

STRUCTURAL ANALYSIS - I
(CIVL 2201)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Castigliano's theorem for deflection i.e. $\frac{\partial u}{\partial P} = \delta$ (deflection) is true for
 (a) Linearly elastic structure (b) rigid structure
 (c) Non-linearly elastic structure (d) any structure
- (ii) The ratio of ordinate value at A and at D as shown in Fig. 1 for ILD of the vertical reaction at D taking the modulus of each value.

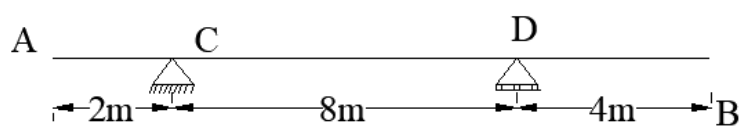


Fig. 1

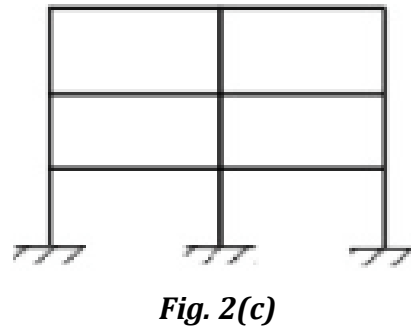
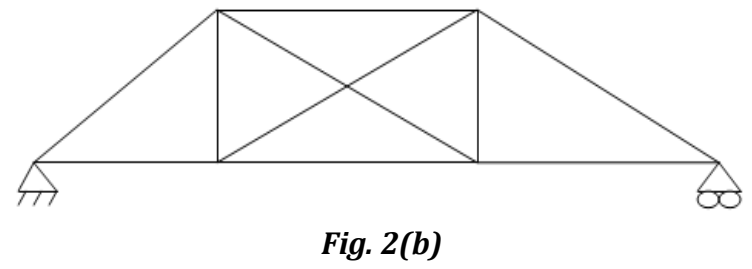
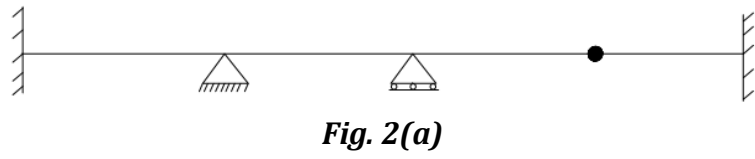
- (a) 0.25 (b) 0.5 (c) 1.0 (d) 1.5
- (iii) A pin-jointed plane frame is unstable if
 (a) $(m+r) < 2j$ (b) $(m+r) = 2j$
 (c) $(m+r) > 2j$ (d) None of the above
- (iv) In the force method of structural analysis, the basic unknowns
 (a) Displacement (b) Force (c) Displacement & Force (d) None of these.
- (v) The number of independent equations to be satisfied for static equilibrium of a plane structure is
 (a) 1 (b) 2 (c) 3 (d) 6
- (vi) When a uniformly distributed load, shorter than the span of the girder, moves from left to right, then the conditions for maximum bending moment at a section is that
 (a) the head of the load reaches the section
 (b) the tail of the load reaches the section
 (c) the load position should be such that the section divides it equally on both side
 (d) the load position should be such that the section divides the load in the same ratio as it divides the span.
- (vii) The Castigliano's second theorem can be used to compute deflections
 (a) in statically determinate structures only (b) for any type of structure
 (c) at the point under the load only (d) for beams and frames only
- (viii) For a two-hinged arch, if one of the supports settles down vertically, then the horizontal thrust
 (a) is increased (b) is decreased
 (c) remains unchanged (d) becomes zero
- (ix) A three hinged arch of span "l" and rise "h", an udl of "w" acts per unit length over the entire span, the horizontal reaction at each support is given by
 (a) $wl^2/8h$ (b) $wl^2/10h$ (c) $wl^2/4h$ (d) $wl^2/6h$
- (x) The Theorem of Three Moments expresses the condition of
 (a) Equilibrium of forces (b) Slope compatibility
 (c) Maxwell's reciprocal theorem (d) Superposition of forces.

Fill in the blanks with the correct word

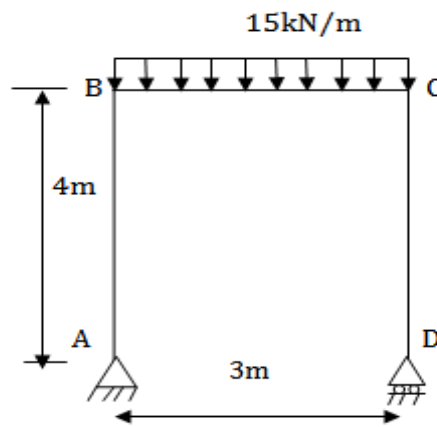
- (xi) The deflection at the free end of a cantilever beam carrying a concentrated load at free end _____.
- (xii) The _____ method is often used to construct influence line diagrams for in determinate structures.
- (xiii) Influence line diagrams can be used to find the maximum _____ along a member.
- (xiv) The degree of static indeterminacy of a propped cantilever beam is _____.
- (xv) The strain energy of a structure due to bending is given by _____.

Group - B

2. (a) Compute the stability, determinacy or indeterminacy of the following frames shown in Fig. 2(a), Fig. 2(b), Fig. 2(c).



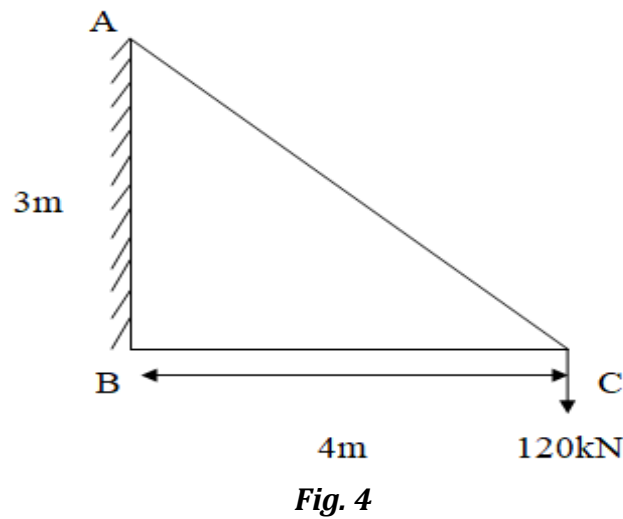
- (b) Determine the deflection at the centre of BC of a portal frame subjected to an udl of 15kN/m as shown in Fig. 3 below. EI is constant throughout.



[[CO1](Evaluate/HOCQ)]

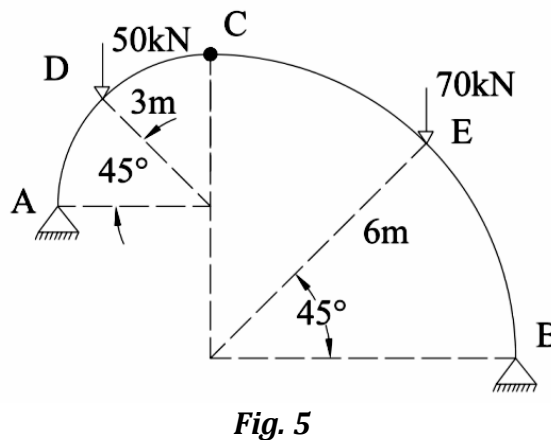
[[CO6](Evaluate/HOCQ)]
6 + 6 = 12

3. (a) Determine the vertical and horizontal deflection at joint C of the truss shown in Fig. 4. The area of the inclined tie is 2000mm², while the area of the horizontal member is 1600mm². Take $e=200\text{kN/mm}$.



[[CO6](Evaluate/HOCQ)]

- (b) A three hinged arch consist of two quadrantal parts AC and CB of radius 3m and 6m respectively as shown in Fig. 5. For the load system acting on the arch, calculate the reactions at supports and bending moments under the load.



[[CO3](Analyse/IOCQ)]

6 + 6 = 12

Group - C

4. (a) Calculate the reaction at B using the influence line diagram under the given set of loading as shown in Fig. 6.

[[CO4](Apply/IOCQ)]

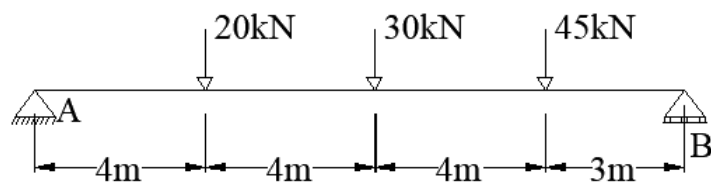


Fig. 6

- (b) Using the influence line diagram locate the position of live load (55kN/m udl of 4 m long) on the simply supported beam of span 20 m given in Fig. 7 below and calculate the maximum value of the reaction at A and B. [[CO4](Apply/IOCQ)]

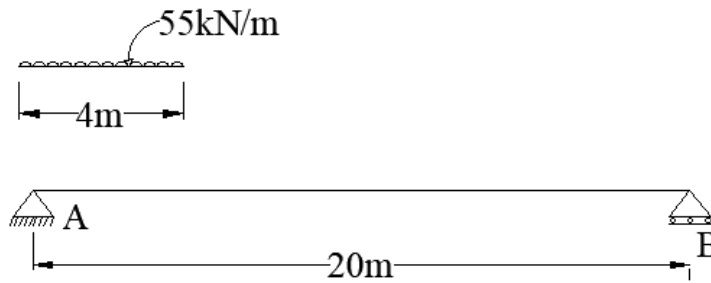


Fig. 7

6 + 6 = 12

5. Locate the position of live wheel load (one wheel load of 200kN and another of 80 kN 2m apart) on the simply supported beam of span 16m given in Fig. 8 and calculate the maximum value of the moment and shear force at C using the influence line diagram.

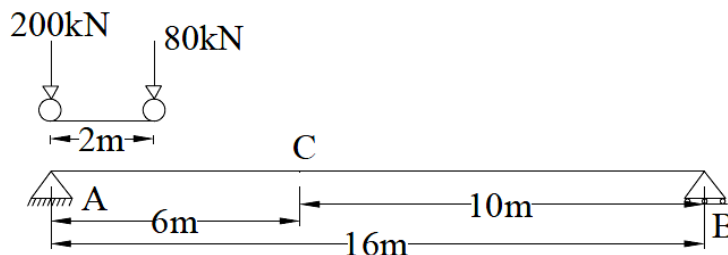


Fig. 8

[[CO4](Apply/IOCQ)]
12

Group - D

6. A semicircular two hinged arch of constant cross section is subjected to a concentrated load as shown in Fig 9. Calculate reactions of the arch and draw bending moment diagram. [[CO3](Apply/IOCQ)]

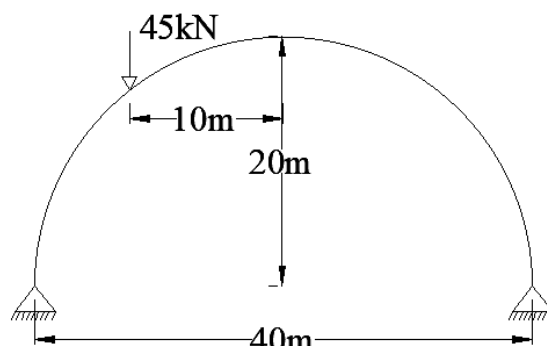


Fig. 9

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7. A continuous beam ABC shown in Fig. 10 is 15m long carried on supports at its end and is propped at the same level of points 7.5m from the left end A. It carries a concentrated load of 80kN at 3m from A and uniformly distributed load of 10kN/m run over the span BC. Using three moment theorem, calculate bending moments and support reactions at three supports. Assume EI is constant. [[CO5](Apply/IOCQ)]

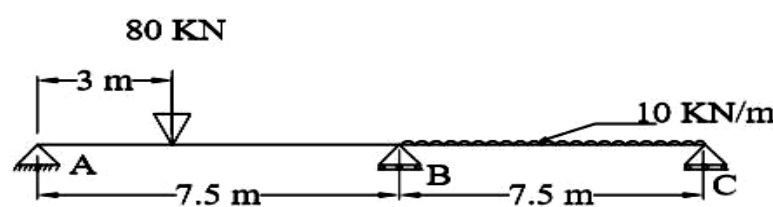


Fig. 10

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Group - E

8. Draw influence line diagram for bending moment at section D, at midpoint of span AB of continuous beam ABC as shown in Fig. 11. Span AB=4m and BC=6m. Find ordinates at 1m interval. [[CO4](Evaluate/HOCQ)]

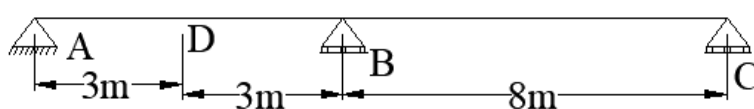


Fig. 11

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9. Draw influence line diagram of the beam as shown in Fig. 12 for reaction at support B of the continuous beam ABC. Span AB=4m and BC=7m. Find ordinates at 1m interval.

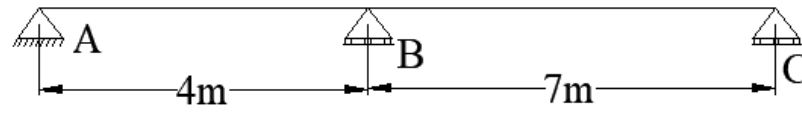


Fig. 12

[(CO4)(Evaluate/HOCQ)]

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	0	56.25	43.75

Course Outcome (CO):

After the completion of the course students will be able to

1. Distinguish between stable and unstable and statically determinate and indeterminate structures.
2. Apply equations of equilibrium to structures and compute the reactions.
3. Calculate the internal forces in cable and arch type structures
4. Evaluate and draw the influence lines for reactions, shears and bending moments in beams due to moving loads.
5. Use approximate methods for analysis of statically indeterminate structures.
6. Calculate the deflections of truss structures and beams.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.