NATIONAL EXAMS DECEMBER 2010

98-CIV-B1 ADVANCED STRUCTURAL ANALYSIS

3 HOURS DURATION

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.

2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.

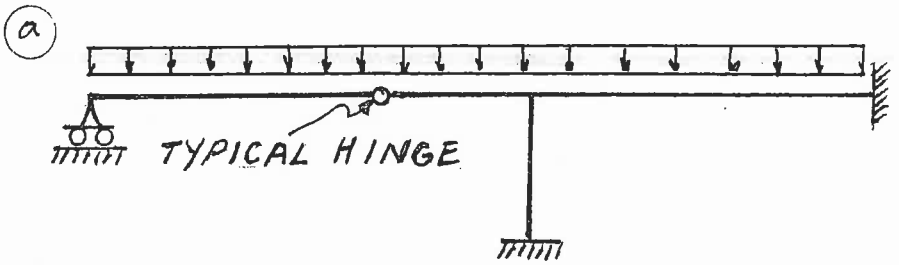
3. Answer BOTH questions #1, and #2. Answer ONLY TWO of questions #3, #4, or #5. Answer ONLY TWO of questions #6, #7 OR #8. SIX questions constitute a complete paper.

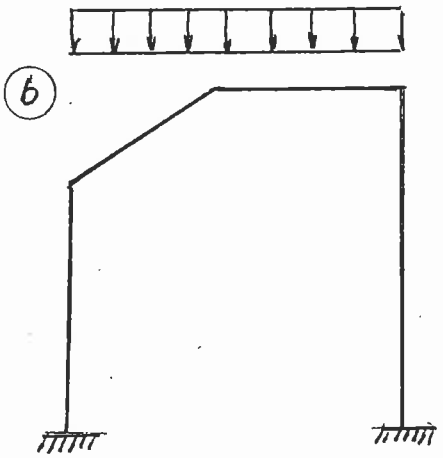
4. The marks assigned to each question are shown in the left margin.

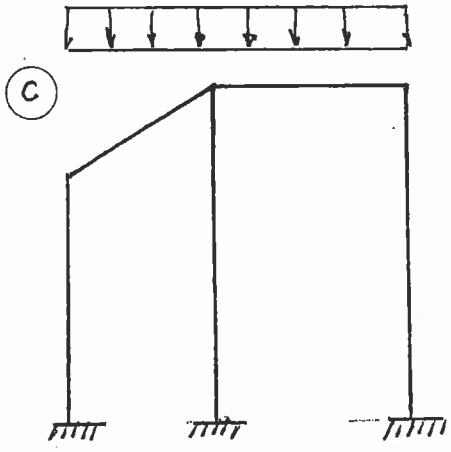
FRONT PAGE

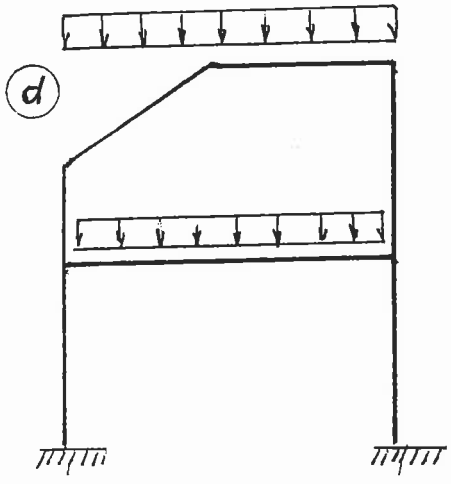
QUESTION #1 MUST BE ANSWERED.

(8) 1. Indicate with arrows (↶ a rotation; → a translation) on each structure and list beside each structure the number of structural degrees of freedom that are required to do an analysis by the slope-defection method. In each case, use the minimum number of structural degrees of freedom; where they occur, take into account symmetry, anti-symmetry and joints that are known to have zero moments.

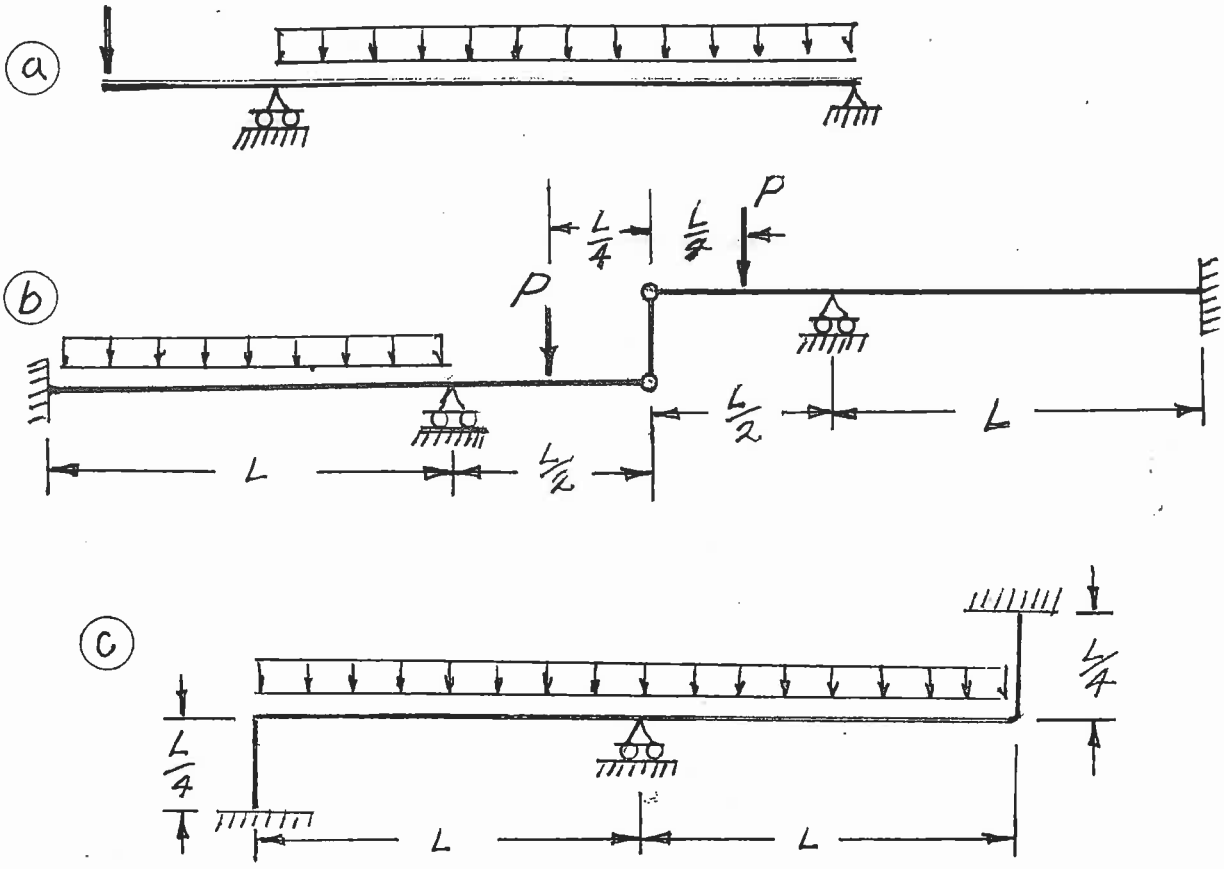






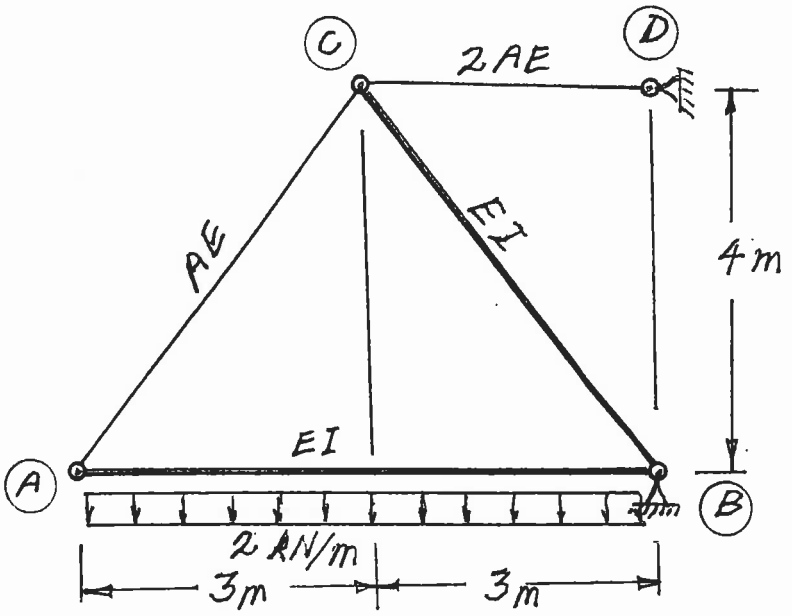


(12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same EI and are inextensible.

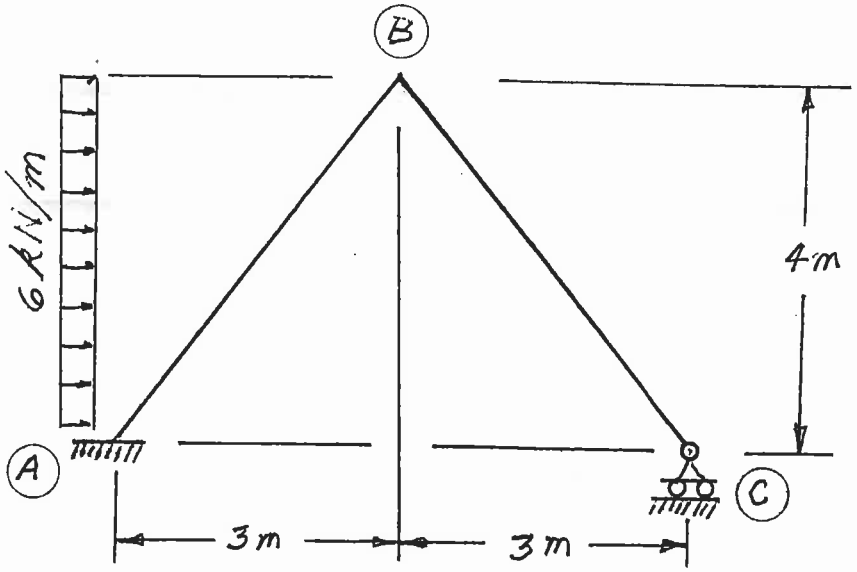


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

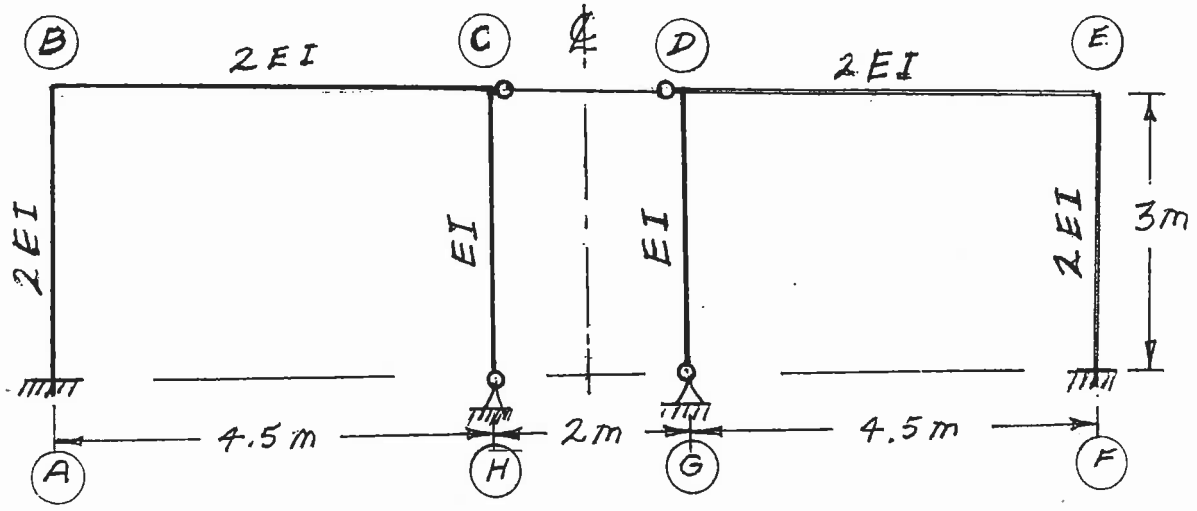
(18) 3. Use Castigliano's theorem to determine the vertical deflection at the mid span of beam Ⓐ–Ⓑ .Beam Ⓐ–Ⓑ is inextensible and has an EI value of 5000 kN.m^2. Strut Ⓒ–Ⓑ is inextensible; the other two tension struts have the relative AE values shown in the sketch where AE = 2500 kN.



(18) 4. Use any **flexibility (force) method**, to analyze the frame structure shown. Draw shear and bending moment diagrams. On both diagrams for each member, indicate the magnitude of maximum and minimum ordinates (Minimum ordinates are frequently negative). Both members have the same EI value and are inextensible.

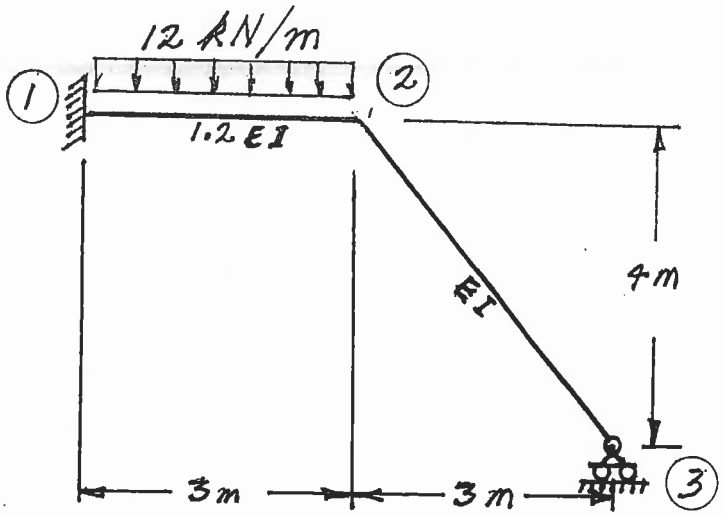


(18) 5. Use the slope-defection method or the moment-distribution method to analyze the frame structure shown. Draw shear and bending moment diagrams. Indicate on both diagrams, for each member, the magnitude of maximum and minimum ordinates (Minimum ordinates are frequently negative). There are no loads on the structure, but member Ⓒ- Ⓓ , the central member, was fabricated 30 mm too long and forced into place. All members of the structure are inextensible and have the relative EI values shown where EI = 2.0×10^4 kN.m^2. Take advantage of symmetry.

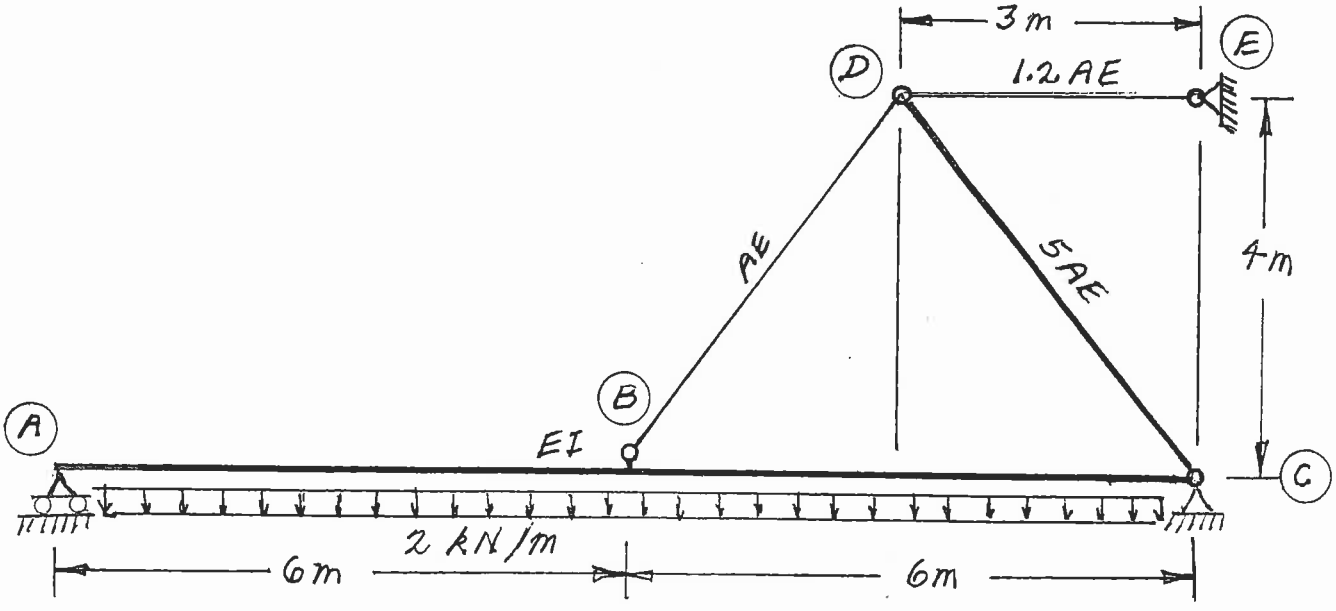


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(22) 6. Using the slope-defection method, analyze the structure shown. Draw shear force and bending moment diagrams. On each diagram for each member, indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). Members have the relative EI values shown and are inextensible.



(22) 7. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Beam Ⓐ – Ⓑ – Ⓒ is continuous, inextensible and has the EI value of 6000 kN.m². The three struts (tension or compression) have the relative AE values shown in the sketch where AE = 5000 kN. Draw shear force and bending moment diagrams for the beam from Ⓐ to Ⓒ. On both diagrams, label the maximum and minimum ordinates (Minimum ordinates are frequently negative).



(22) 8. a) For the frame shown, derive the equilibrium equation for the translation shown at joint ③. Neglect the effects of axial strain. EI has the same value for all members.

b) Derive the equilibrium equations for moment equilibrium at joints ② and ③.

c) Present your results in matrix form by giving the terms of the stiffness matrix [K] and the load vector {P} in the following equation:

$$[K]\begin{Bmatrix}\delta\\ \theta_2\\ \theta_3\end{Bmatrix} = \{P\}$$

DO NOT SOLVE THE EQUATIONS.

The unknowns of the problem shall be:

δ = translation at joint ③ (positive in direction shown)

θ_2 = rotation of joint ②

θ_3 = rotation of joint ③

} (counter clockwise positive)