B.TECH/CE/4TH SEM/CIVL 2201/2023

STRUCTURAL ANALYSIS - I
(CIVL 2201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A cantilever beam of length *l* carries a point load *P* at its free end. Vertical displacement of its free end will be
(a) $Pl^3/3EI$ (b) $Pl^4/3EI$ (c) $Pl/3EI$ (d) $3Pl/EI$

(ii) Which of the following is statically determinate structure?
(a) Two hinged arch (b) Fixed beam
(c) Cantilever beam (d) Continuous beam.

(iii) What is the degree of static indeterminacy of the beam shown in Fig.1, if the axial deformation is ignored?

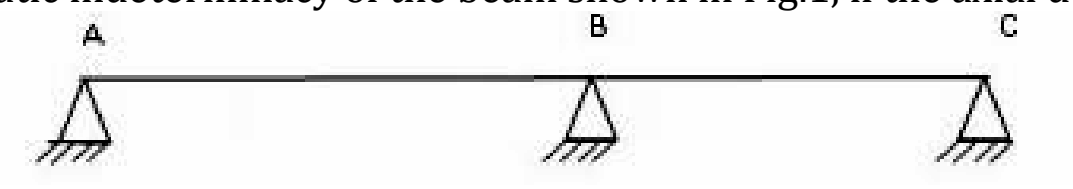

Fig.1

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

(iv) The maximum bending moment due to train of wheel loads on a simply supported girder
(a) always occurs at centre of span
(b) always occurs under a wheel load
(c) always occur under the resultant of wheel loads
(d) never occurs under a wheel load

(v) Calculate the force in member BC of the truss shown in Fig.2 below

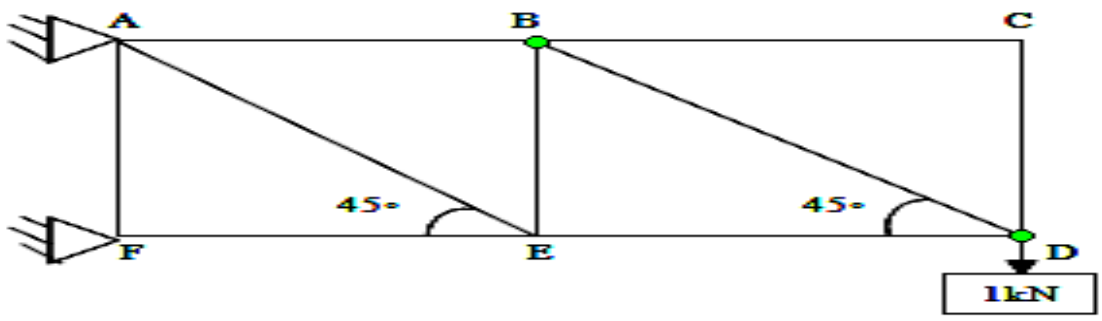

Fig.2

(a) 0KN (b) 2–√ KN (TENSILE) (c) 1KN (TENSILE) (d) 1KN (COMPRESSIVE).

(vi) When a uniformly distributed load, longer than the span of the girder, moves from left to right then the maximum bending moment at a mid section of span occurs when uniformly distributed load occupies
(a) less than the left half span (b) whole of left half span
(c) more than the left half span (d) whole span.

(vii) 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.

(viii) 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.

(ix) The ordinates of influence line diagram for bending moment always have the dimensions of
(a) force (b) length (c) force × length (d) force/length.

(x) Muller Breslau's principle is applicable to
(a) only statically determinate structure (b) only beams
(c) only statically indeterminate structure (d) when principle of superposition is valid.

Group – B

2. (a) Compute the stability, determinacy or indeterminacy of the following frames shown in Fig.3(a), 3(b), 3(c). [(CO1)(Evaluate/HOCQ)]

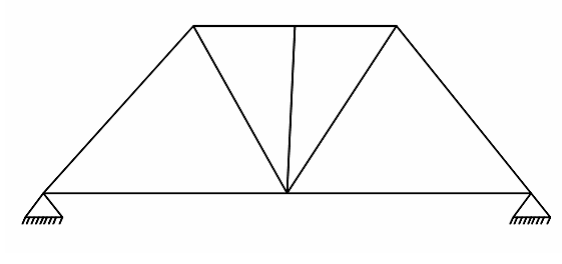

Fig.3(a)

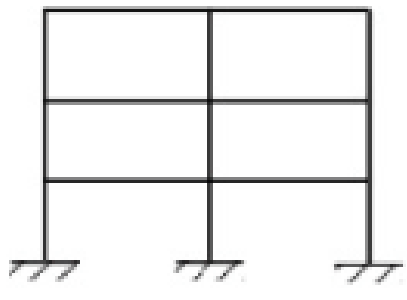

Fig.3(b)

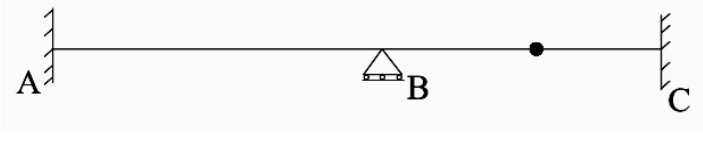

Fig.3(c)

(b) Determine the deflection at the centre of BC of a portal frame subjected to an udl of 15 kN/m as shown in Fig.4. EI is constant throughout. [(CO2)(Evaluate/HOCQ)]

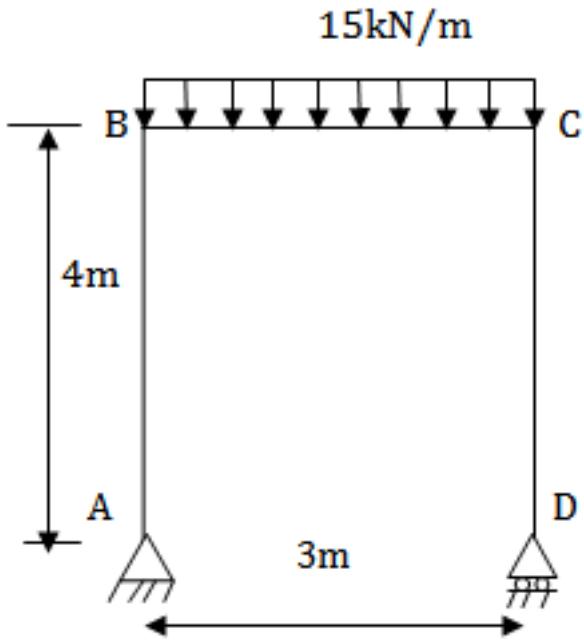

Fig.4

6 + 6 = 12

3. (a) Determine the deflection at the free end of the cantilever beam given in Fig.5 using unit load method. [(CO6)(Evaluate/HOCQ)]

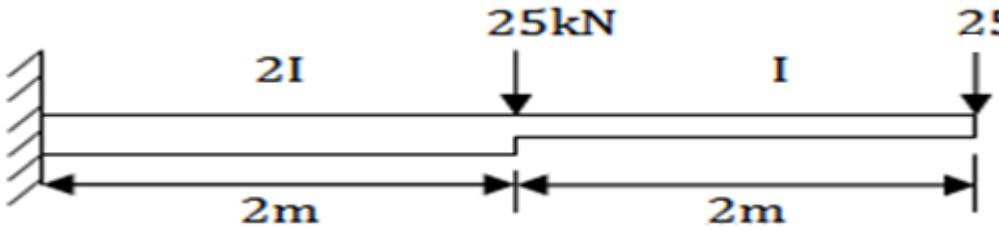

Fig.5

(b) A three hinged arch has a span of 40 m and a rise of 10 m. The arch carries an udl of 15 kN/m at left half of the span. Determine horizontal thrust at each support. [(CO3)(Analyze/IOCQ)]

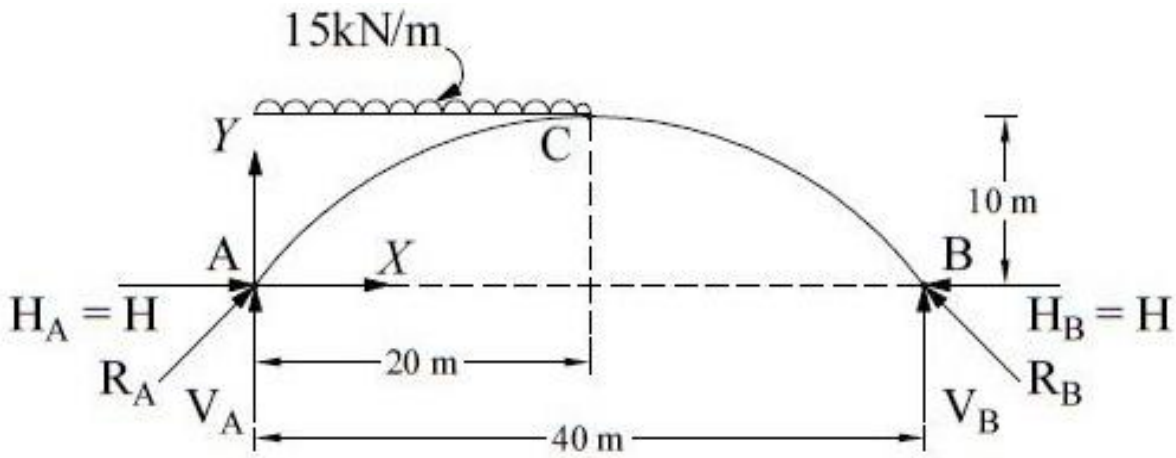

Fig.6

6 + 6 = 12

Group - C

4. Calculate the reaction at B using the influence line diagram as shown in the Fig.7 under the given set of loading. [(CO4)(Evaluate/HOCQ)]

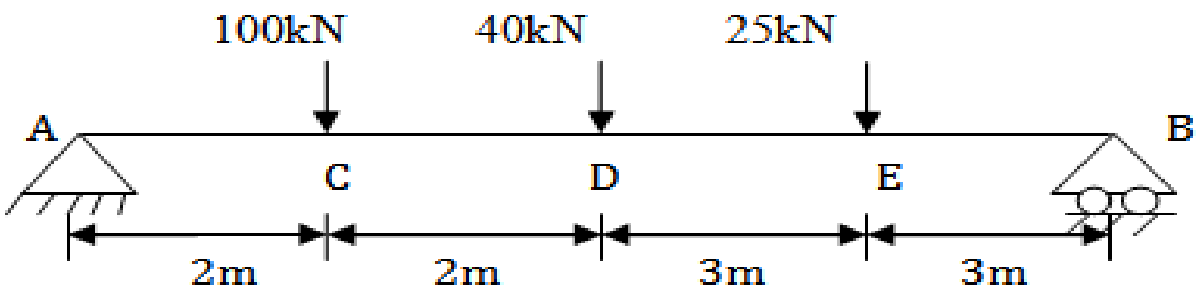

Fig.7

12

5. A uniformly distributed load of 80 kN/m spaced at 4 m on the simply supported girder of span 16 m given in Fig.8 below. Find the maximum positive and negative shear force at 6 m from left end and calculate the maximum value of the reaction at A and B. [(CO4)(Evaluate/HOCQ)]

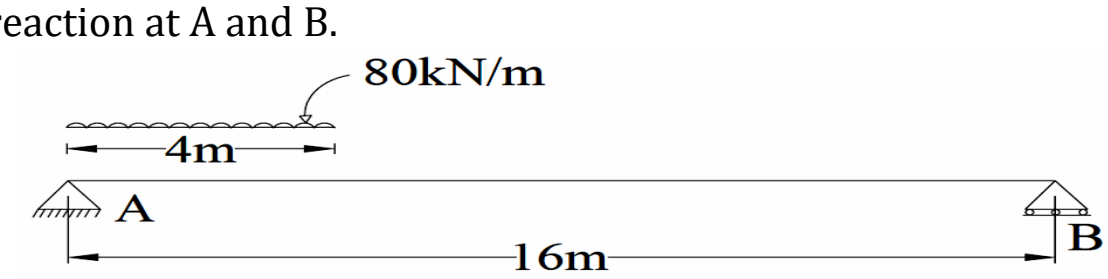

Fig. 8

(6 + 6) = 12

Group - D

6. (a) Solve the continuous beam shown in Fig.9 using Castigliano's 2nd Theorm. [(CO5)(Analyze/IOCQ)]

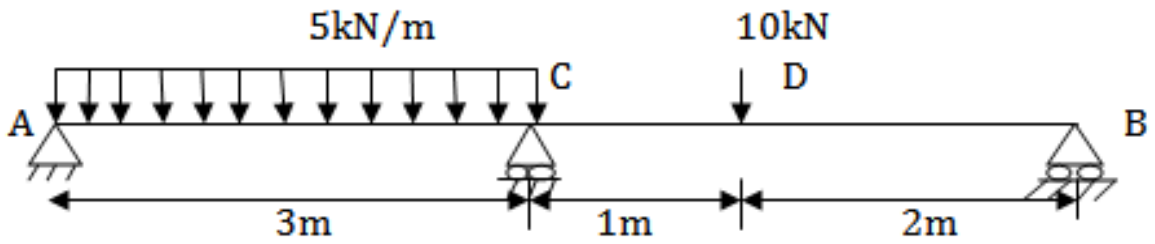

Fig.9

(b) A continuous beam ABC given in Fig.10, 15 m long is carried on supports at its end and is propped at the same level at points 7.5 m from left end A. It carries a concentrated load of 80 kN at 3.0 m from A and uniformly distributed load of 10 kN/m run over the span BC. Using three-moment equations, Calculate bending moment and support reactions at three supports. Assume EI is constant. [(CO5)(Evaluate/HOCQ)]

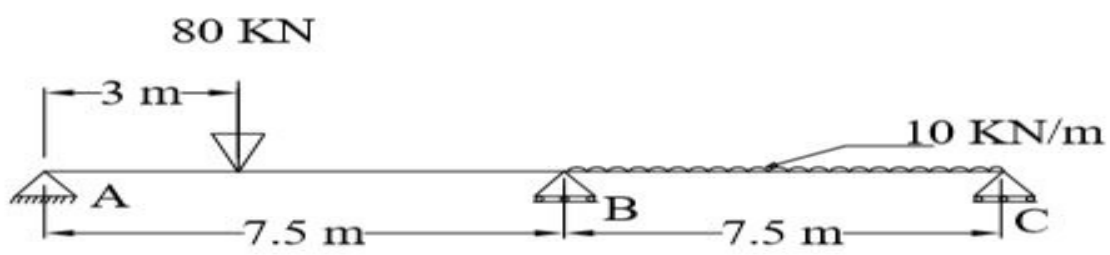

Fig.10

6 + 6 =12

7. (a) Determine the horizontal thrust developed in semi-circular arch of radius R subjected to concentrated load w at the crown shown in Fig.11. [(CO3)(Evaluate/HOCQ)]

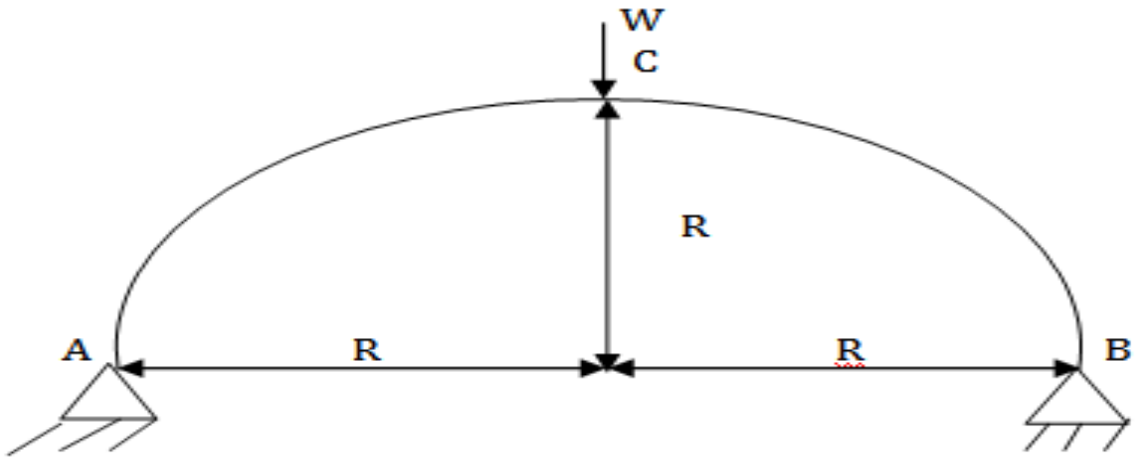

Fig.11

(b) A two hinged parabolic arch shown in Fig.12 has a span of 40 m and a rise of 5 m. Determine the horizontal thrust at the supports and maximum bending moment for the arch under given loading conditions. Assuming secant variation of moment of inertia of the arch section.

[(CO3)(Evaluate/HOCQ)]

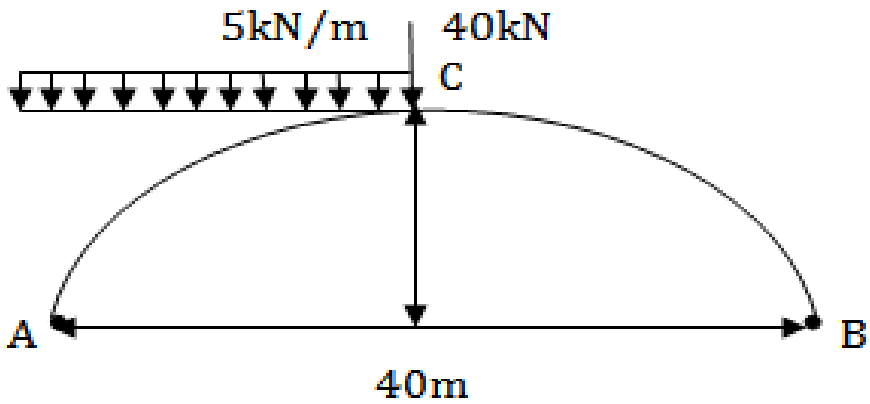

Fig.12

6 + 6 = 12

Group - E

8. Explain Muller Breslau Principle and by using that construct the influence line diagram of the Fig.13 shown below for (i) reaction at A, (ii) reaction at E, (iii) shear force at B and (iv) bending moment at B for the given beam where there is an internal hinge at D. [(CO4)(Remember/LOCQ)]

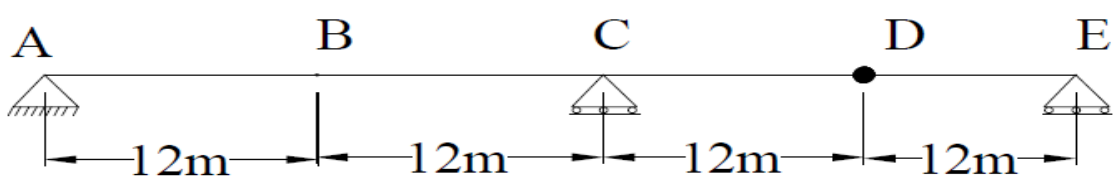

Fig.13

12

9. Draw the influence line diagram for shear force at D in the beam shown in Fig.14 after computing the values of the ordinates at 1 m interval. [(CO4)(Evaluate/HOCQ)]

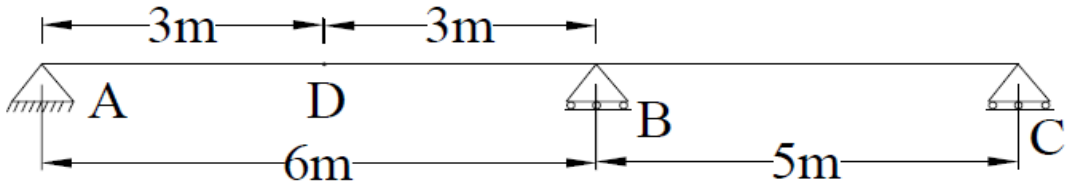

Fig.14

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	12.5	12.5	75.0

Course Outcome (CO):

After going through this course, the 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