Serial No. 51205

QUESTION BOOKLET

A

CIVIL ENGINEERING (05)

Time Allowed : 3 Hours
[1 Hour for Objective
2 Hours for Subjective]

Maximum Marks : 200
[100 Marks for Objective
100 Marks for Subjective]

INSTRUCTIONS FOR CANDIDATES

1. This Question Booklet consists of **two** Parts (Objective and Subjective). Candidate has to attempt both the Parts.
2. **In Objective Part, there are 50 questions carrying 2 marks each. There is no negative marking for any wrong answer. In Subjective Part, four (4) questions should be answered in which Question No. 1 is compulsory.**
3. Please do not open this Question Booklet until you are told to do so.
4. Candidate must fill up the necessary information in the space provided on the OMR Answer Sheet before commencement of the test.
5. For marking the correct answer, darken one circle by **black or blue** ball-point pen only. Please do not mark on more than one circle. Darkening on more than one circle against an answer will be treated as wrong answer.
6. Do not detach any leaf from this Question Booklet. After the examination, hand over the OMR Answer Sheet to the Room Invigilator.
7. Possession and use of Calculator, Mobile Phone and Pager is prohibited in the Examination Hall.
8. Candidates are informed that evaluation of OMR Sheets will be done by Electronic Machine. So, they should shadow the bubbles of Roll No., Booklet Series and Booklet No. properly, otherwise Machine will not be able to evaluate it. Failure to comply this instruction will be sole responsibility of the candidates.

SEAL

PART—A

(Objective)

1. Maximum strain at the level of compression steel for a doubly reinforced rectangular section having effective depth d, effective cover to compression steel as d and neutral axis depth from compression face as x_u will be

(A) 0·0035

(B) $0 \cdot 0035 \frac{d'}{x_u}$

(C) $0 \cdot 0035\left(1-\frac{d'}{x_u}\right)$

(D) 0·002

2. The main reinforcement in an RC slab consists of 10 mm bars @ 100 mm spacing center to center. If it is desired to replace the 10 mm bars by 12 mm bars, then the spacing of the 12 mm bars will be

(A) 100 mm

(B) 120 mm

(C) 144 mm

(D) 240 mm

3. A steel hook of 10 mm diameter is embedded in concrete for a distance 70 mm. If permissible stress in steel is 343 N/mm^2 and the bond stress is not to exceed 0·7 N/mm^2, then the maximum load that can be suspended on the hook is

(A) 55 N

(B) 1540 N

(C) 26950 N

(D) 74300 N

4. A short square column with side 200 mm is subjected to a design load of 300 kN. If the grade of concrete is M-20 and the grade of steel is Fe-415, then the area of longitudinal steel required for the section in the limit state design will be

(A) 0

(B) 320 mm^2

(C) 300 mm^2

(D) 160 mm^2

5. If f_{ck} is the characteristic strength of concrete, then as per IS 456:2000, the modulus of elasticity of concrete in N/mm^2 will be

(A) $5700\sqrt{f_{ck}}$

(B) $5000\sqrt{f_{ck}}$

(C) $5700 f_{ck}$

(D) $5000 f_{ck}$

6. In the limit state design method, the material safety factors for steel and concrete are taken as

(A) 1·5 for both steel and concrete

(B) 1·15 for both steel and concrete

(C) 1·15 for steel and 1·5 for concrete

(D) 1·5 for steel and 1·15 for concrete

7. For M-30 grade concrete, the 28 days characteristic compressive strength will be

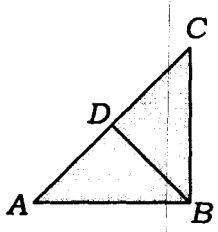
(A) 30 kN/m^2

(B) 30 N/m^2

(C) 30 N/cm^2

(D) 30 N/mm^2

8. For the fillet weld cross-section shown in the figure below, the throat thickness is



(A) *AB*

(B) *BC*

(C) *AC*

(D) *BD*

9. The effective length of the fillet weld is taken as

(A) total length – 2 × throat size

(B) total length – 2 × weld size

(C) total length – $\sqrt{2}$ × weld size

(D) 0·7 × total size

10. Two steel plate each 300 mm wide and 10 mm thick are connected by single bolt. If the plates are in tension and diameter of bolt hole is 20 mm, the net section area of the plate will be

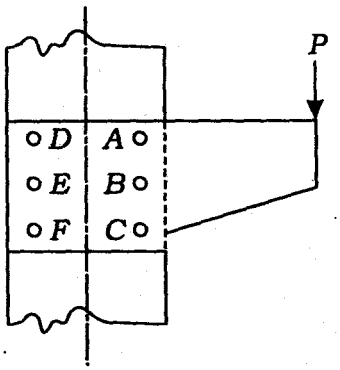
(A) 2686 mm^2

(B) 2780 mm^2

(C) 2800 mm^2

(D) 3000 mm^2

11. For the eccentric bolted connection of bracket shown in figure, which bolt will have the maximum resultant force?



(A) Bolt *A*

(B) Bolt *B*

(C) Bolt *D*

(D) Bolt *E*

13. In the built-up compressions members, the number of battens should be such that the member is divided into not less than

(A) two ways

(B) three ways

(C) four ways

(D) six ways

14. Loads on a connection is not eccentric for

(A) lap joint

(B) single-cover butt joint

(C) double-cover butt joint

(D) any of the joints mentioned above

12. Intermediate vertical stiffeners are provided in plate girders to

(A) eliminate the web buckling

(B) eliminate the local buckling

(C) transfer the vertical loads

(D) prevent the excessive deflection

15. In case of laterally unrestrained beams

(A) the compression flange deflects laterally

(B) the tension flange deflects laterally

(C) the web deflects laterally

(D) None of the above

16. In a simply supported pre-stressed concrete beam subjected to uniformly distributed load on entire span, the ideal shape of the cable profile will be

(A) concentric with the center of cross-section

(B) at constant eccentricity over the entire span

(C) varying linearly with zero eccentricity at ends and maximum eccentricity at mid-span

(D) parabolic with zero eccentricity at ends and maximum eccentricity at mid-span

17. Point of contraflexure occurs in a structure when

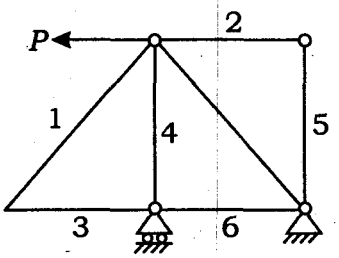
(A) bending moment is zero

(B) bending moment changes sign

(C) shear force is zero

(D) All of the above

18. For the truss shown in the figure below, the number of zero-force members will be



(A) 1

(B) 2

(C) 3

(D) 4

19. For the simply supported beam of span L, the shape of the shear force diagram will be rectangle of length L if the beam is subjected to

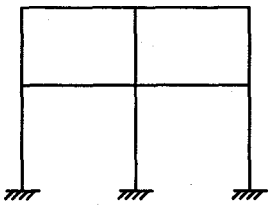
(A) a point load at mid-span

(B) uniformly distributed load over the full-span

(C) a clockwise moment at any point within the span

(D) equal magnitude hogging moments at supports

20. For the frame shown in the figure below, the degree of static indeterminacy is



(A) 6

(B) 9

(C) 12

(D) 15

21. If a framed structure is statically indeterminate to the second degree, then the minimum number of plastic hinges required for the complete collapse of the structure will be

(A) 1 (B) 2

(C) 3 (D) 4

22. Which of the following represents the increasing order of shape factor?

(A) Rectangle, I-section, solid-circular section, diamond

(B) I-section, rectangle, solid-circular section, diamond

(C) Diamond, solid-circular section, rectangle, I-section

(D) Diamond, solid-circular section, I-section, rectangle

23. A point load of 50 kN acting at mid-span of a simply supported beam produces the same maximum deflection in the beam as caused by a uniformly distributed load of 20 kN/m over the whole span. The span of the beam is

(A) 10 m

(B) 8 m

(C) 6 m

(D) 4 m

24. A beam of length 10 m, carrying a uniformly distributed load of 10 kN/m over the entire length, rests on two simple supports symmetrically. In order to have maximum sagging bending moment developed in the beam least possible, the distance between the supports must be

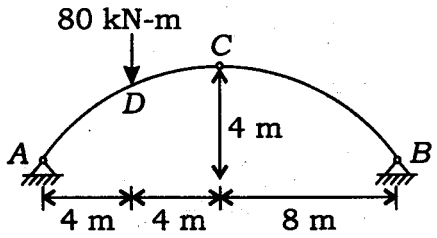
(A) 2·07 m

(B) 4·14 m

(C) 5·86 m

(D) 7·93 m

25. A three-hinged parabolic arch of span 16 m and rise 4 m is subjected to a vertical downward concentrated load of 80 at quarter span. The horizontal reaction at A will be



(A) 20 kN

(B) 30 kN

(C) 40 kN

(D) 50 kN

26. Influence line for redundant structures can be obtained by

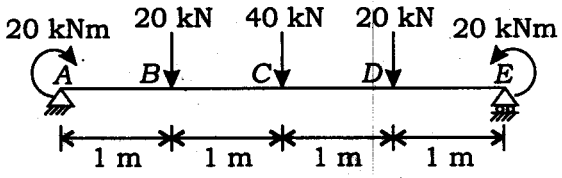
(A) Castigliano's theorem

(B) Muller-Breslau principle

(C) Unit load method

(D) Maxwell-Betti reciprocal theorem

27. A simply supported beam is loaded as shown in the figure below. The bending moment at C will be



(A) 20 kN-m (hogging)

(B) 80 kN-m (sagging)

(C) 60 kN-m (sagging)

(D) 40 kN-m (sagging)

28. A beam simply supported at both ends of length L carries two equal unlike couples M at two ends. If the flexural rigidity is EI = constant, then the central deflection will be

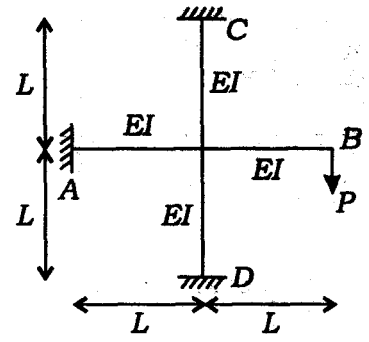
(A) $\frac{ML^2}{4EI}$

(B) $\frac{ML^2}{8EI}$

(C) $\frac{ML^2}{16EI}$

(D) $\frac{ML^2}{64EI}$

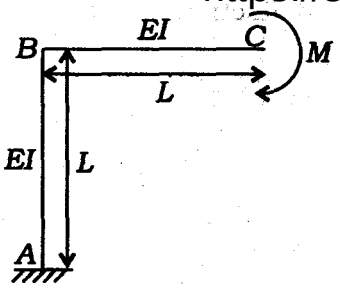
29. The given figure shows frame with a single-concentrated load P. The fixed end moment developed at joint A will be



(A) $\frac{PL}{8}$ (B) $\frac{PL}{6}$

(C) $\frac{PL}{4}$ (D) $\frac{PL}{3}$

30. What is the horizontal displacement at free end C of the frame shown in the given figure?



(A) $\frac{3ML^2}{EI}$ (B) $\frac{2ML^2}{EI}$

(C) $\frac{ML^2}{EI}$ (D) $\frac{ML^2}{2EI}$

31. The maximum bending moment at the left quarter point of a simply supported beam due to crossing of UDL of length shorter than span in the direction left to right, would occur when the load has just crossed the section by

(A) one-fourth of its span

(B) half of its span

(C) three-fourths of its span

(D) its full length

32. The size of the basic stiffness matrix for a plane truss member, in member coordinate system is

(A) 2×2

(B) 3×3

(C) 4×4

(D) 6×6

33. The number of simultaneous equations to be solved in the slope-deflection method is equal to the

(A) degree of static indeterminacy

(B) degree of kinematic indeterminacy

(C) number of joints in the structure

(D) number of members in the structure

34. From among the ranges of numerical values given, select the range valid for the void ratio e, as a ratio

(A) $e \leq 0$

(B) $0 < e < 1$

(C) $0 \leq e \leq 1$

(D) $0 < e$

35. Flocculent structure is found in

(A) gravels

(B) coarse sands

(C) silts

(D) clays

36. Which of the following types of soil is not wind-blown deposit?

(A) Drift

(B) Loess

(C) Dune sand

(D) Aeolian deposits

37. At liquid limit, all soil passes the

(A) same shear strength of large magnitudes

(B) same shear strength of small magnitude

(C) different shear strengths of small magnitude

(D) zero shear strength

38. Lowering of groundwater table causes

(A) a decrease in effective stress

(B) an increase in effective stress

(C) no change in effective stress

(D) no change in pore water pressure

39. If the flow net of a cofferdam foundation had 6 numbers of flow channels and 16 numbers of equipotential drops, with the head of water lost during seepage being 6 m through the foundation having $k = 4 \times 10^{-5}$ m/minute, then the seepage loss (in m^3/day) per meter length of the dam will be

(A) $2 \cdot 16 \times 10^{-3}$

(B) $6 \cdot 48 \times 10^{-3}$

(C) $12 \cdot 96 \times 10^{-2}$

(D) $25 \cdot 92 \times 10^{-2}$

40. Immediately after loading the excess pore pressure will be

(A) equal to applied load

(B) zero

(C) 50% of the applied load

(D) infinite

41. In a compaction test, if the compacting effort is increased, it will result in

(A) increase in maximum dry density and in OMC

(B) increase in maximum dry density and OMC remains unchanged

(C) increase in maximum dry density and decrease in OMC

(D) no change in maximum dry density but decrease in OMC

42. Consider the following shortcomings of direct shear test :

(1) Volume changes cannot be measured.

(2) Cannot be used for gravels.

(3) Difficult to control drainage.

(4) Direction of failure plane is fixed.

Of these statements

(A) 1, 2 and 3 are correct

(B) 2, 3 and 4 are correct

(C) 3, 4 and 1 are correct

(D) 1 and 2 are correct

43. Which of the following statements are correct?

(1) The sand with its void ratio higher than its critical void ratio increases in volume when sheared.

(2) The sand with its void ratio less than its critical void ratio increases in volume when sheared.

(3) For the sand at critical void ratio, the volume change during shear is minimum.

(A) 1, 2 and 3

(B) 1 and 2

(C) 2 and 3

(D) 1 and 3

44. Two footings, one circular and the other square, are found on the surface of a purely cohesionless soil. Diameter of the circular footing and width of square footing is the same. Ratio of ultimate bearing capacity of circular to square footing is

(A) 1·00 (B) 1·20

(C) 0·75 (D) 1·33

45. Bearing capacity increases with the

(A) increase in eccentricity of load

(B) increase in inclination of load

(C) increase in depth of water table below footing up to twice the width of footing

(D) decrease in unit weight of soil

46. Black cotton soils cover a large part of

(A) Northern India

(B) Rajasthan

(C) Central India

(D) Southern India

47. In using a Newmark's chart, the loaded area is drawn to a scale equal to

(A) the depth scale shown in the chart

(B) the width scale shown in the chart

(C) the area scale shown in the chart

(D) any convenient scale depending on intensity of load

48. The wall friction of retaining wall

(A) decreases active earth pressure but increases passive earth pressure

(B) decreases passive earth pressure but increases active earth pressure

(C) decreases both active and passive earth pressures

(D) increases both active and passive earth pressures

49. Consider the following statements :

(1) Coulomb earth pressure theory does not take the roughness of wall into consideration.

(2) Active earth pressure on a retaining wall decreases due to increase in wall friction.

(3) Rankine theory of earth pressure assumes that back of wall is vertical and smooth

Of these statements

(A) 1 and 2 are correct

(B) 3 and 1 are correct

(C) 2 and 3 are correct

(D) 1, 2 and 3 are correct

50. Study the statements listed below :

(1) Negative skin friction is developed when the pile is driven through a recently deposited clay layer.

(2) Negative skin friction is developed when the pile is driven through a layer of dense sand.

(3) Negative skin friction is developed due to a sudden drawdown of the water table.

Of these statements

(A) 1 alone is correct

(B) 2 alone is correct

(C) 2 and 3 are correct

(D) 1 and 3 are correct

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CIVIL ENGINEERING (05)

PART—B

(Subjective)

Full Marks : 100 *Time* : 2 hours

The figures in the margin indicate full marks for the questions

Candidates are required to answer **four** questions of which Question No. **1** is compulsory

1. Answer any *five* of the following questions : 5×5=25

(a) Show that the depth of neutral axis for balanced section in working stress method does not depend on grade of concrete.

(b) Show that for a simply supported beam subjected to UDL, (δ/L) may be controlled by limiting the (L/D) ratio.

(c) In the slab and girder construction, mark the T-beam and L-beam and explain in brief why the monolithic connection between slab and girder is preferred.

(d) In the bolted bracket connections Type-II (bolts in tension and shear), why is the line of rotation considered at $h/7$ from bottom?

(e) A natural soil deposit has a bulk unit weight of 18 kN/m^3 and water content of 5 percent. Calculate the amount of water required to be added to 1 cubic meter of soil to raise the water content to 15 percent. Assume the void ratio to remain constant. What will then be the degree of saturation? Take $G = 2 \cdot 7$.

(f) A cylindrical soil sample, having cohesion of 0·8 kg/cm^2 and angle of internal friction of 20°, is subjected to a soil pressure of 1·0 kg/cm^2. Calculate the maximum deviator stress at which the sample will fail and the angle made by the failure plane with the axis of the sample.

(g) A column load of 1200 kN is supported on a round footing (diameter 2 m) at a depth of 1·5 m. The soil properties are known as $\gamma = 18{\cdot}0\ kN/m^3$, $c = 30{\cdot}0\ kN/m^2$, $\varphi = 20°$. Calculate the factor of safety.

(h) A cylindrical shell made of mild steel plate of 100 cm diameter is to be subjected to an internal pressure of 10 kg/cm^2. If the material yields at 200 kg/cm^2, assuming factor of safety as 4 and using maximum principal stress theory, calculate the thickness of the plate.

2. Determine the tension in each segment of the cable as shown in Fig. 1. What is the dimension of h? 25

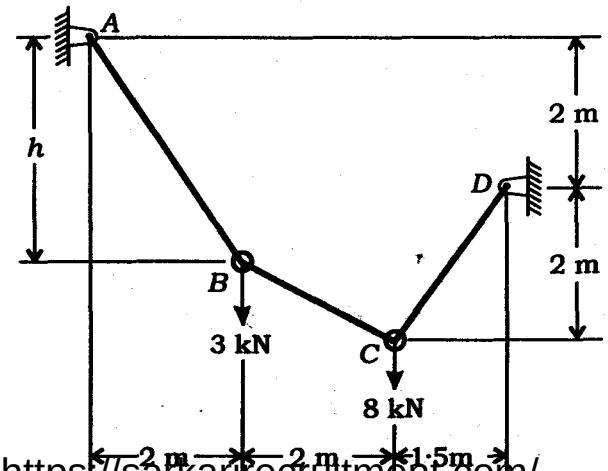

Fig. 1

3. Draw the influence line for the shear in panel CD of the floor girder shown in Fig. 2 : 25

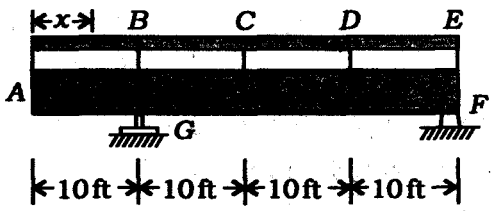

Fig. 2

4. A plate girder of span 36 m carries a factored uniformly distributed load of 79·5 kN/m and two concentrated loads each of 870 kN at distance 9 m from each support as shown in Fig. 3. The section adopted for the plate girder and location of web stiffeners are also shown in the figure.

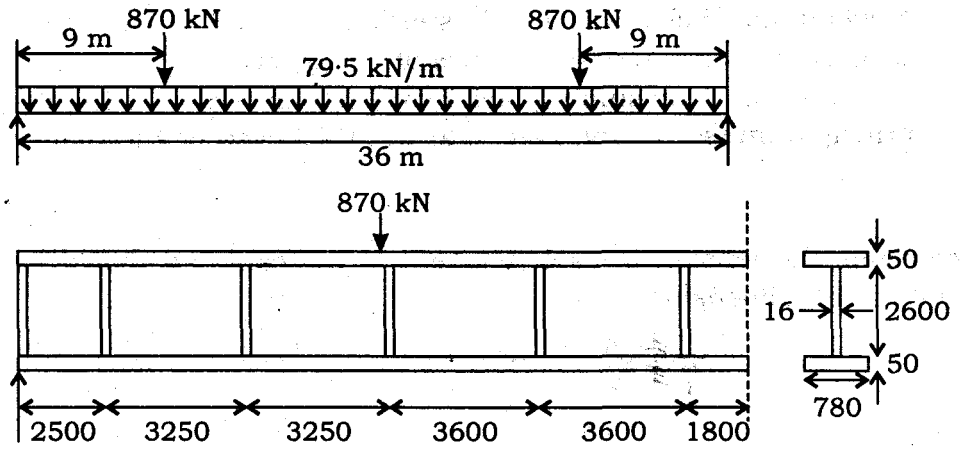

Fig. 3

(a) Check the section for flexure.

(b) Using 'post critical method', show that intermediate transverse web stiffeners are required.

(c) If thickness of the support is 500 mm, check end panel for web buckling and web crippling. 25

5. A roof slab of a hall with internal dimensions 8 m × 8 m is supported on beams and walls each of width 250 mm as shown in Fig. 4. The overall thickness of the slab is 150 mm. In order to reduce the span of the beams, a rectangular column 250 mm × 250 mm is provided at center of the hall.

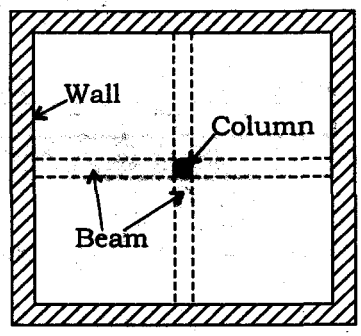

Fig. 4

(a) Design any one of the slab panels. 10

(b) Determine the longitudinal steel in the column and design the lateral reinforcement in the form of lateral ties. 15
Assume live load on slab = 5 kN/m^2. Ignore the load due to finish and partition walls, etc. Grade of concrete as M-20 and grade of steel as Fe-415.

6. A deep cut of height 12 m having side slope of 1·5 : 1 (horizontal : vertical) intersects plane of contact of two strata at a height of 2 m above base of cut. The plane of contact of the two strata makes an angle 120 with horizontal. The lower stratum is less pervious than the upper one. The soil of the upper stratum is having unit weight of 1·9 t/m^3 with level ground surface. The values of c and φ between the two strata are 0·25 kg/cm^2 and 15° respectively. Check whether a slide is likely to occur along the plane of contact between two strata. If a slide is not likely to occur, find out the factor of safety against sliding. 25

7. A group of 9 piles, 12 m long and 250 mm in diameter, is to be arranged in a square form in a clayey soil with an average unconfined compressive strength of 60 kN/m^2. Work out the centre-to-centre spacing of the piles for a group efficiency factor of 1. Neglect bearing at the tip of piles and assume adhesion factor = 0·9. 25

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SPACE FOR ROUGH WORK

SEAL