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.

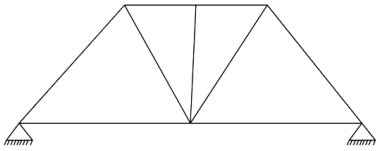
Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

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

(i) The number of independent equations to be satisfied for static equilibrium of a planar structure is
(a) 1 (b) 2 (c) 3 (d) 4.

(ii) The plane truss shown below having total degree of indeterminacy:



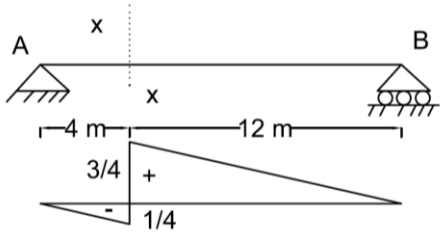
(a) 0 (b) 1 (c) 2 (d) 3.

(iii) The three moments equation is applicable only when
(a) the beam is prismatic
(b) there is no settlement of supports
(c) there is no discontinuity such as hinges within the span
(d) the spans are equal.

(iv) The deflection at any point of a frame can be obtained by applying a unit load at the joint in
(a) vertical direction
(b) horizontal direction
(c) inclined direction
(d) the direction in which the deflection is required.

(v) Bending moment at any section in a conjugate beam gives in the actual beam
(a) slope (b) curvature
(c) deflection (d) bending moment.

(vi) The influence line for shear at section x-x(Fx) at a distance of 4 m from the left support of a simply supported girder AB is shown in the figure. The shear force at section x-x due to a uniformly distributed dead load of intensity 2 t/m covering the entire span will be



(a) 8t (b) 4t (c) 2t (d) 1t

(vii) A symmetrical two-hinged parabolic arch when subjected to a uniformly distributed load on the entire horizontal span, is subject to
(a) radial shear alone
(b) normal thrust alone
(c) normal thrust and bending moment
(d) normal thrust, radial shear and bending moment.

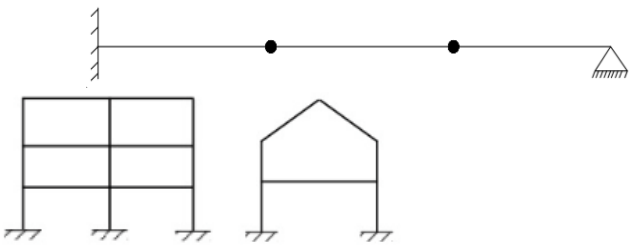
(viii) Castigliano's theorem for deflection i.e. $\frac{\partial u}{\partial P} = \delta$ (deflection) is true for
(a) linearly elastic structure (b) rigid structure
(c) non-linearly elastic structure (d) any structure.

(ix) The Muller-Breslau principle can be used to
(i) determine the shape of the influence line
(ii) indicate the parts of the structure to be loaded to obtain the maximum effect
(iii) calculate the ordinates of the influence lines
The correct answer is
(a) only (i) (b) both (i) and (ii)
(c) both (ii) and (iii) (d) all (i), (ii) and (iii)

(x) When a uniformly distributed load, longer than the span of the girder, moves from left to right, then the maximum bending moment at mid section of span occurs when the 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.

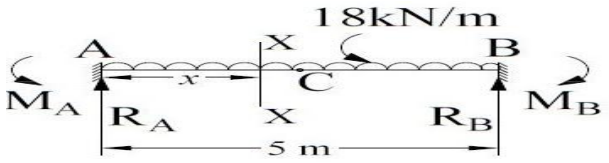
Group- B

2. (a) Determine the stability, determinancy or indeterminancy of the structures shown in the figure below:



[(CO1)Analyze/IOCQ]

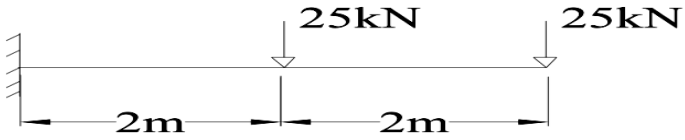
(b) Evaluate the fixed-end moment M_A of a fixed beam shown in the figure by Castigliano's 1st theorm. EI is constant.



[(CO2)Evaluate/HOCQ]

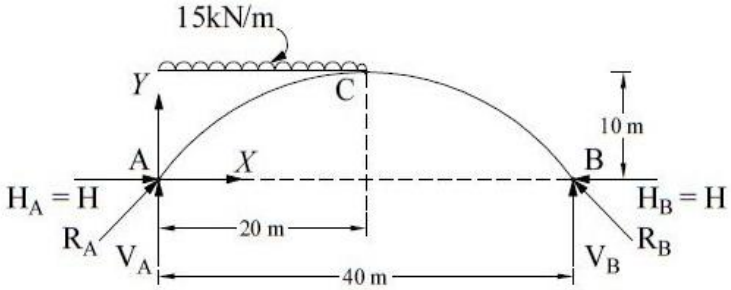
6 + 6 = 12

3. (a) Determine the deflection and rotation at the free end of the cantilever beam given in the figure using unit load method.



[(CO2)Analyze/IOCQ]

(b) A three hinged arch shown in the figure has a span of 30 m and a rise of 10 m. The arch carries an udl of 15 kN/m at half of the span. Determine horizontal thrust at each support.

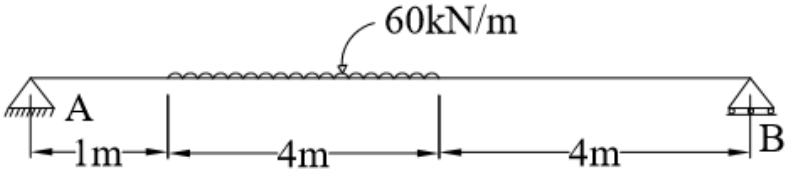


[(CO3)Evaluate/HOCQ]

6 + 6 = 12

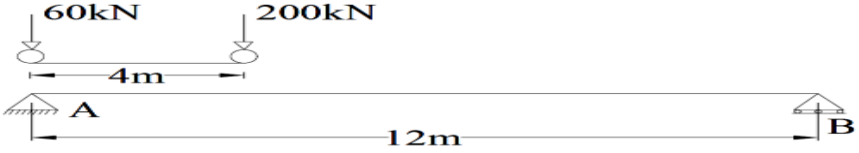
Group - C

4. (a) Calculate the reaction at B using the influence line diagram under the given loading shown in the figure below.



[(CO4)(Remember/LOCQ)]

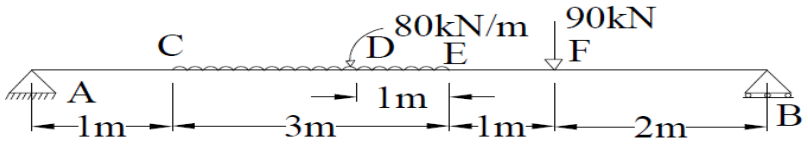
(b) Locate the position of live wheel load (one wheel load of 60 kN and another of 200 kN 4 m apart) on the simply supported beam of span 12 m given in the figure below and calculate the maximum value of the reaction at B.



[(CO4)(Understand/LOCQ)]

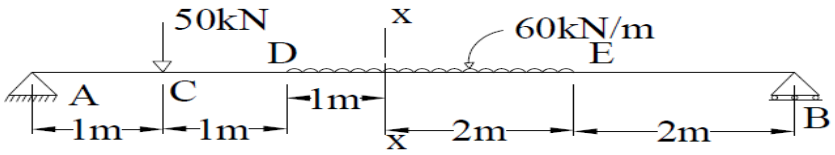
6 + 6 = 12

5. (a) Calculate the shear force at D (point D is 1 m from E) of the given beam shown in the figure using the influence line diagram under the given set of loading (udl of 80 kN/m and a concentrated load of 90 kN).



[(CO4)(Remember/LOCQ)]

(b) Calculate the bending moment at section x-x of the given beam shown in the figure using the influence line diagram under the given set of loading.

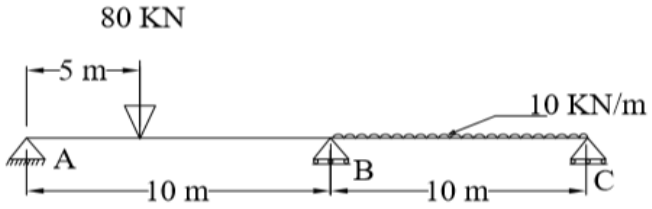


[(CO4)(Remember/LOCQ)]

6 + 6 = 12

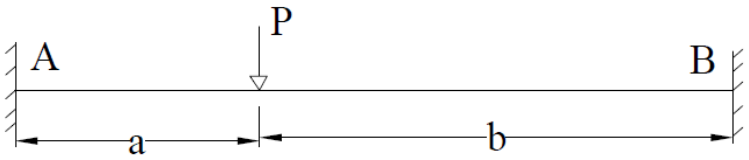
Group – D

6. (a) A continuous beam ABC shown in the figure, 20 m long is carried on supports at its end and is propped at the same level at points 10 m from left end A. It carries a concentrated load of 80 kN at 5m from A and uniformly distributed load of 10 kN/m run over the span BC. If the support B sinks by 2 mm below A and C Find the B.M. and the reactions at the three supports using three-moment equations. Assume moment of inertia of the whole beam, I = 85 × 10^6 mm^4; and E = 2.1 × 10^5 N/mm^2.



[(CO5)(Evaluate/HOCQ)]

(b) Calculate the moment at joint A shown in the figure below by using the consistent deformation method.



[(CO5)(Evaluate/HOCQ)]

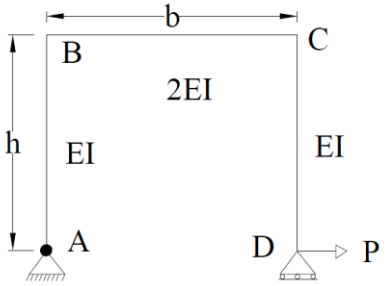
6 + 6 = 12

7. (a) A two-hinged parabolic arch of span l and rise h carries a concentrated load W at the crown. Show that the horizontal thrust equals $\frac{25}{128}\frac{Wl}{h}$, at each support.

[(CO5)(Evaluate/HOCQ)]

(b) A portal frame ABCD shown in the figure, has its end A hinged while the end D is placed on rollers. A horizontal force P is applied on the end D. Determine the

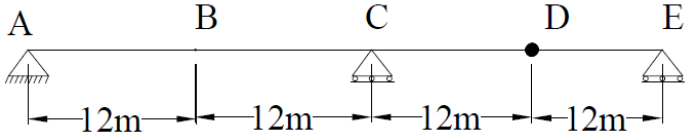
horizontal movement at D by using strain energy. EI of each members are designated along with the members.



[(CO5)(Analyze/IOCQ)]
6 + 6 = 12

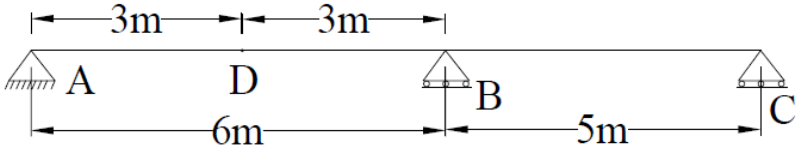
Group - E

8. Explain Muller Breslau Principle and by using that construct the influence line diagram for reaction at A, reaction at E, shear force at B and bending moment at B for the given beam AB shown in the figure, where there is an internal hinge at D.



[(CO5)(Analyze/IOCQ)]
12

9. Draw the influence line diagram for shear force at D in the beam shown in the figure after computing the values of the ordinates at 1 m interval.



[(CO4,CO5)(Evaluate/HOCQ)]
12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	31.25	43.75

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