 0$ (*b*) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ (*c*) $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} = 0$ (*d*) $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

GATE-1999(1-Mark)

21. In a steady radial flow into an intake, the velocity is found to vary as $\left(\frac{1}{r^2}\right)$, where '$r$' is the radial distance. The acceleration is proportional to

(*a*) $\frac{1}{r^5}$ (*b*) $\frac{1}{r^3}$ (*c*) $\frac{1}{r^4}$ (*d*) $\frac{1}{r}$

4. Fluid Dynamics

GATE-1999(5-Marks)

22. A vertical water jet is issuing upwards from a nozzle with a velocity of 10 m/s. The nozzle exit diameter is 60 mm. A flat horizontal plate with a total of 250 N is supported by the impact of the jet. Determine the equilibrium height of the plate above the nozzle exit. Neglect all losses and take unit weight of water as $1000\ \text{kg/m}^3$.

GATE-2009(2-Marks)

23. Water ($\gamma_w = 9.879\ \text{kN/m}^3$) flows with a flow rate of 0.3 m^3/sec through a pipe AB of 10 m length and of uniform cross section. The end B is above end A and the pipe makes an angle of 30º to the horizontal. For a pressure of 12 kN/m^2 at the end B, the corresponding pressure at the end A is

(*a*) 12.0 kN/m^2 (*b*) 17.0 kN/m^2 (*c*) 56.4 kN/m^2 (*d*) 61.4 kN/m^2

GATE-2007(2-Marks)

24. At two points 1 and 2 in a pipeline the velocities are V and 2V respectively. Both the points are at the same elevation. The fluid density is ρ. The flow can be assumed to be incompressible, inviscid, steady and irrotational. The difference in pressures P_1 and P_2 at points 1 and 2 is

(*a*) $0.5\rho V^2$ (*b*) $1.5\rho V^2$ (*c*) $2\rho V^2$ (*d*) $3\rho V^2$

25. A horizontal water jet with a velocity of 10 m/s and cross sectional area of 10 mm^2 strikes a flat plate held normal to the flow direction. The density of water is 1000 kg/m^3. The total force on the plate due to the jet is

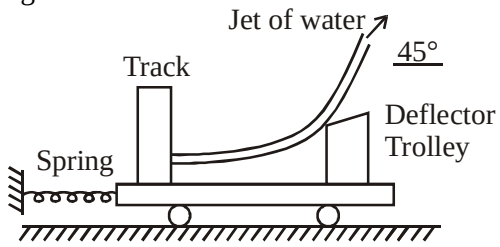
(*a*) 100 N (*b*) 10 N (*c*) 1 N (*d*) 0.1 N

GATE-2005(2-Marks)

26. The reading of differential manometer of a venturimeter, placed at 45º to the horizontal is 11 cm. If the venturimeter is turned to horizontal position, the manometer reading will be

(*a*) zero (*b*) $\frac{11}{\sqrt{2}}$ cm (*c*) 11 cm (*d*) $11\sqrt{2}$ cm

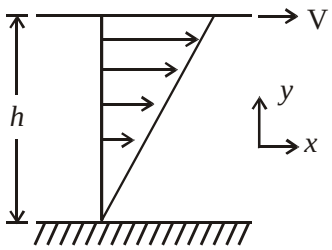
27. A tank and a deflector are placed on a frictionless trolley. The tank issues water jet (mass density of water = 1000 kg/m^3), which strikes the deflector and turns by 45º. If the velocity of jet leaving the deflector is 4 m/s and discharge is 0.1 m^3/s, the force recorded by the spring will be



(*a*) 100 N (*b*) $100\sqrt{2}$ N (*c*) 200 N (*d*) $200\sqrt{2}$ N

GATE-2004(2-Marks) : Data for Q. 28 and Q. 29 are given below

The laminar flow takes place between closely spaced parallel plates as shown in figure below. The velocity profiles is given by $u = V\frac{y}{h}$.



The gap height *h*, is 5 mm and the space is filled with oil (specific gravity = 0.86, viscosity $\mu = 2\times10^{-4}$ N-s/ m^2). The bottom plate is stationary and the top plate moves with a steady velocity of V = 5 cm/s. The area of the plate is 0.25 m^2.

28. The rate of rotation of a fluid particle is given by

(*a*) $\omega_y = 0; \omega_z = -\frac{V}{2h}$ (*b*) $\omega_y = 0; \omega_z = -\frac{V}{h}$

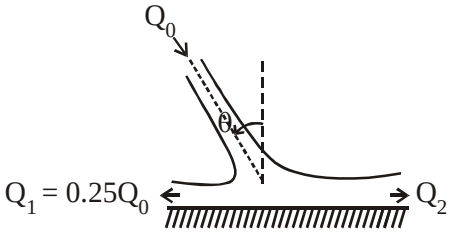
(*c*) $\omega_y = \frac{V}{h}; \omega_z = \frac{V}{h}$ (*d*) $\omega_y = \frac{V}{h}; \omega_z = 0$

29. The power required to keep the plate in steady motion is

(*a*) 5×10^{-4} watts (*b*) 10^{-5} watts (*c*) 2.5×10^{-5} watts (*d*) 5×10^{-5} watts

GATE-2003(1-Mark)

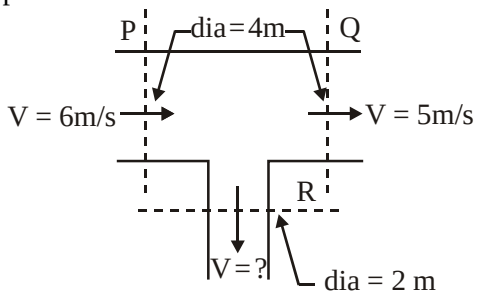
30. A horizontal jet strikes a frictionless vertical plate (the plane view is shown in the figure). It is then divided into two parts, as shown in the figure. If the impact loss is neglected, what is the value of θ?



(*a*) 15º (*b*) 30º (*c*) 45º (*d*) 60º

GATE-2012(1-Mark)

31. The circular water pipes shown in the sketch are flowing full. The velocity of flow (in m/s) in the branch pipe "R" is



(*a*) 3 (*b*) 4 (*c*) 5 (*d*) 6

GATE-2010(1-Mark)

32. Group-I gives a list of devices and group-II gives a list of uses.

Group-I	**Group-II**
P. Pitot tube	1. Measuring pressure in a pipe
Q. Manometer	2. Measuring velocity of flow in a pipe
R. Venturimeter	3. Measuring air and gas velocity
S. Anemometer	4. Measuring discharge in a pipe

The correct math of Group-I with Group-II is

	P	**Q**	**R**	**S**
(*a*)	1	2	4	3
(*b*)	2	1	3	4
(*c*)	2	1	4	3
(*d*)	4	1	3	2

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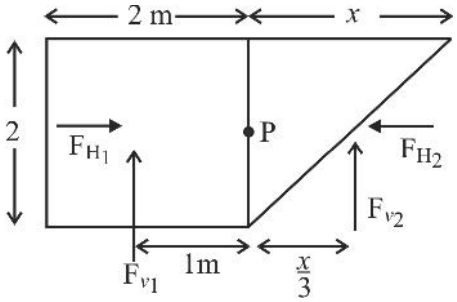
ANSWER-KEY

1	2	3	4	5	6	7	8	9	10
B	A	B	A	D	A	D	B	C	(3.8)
11	12	13	14	15	16	17	18	19	20
C	B	C	A	D	D	D	D	C	A
21	22	23	24	25	26	27	28	29	30
A	1.1m	D	B	C	C	D	C	C	B
31	32	33	34	35	36	37	38	39	40
B	C	C	A	C	-	A	B	D	D
41	42	43	44	45	46	47	48	49	50
B	D	B	C	D	D	C	B	C	B
51	52	53	54	55	56	57	58	59	60
B	D	C	8.4m/s	A	A	C	B	D	C
61	62	63	64	65	66	67	68	69	70
D	C	C	B	D	B	C	C	C	C
71	72	73	74	75	76	77	78	79	80
A	D	C	B	0.84m	6.87m	C	A	D	-
81	82	83	84	85	86	87	88	89	90
A	B	C	B	D	B	B	D	D	C
91	92	93	94	95	96	97	98	99	100
A	B	A	D	C	C	C	D	D	B
101	102	103	104	105	106	107	108	109	110
A	B	A	A	B	B	C	C	A	D
111									
B									

SOLUTIONS

1. Cavitation is due to formation of gas bubble because pressure falls below its vapor pressure. It is caused because of low pressure or because of high velocity.

2. ***(a)***



Concept: Moment due to horizontal force = 0

As $f_{H_1} = f_{H_2}$ and lever arm for both f_{H_1} and f_{H_2} are same.

Now, moment due to vertical force about P should be 0 for equilibrium

$\Rightarrow \quad F_{V_1} \times 1 - F_{V_2} \times \frac{x}{3} = 0 \qquad \ldots(i)$

$\Rightarrow$ Assuming length = 1 m

F_{V_1} = Area × Length × Density

$\Rightarrow \quad F_{V_1} = (2 \times 2 \times 1) \times \rho_w \, g \qquad F_{V_2} = \frac{1}{2} \times 2 \times x \times 1 \times \rho_w \times g$

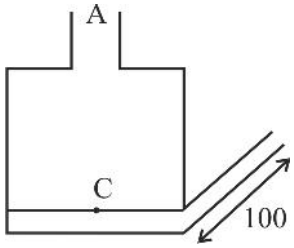
Now from equation (*i*)

$\Rightarrow \quad (2 \times 2 \times 1 \times \rho_w \times g) - \left(\frac{1}{2} \times 2 \times x \times 1 \times \rho_w \times g\right) \frac{x}{3} = 0$

$\Rightarrow \quad 4 - \frac{x^2}{3} = 0 \qquad \Rightarrow \qquad x^2 = 12$

$\Rightarrow \quad x = 2\sqrt{3}$ m

3. (*b*)



Concept: Pressure at A = Pressure at C (Because from A to C gas is fluid)

Pressure at A = $\rho_{oil} \, g \, l_{oil} = \rho_{oil} \, g(l \sin\theta)$ = (.86 × 1000) (9.81) (.1 × sin 30º)

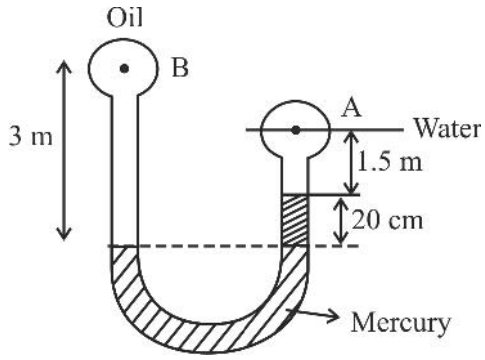
$= 421.83 \text{ N/ m}^2$

Or pressure at A = 100 sin 30º mm of oil = 50 mm of oil.

We know that $s_1 \, h_1 = s_2 \, h_2$ Where s_1 = specific gravity

$\Rightarrow \quad .86 \times 50 = 1 \times h_2 \qquad \Rightarrow \qquad h_2 = 43$ mm of water

4.



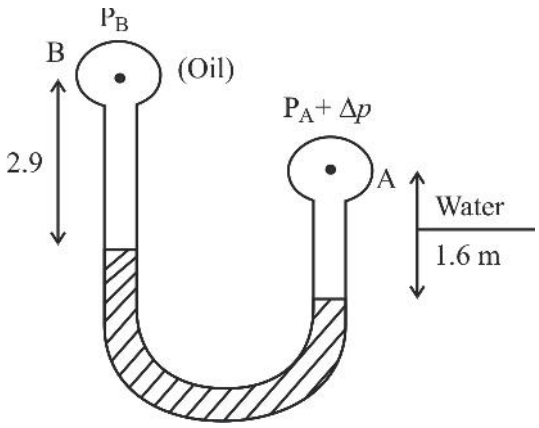
Specific gravity of oil = $\frac{900}{1000} = .9$

$P_A + 1.5 + .2 \times 13.55 - 3 \times .9 = P_B$

$P_A - P_B = -1.51 \text{ m of water} = -1.51 \, \rho_w \times g$

To make the same level of mercury in both the limbs, the level of mercury should be decreased by 10 cm in right limb and increased by 10 cm in left limb.

$\Rightarrow$

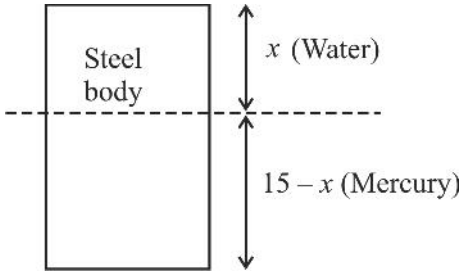


$$P_A + \Delta p + 1.6 - 2.9 \times .9 = P_B$$

$\Rightarrow \quad \Delta p = P_B - P_A + 1.01 = 1.51 + 1.01 = 2.52$ m of water

$= 2.52 \times 9.81 \times 1000$ Ka = 24.27 kPa

5. (*d*)



Now From Equilibrium condition:

Given: Specific gravity of body, $s_b = 7.4$

Specific gravity of water, $s_w = 1$

Specific gravity of mercury, $s_m = 13.6$

Now using the concept of buoyancy of floating bodies

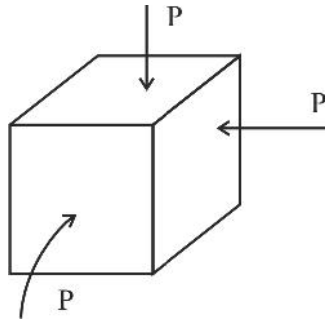
$15 \times A \times 7.4 = x \times 1 \times A + (15 - x)\, 4 \times 13.6$

$\Rightarrow \quad x = \dfrac{15(13.6 - 7.4)}{12.6} \quad \Rightarrow \quad x = 7.38$ cm

6. Concept: As pressure exerted on all faces of cube is uniform in all direction

$\Rightarrow$ Shear stress = 0

Mathematically:



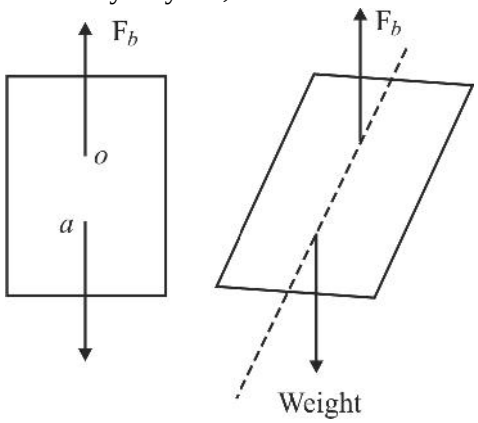
$\sigma_1 = \sigma_2 = \sigma_3 = p \qquad \tau = \dfrac{\sigma_1 - \sigma_2}{2} = \dfrac{p - p}{2} = 0$

$\Rightarrow$ Maximum shear stress, $\tau_{max} = 0$

7. (*d*)

Concept: A submerged body is said to be in stable equilibrium, if it comes back to its original position after a slight disturbance.

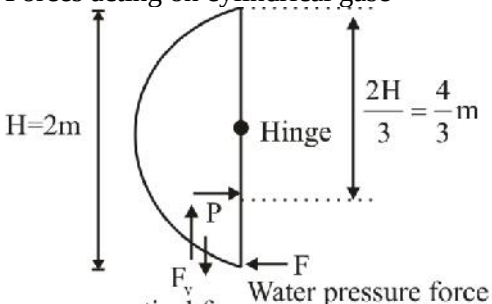
→ The wholly submerged body is considered to be in stable equilibrium if its center of gravity lies below center of buoyancy *i.e.*, a lies below 0.



F_b produced restoring torque

8. (*b*)

Forces acting on cylindrical gase



Water pressure force in horizontal = vertical force direction applied by water

$$P = \rho g \bar{h} \times A$$

$$= \rho_w g \times 1 \times 2$$

$$F_v = \rho_w g v$$

$$= \rho_w g \times \frac{\pi r^2}{2} \times 1$$

$$= \rho_w g \times \frac{\pi \times 1}{2}$$

$$= 1.57 \rho_w g$$

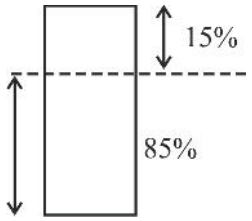
Taking moment about Hinge

$$F_v \times \frac{4R}{3\pi} + F \times 1 = P \times \frac{1}{3}$$

$$1.57 \rho_w g \times \frac{4 \times 1}{3 \times \pi} + F \times 1 = \rho_w \times g \times \frac{2}{3}$$

$$\boxed{F = 0}$$

9. **(*c*)** For floating bodies, weight of body = Weight of fluid displaced
Say V = Volume of iceberg (85% in sea water)



$mg = \rho V_{sub}\, g \quad \Rightarrow \quad \rho_{iceberg} \times V_{iceberg} = \rho_{water} \times .85\, V$

$\Rightarrow$ Specific weight of iceberg = $10.5 \times .85 = 8.93\ kN/m^3$

10. As H does not vary in *y* and *z* direction

$\Rightarrow \quad \frac{\partial^2 H}{\partial x^2} = 0 \quad \Rightarrow \quad \frac{\partial H}{\partial x} = C_1$

$\Rightarrow \quad H_1 = C_1 x + C_2$

At $x = 0$, $H = 5$ m

$\Rightarrow \quad 5 = C_1 \times 0 + C_2 \quad \Rightarrow \quad C_2 = 5$

$\Rightarrow \quad H = C_1 x + 5$

Now $\frac{dH}{dx} = C_1 = -1 \quad \Rightarrow \quad H = -x + 5$

At $x = 1.2$ m $\quad H = -1.2$ m $+ 5 = 3.8$ m

11. **(*c*)** **Given:** $u = V_x = 5x + 6y + 7z \qquad v = V_y = 6x + 5y + 9z$

$w = V_z = 3x + 2y + \lambda z \qquad f = \rho_o\, e^{-2t}$

Continuity equation for 3D, steady and compressible fluid is

$$\frac{\partial(\rho_u)}{\partial x} + \frac{\partial(\rho_v)}{\partial y} + \frac{\partial(\rho_w)}{\partial z} + \frac{\partial \rho}{\partial t} = 0$$

$$\Rightarrow \quad \frac{\partial(\rho_u)}{\partial x} + \frac{\partial(\rho_o\, e^{-2t}(5x + 6y + 7zx))}{\partial x} = 5\rho$$

$$\frac{\partial(\rho_u)}{\partial y} = 5\rho \qquad \frac{\partial(\rho_w)}{\partial z} = \lambda \rho$$

$$\Rightarrow \quad \frac{\partial \rho}{\partial t} = \frac{\partial}{\partial t}(\rho_o\, e^{-2t}) = \rho_o\, e^{-2t}(-2) = -2\rho$$

Now, $5\rho + 5\rho + \lambda\rho - 2\rho = 0 \quad \Rightarrow \quad \boxed{\lambda = -8}$

12. **(*b*)** **Concept:** Circulation = Vorticity × Area and Vorticity = $2w$

Given: $u = 2x + 3y \qquad v = -2y$

$$\frac{\partial u}{\partial y} = 3, \qquad \frac{\partial v}{\partial x} = 0$$

$$w = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right) = \frac{-3}{2} \qquad \text{Vorticity} = 2w = 2 \times \frac{-3}{2} = -3$$

Area = $\pi r^2 = \pi 2^2 = 4\pi$

$\Rightarrow$ Circulation = $-3 \times 4\pi = -12\pi$ (units)