ANALYSIS OF STRUCTURES 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) Castigliano's theorem for deflection is true for
(a) linearly elastic structure (b) rigid structure
(c) non linearly elastic structure (d) any structure.

(iii) Arch is a
(a) one dimensional structure (b) two dimensional structure
(c) three dimensional structure (d) flexible structure.

(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) 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) head of the load reaches the section
(b) tail of the load reaches the section
(c) the load position should be such that the section divides it equally on both sides
(d) load position should be such that section divides the load in the same ratio as it divides the span.

(vi) A single rolling load of 8 kN along a girder of 15 m spans. The absolute maximum bending moment will be
(a) 8 kN.m (b) 15 kN.m (c) 30 kN.m (d) 60 kN.m

(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) 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.

(x) If in a pin-jointed plane truss (m + r) > 2j, then the truss is (Where 'm', 'r' and 'j' are standard notations)
(a) stable and statically determinate (b) stable and statically indeterminate
(c) unstable (d) internally stable but externally unstable.

Group – B

2. (a) Compute the kinematic indeterminacy of the following structures as shown in Fig.1(a), 1(b), 1(c). Consider extensibility of the member.

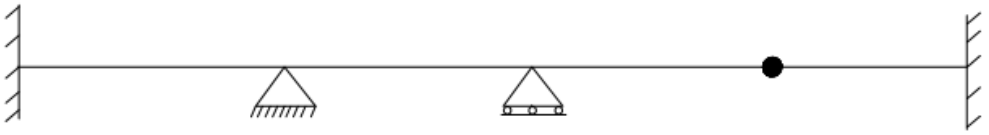

Fig.1(a)

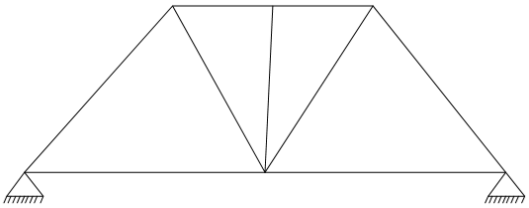

Fig.1(b)

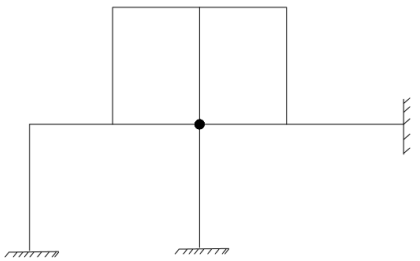

Fig.1(c)

(b) Analyse the following portal frame as shown in Fig.2 and draw the bending moment diagram of the frame.

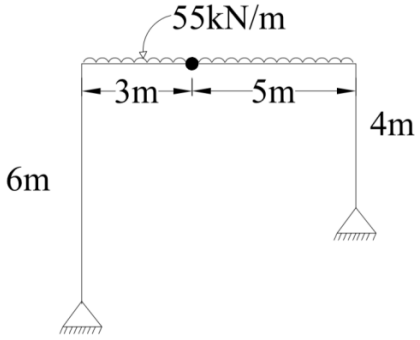

Fig.2

(3 × 2) + 6 = 12

3. (a) Calculate the deflection of joint B as shown in Fig.3 by unit load method.

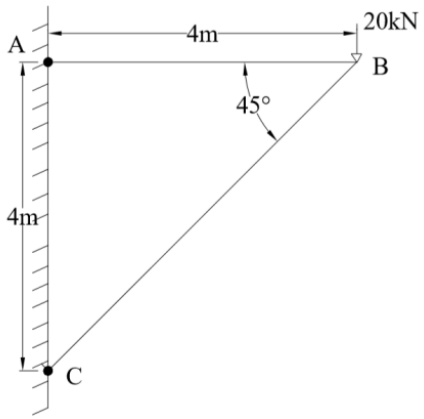

Fig.3

(b) A beam AB 7m long is fixed at A and simply supported at B as shown in Fig.4. It carries a point load of 20kN at a distance 2m from B. Determine the reactions at the support by castigliano's 2nd theorem.

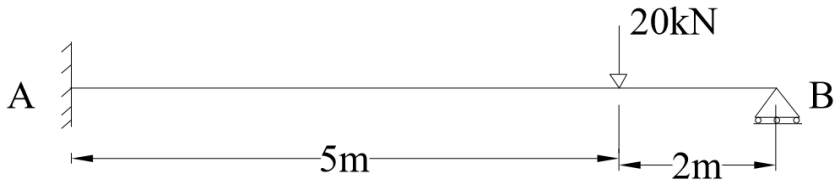

Fig.4

6 + 6 = 12

Group – C

4. Determine the maximum compressive force developed in member *BG* of the given truss (refer Fig.5) due to the right side wheel loads of the car and trailer. Assume the loads are applied directly to the truss and move only to the right.

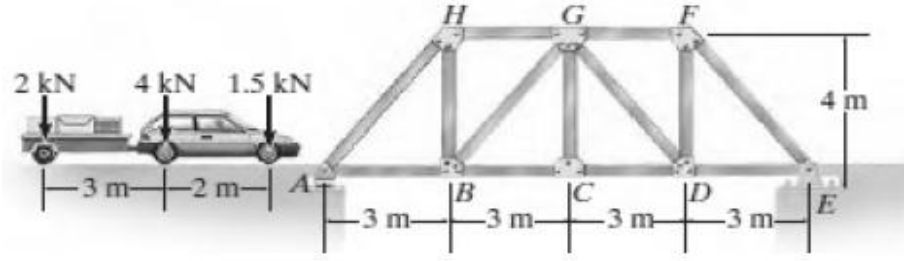

Fig.5

12

5. Determine the absolute maximum bending moment in the beam due to the loading shown (refer Fig.6).

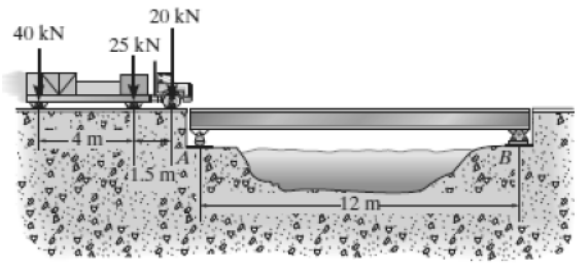

Fig.6

12

Group – D

6. (a) A continuous beam ABC (refer Fig.7), 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 5.0 m 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.

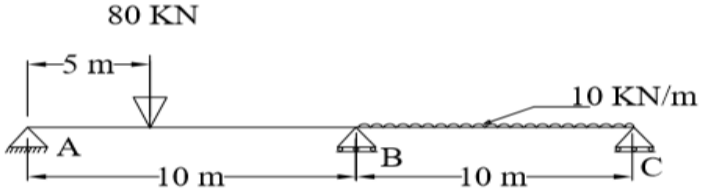

Fig.7

(b) Determine the reaction at the roller support B of the beam as shown in the Fig.8 using method of consistent deformation. Assume EI is constant

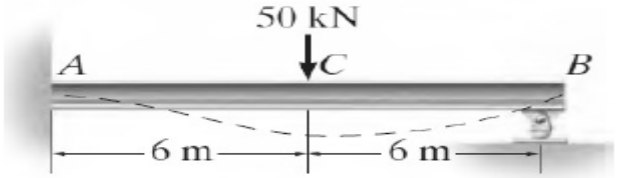

Fig.8

6 + 6 = 12

7. (a) A beam (refer Fig.9) of uniform section and of length 2L is freely supported by rigid supports at its ends and by an elastic prop at its centre. If the prop deflects by an amount λ times the load it carries and if the beam carries a total distributed load of *W* show that the load carried by the prop is $\frac{5W}{g(1+\frac{6EI\lambda}{L^3})}$

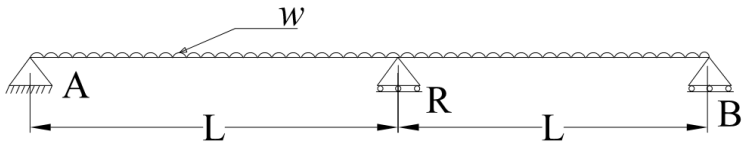

Fig.9

(b) A parabolic two hinged arch (refer Fig.10) has a span of 32 m and a rise of 8 m. A uniformly distributed load of 10 KN/m covers 8m horizontal length of the left side of the arch. If $I=I_0Sec\theta$ where θ is the inclination of the arch of the section to the horizontal, and I_0 is the moment of inertia of the section at the crown, find out the horizontal thrust at hinges and bending moment 8m from the left hinge. Also find the normal thrust and radial shear at this section.

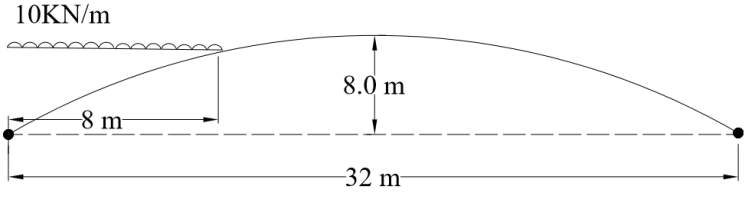

Fig.10

6 + 6 = 12

Group – E

8. Draw the influence line diagram for shear force at D in the beam shown in Fig.11 after computing the values of the ordinates at 1m interval.

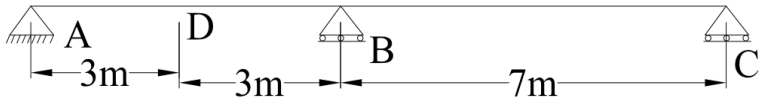

Fig.11

12

9. A two-hinged parabolic arch has a horizontal span of 18m and a central rise of 1.8 m (refer Fig.12). Draw influence line diagrams for (i) Horizontal thrust at support (ii) B.M. at a section 6 m from the left support.

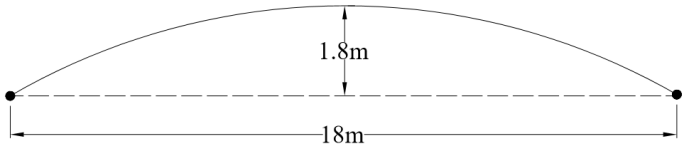

Fig.12

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