NATIONAL EXAMS DECEMBER 2011

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.

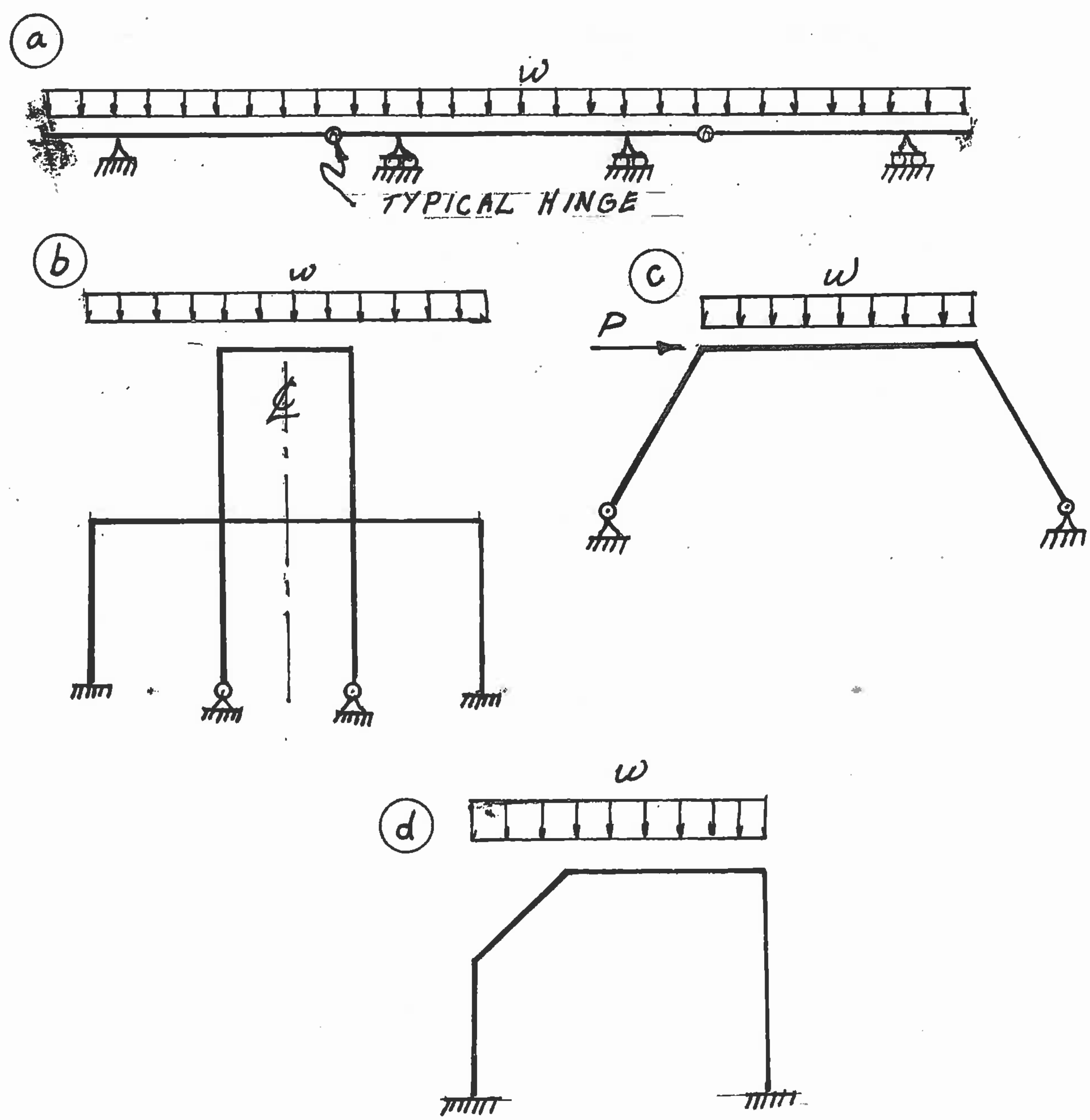
2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.

3. Answer BOTH Questions #1, and #2. Answer ONLY TWO of Questions #3, #4, or #5. Answer ONLY TWO of Questions #6, #7, #8 OR #9. SIX Questions constitute a complete paper.

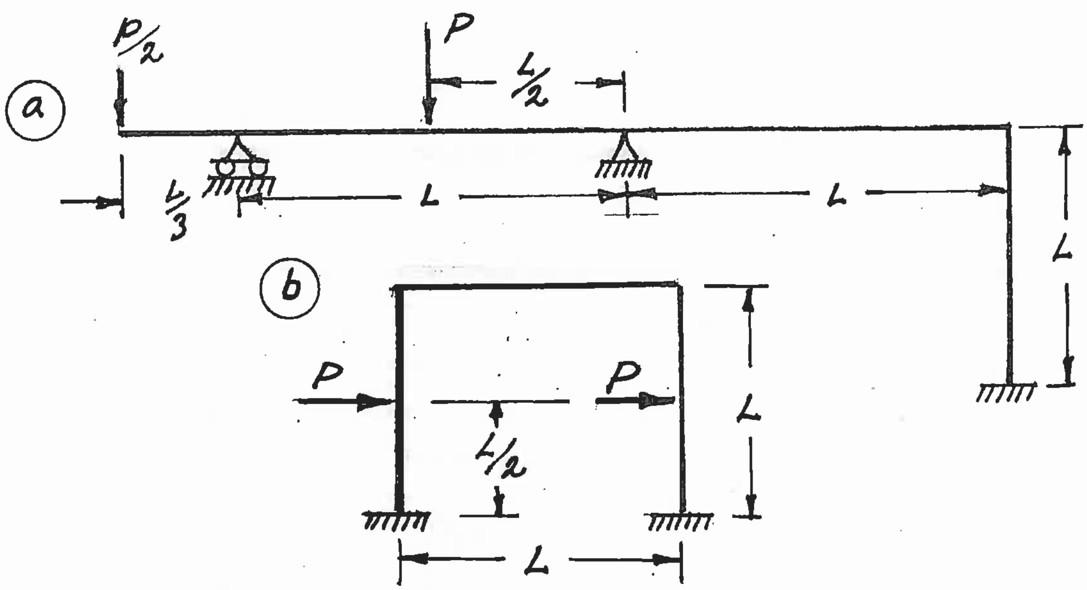
4. The marks assigned to each question are shown in the left margin.

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.

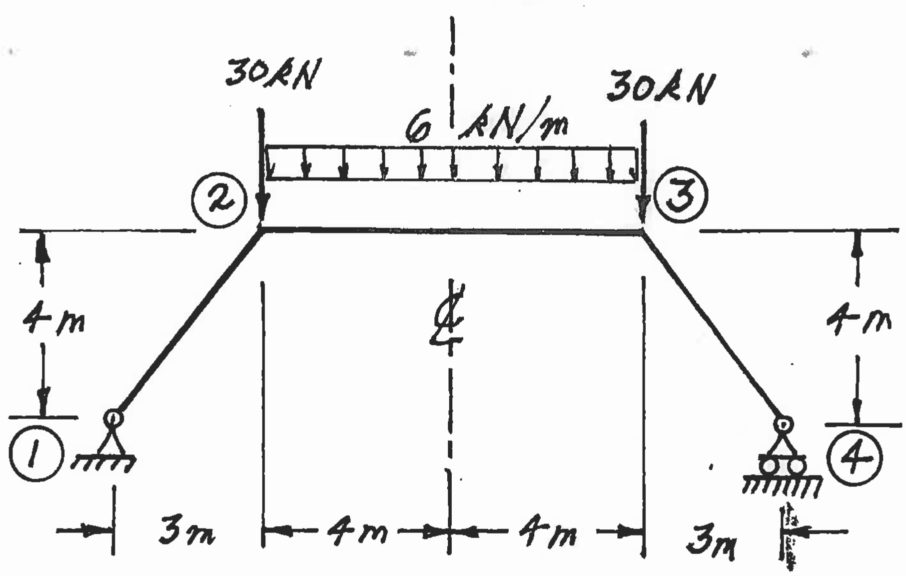


(12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same EI and are inextensible.

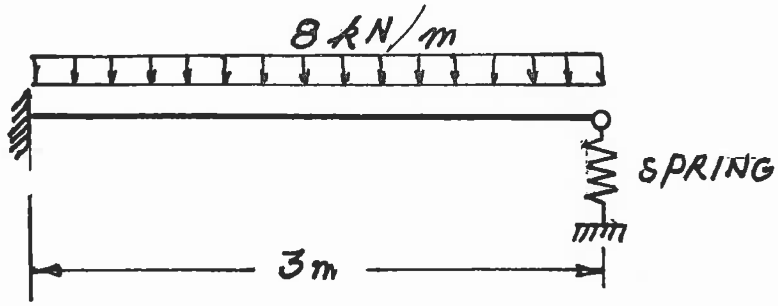


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

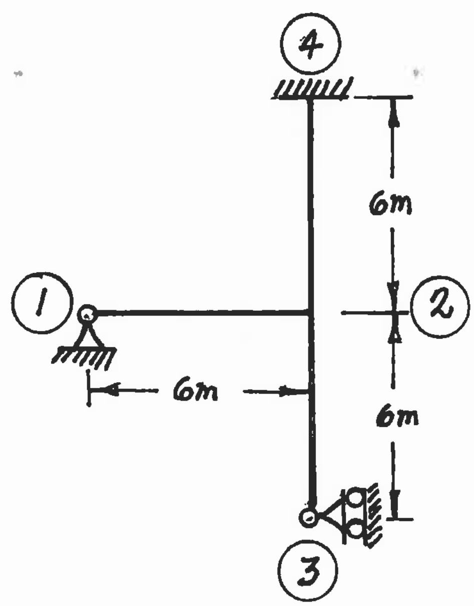
(16) 3. Use Castigliano's theorem to determine the horizontal displacement at joint (4) of the frame shown below. Take advantage of symmetry. All members have the same EI which is 2.0 x 10^5 kN.mm^2 and the members are inextensible.



(16) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Calculate the maximum absolute value of bending moment and shear on the beam. The beam has an EI = 9.0×10^4 kN.m^2. The spring has a stiffness of 2.0×10^4kN/m.

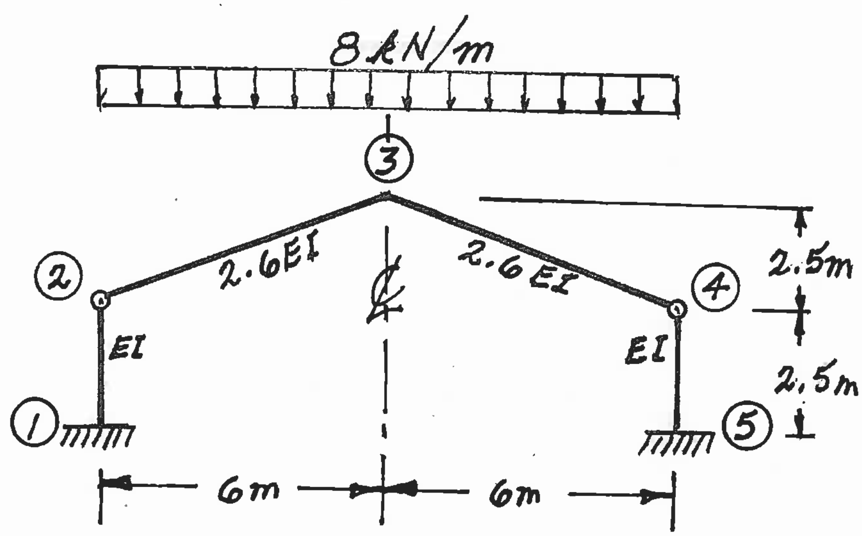


(16) 5. Use the slope-defection method or the moment-distribution method to analyze the frame structure shown. Draw shear and bending moment diagrams. Indicate on both diagrams the magnitude of maximum and minimum ordinates (Minimum ordinates are frequently negative values). There are no loads on the structure, but member(2)-(4) was fabricated 0.024 m too long and the member was forced into place. All members of the structure have the same EI value which is 5.0×10^4 kN.m^2.

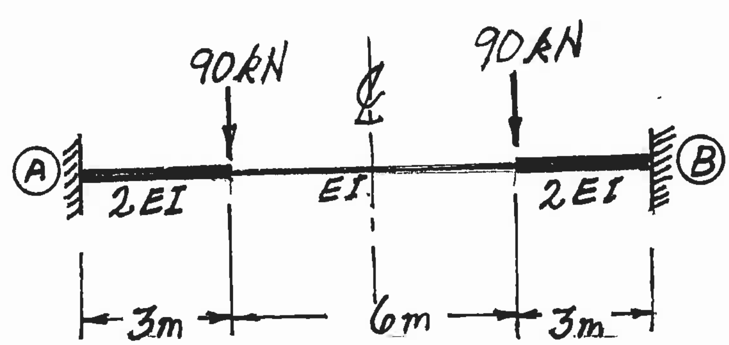


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(24) 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). Members have the relative EI values shown on the diagram and are inextensible. Take advantage of symmetry to simplify your work.

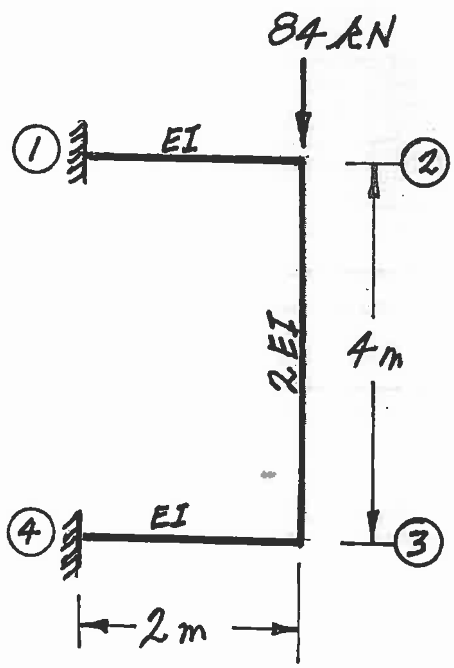


(24) 7. Using a flexibility (force) method, determine the fixed-end moments for the ends of the fixed-ended, non-prismatic beam shown below. Take advantage of symmetry to simplify your work.



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

(24) 8. Using the slope-defection method or the moment-distribution method, analyze the structure shown below. Take advantage of symmetry or anti-symmetry. Plot shear force and bending moment diagrams. On each diagram for each member, indicate the magnitude of the maximum and minimum ordinates (Minimum ordinates are frequently negative). All members are inextensible and have the relative EI values shown on the diagram.



(24) 9. a) For the frame shown, derive the equilibrium equation for the translation shown at joint (2). Neglect the effects of axial strain. The members have the relative EI values shown on the diagram.

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 (2) (positive in direction shown)

θ_2 = rotation of joint (2)

(counter clockwise positive)

θ_3 = rotation of joint (3)