NATIONAL EXAMS MAY 2013

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.

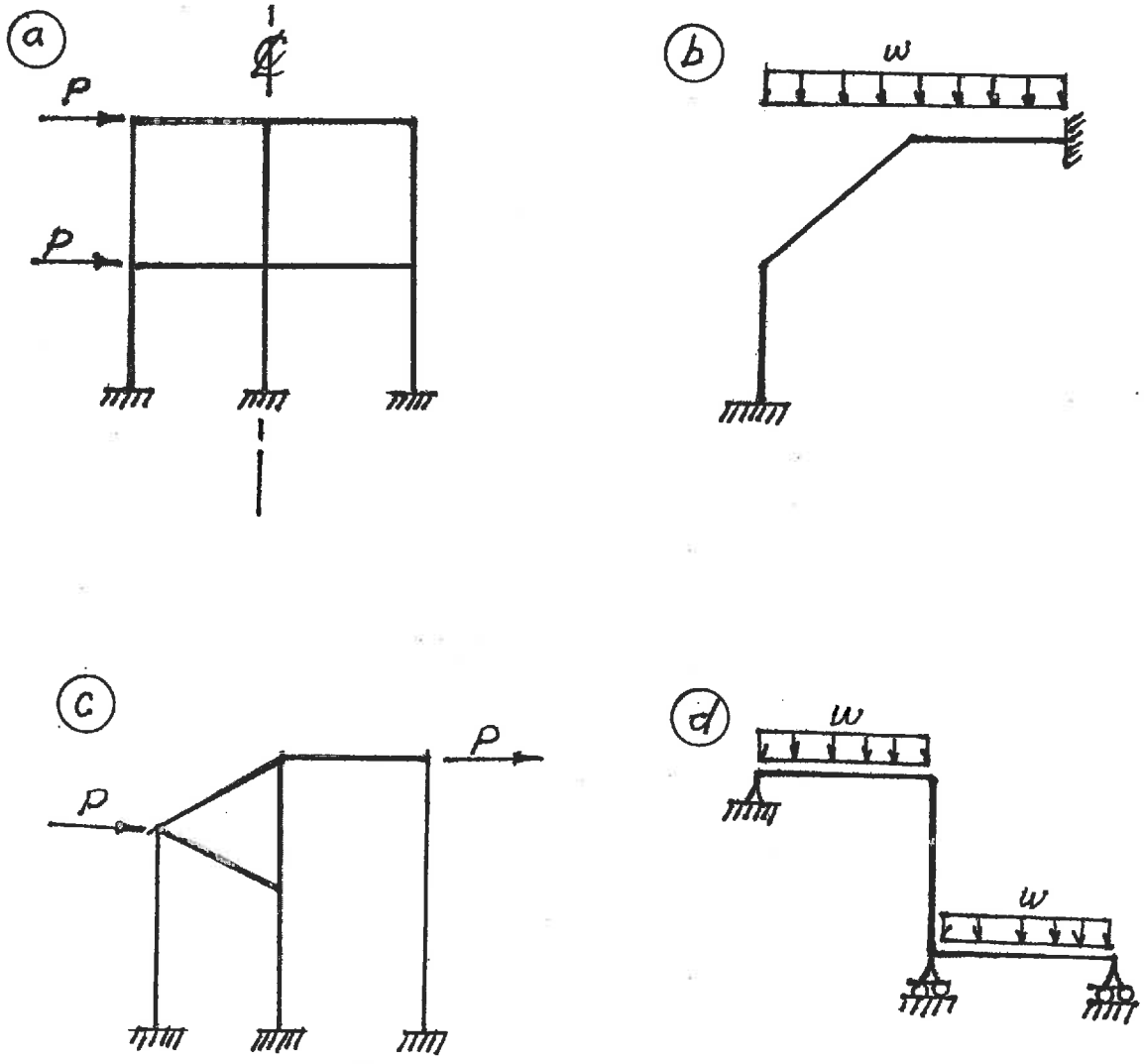
3. Answer BOTH questions #1, and #2. Answer ONLY TWO of questions #3, #4, or #5. Answer ONLY TWO of questions #6, #7, #8 OR #9. SIX questions constitute a complete paper.

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

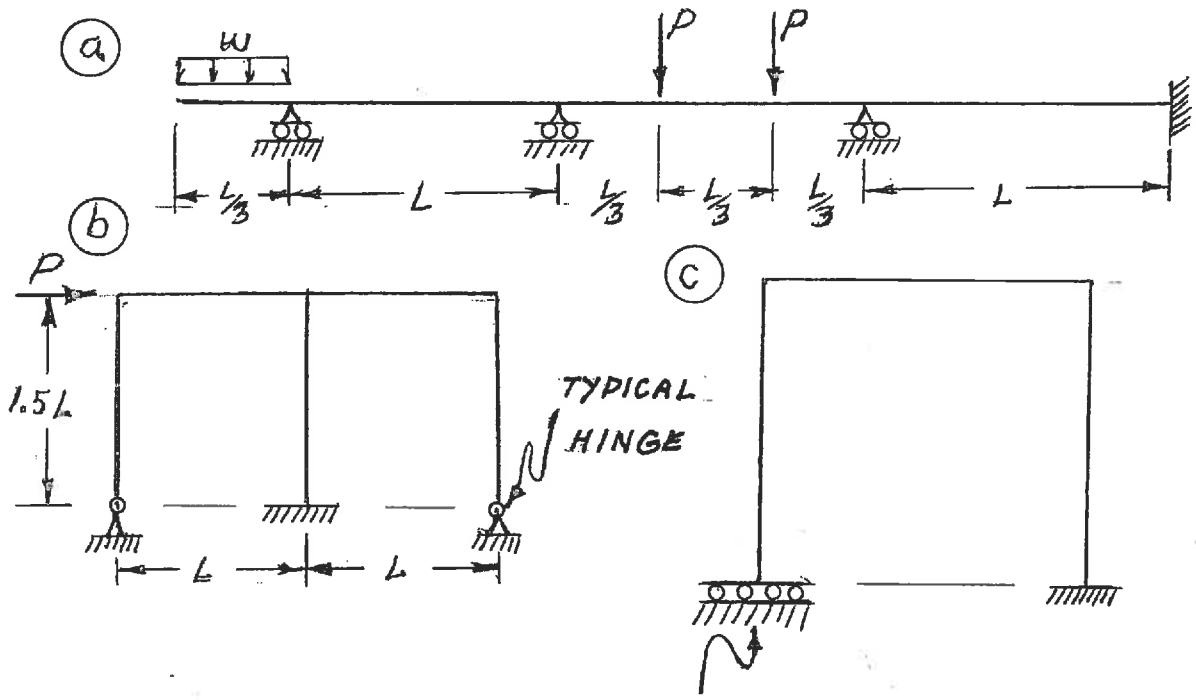
FRONT PAGE

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.

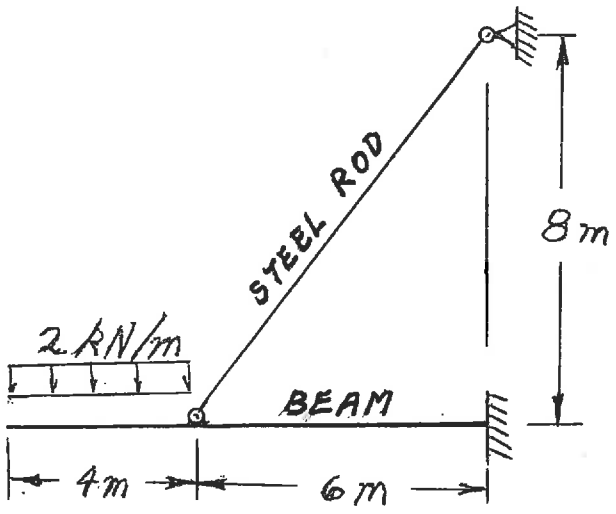


(12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same EI and are inextensible.



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

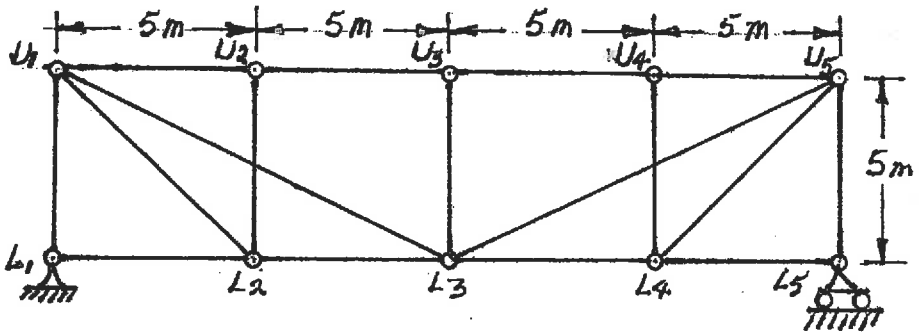
(16) 3. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Calculate the maximum bending moment and shear in the beam; plot shear and bending moment diagrams for the beam. The beam has $EI = 1.44 \times 10^4$ kN.m^2 and is inextensible. The steel rod has $EA = 1.25 \times 10^4$ kN.



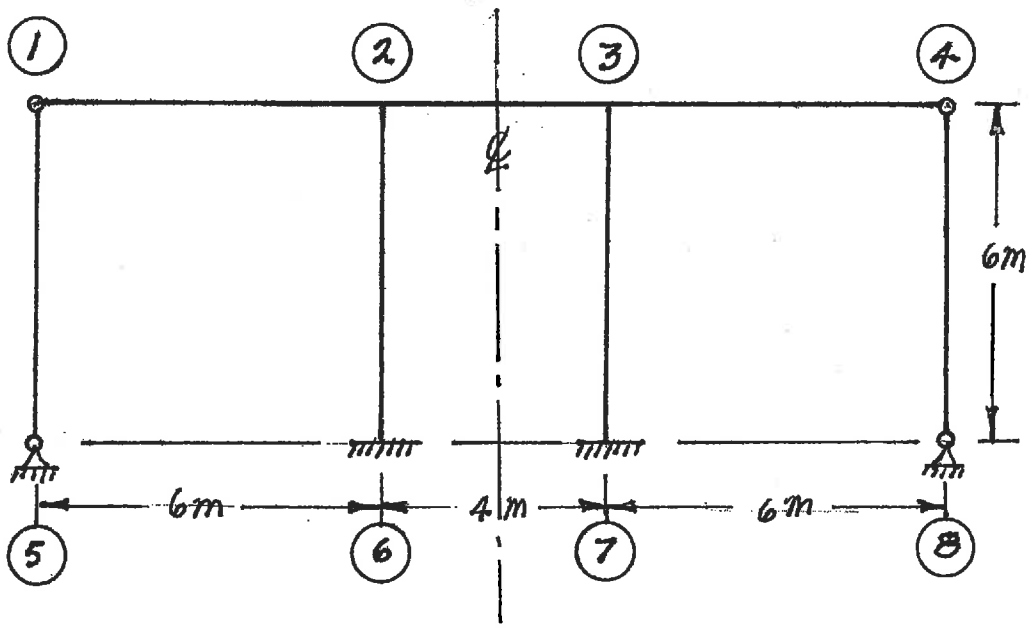
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

(16) 4. Loads are applied to the top chord of the pin-jointed truss shown below. Members U_1L_3 and U_2L_2 are not connected; similarly, L_3U_5 and U_4L_4 are not connected. Draw influence lines for forces in the following members and calculate and indicate the maximum and minimum ordinates on the influence lines:

a) U_1L_2
b) U_1L_3
c) L_2L_3

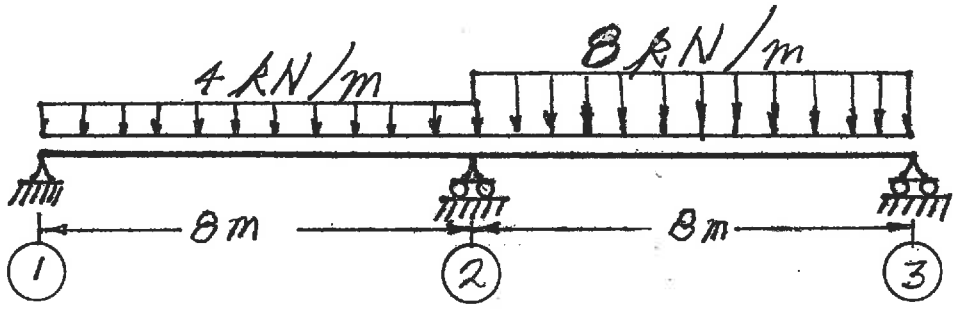


(16) 5. Use the slope-defection method to analyze the frame structure shown. Draw shear and bending moment diagrams. Indicate on both diagrams the magnitude of maximum and minimum ordinates. There are no loads on the structure, but pin-ended columns ①–⑤ and ④–⑧ were both fabricated 0.048 m too long; the columns were forced into place. All members of the structure have the same EI value that is 5.0×10^4 kN.m^2 and all members are inextensible.

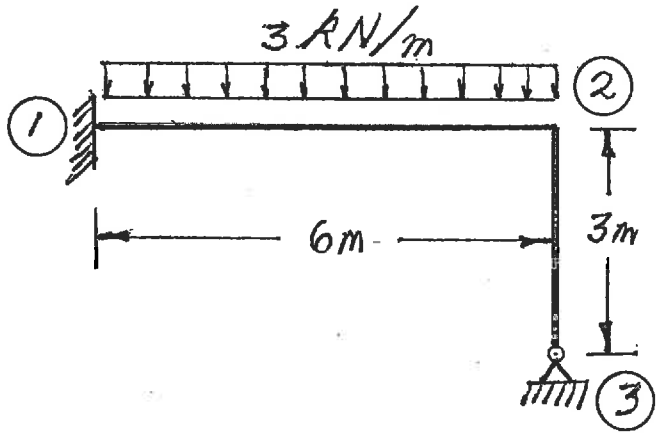


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(24) 6. Using the slope-defection method or the moment-distribution method, analyze the two-span beam shown. In addition to the effects of the loading shown, stresses and strains are caused because the central support is 64 mm below the elevation of the two end supports. Draw shear force and bending moment diagrams. For each diagram and both beams, calculate and indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). The continuous beam is straight and inextensible; it has EI = 2.0×10^4 kN.m^2 .

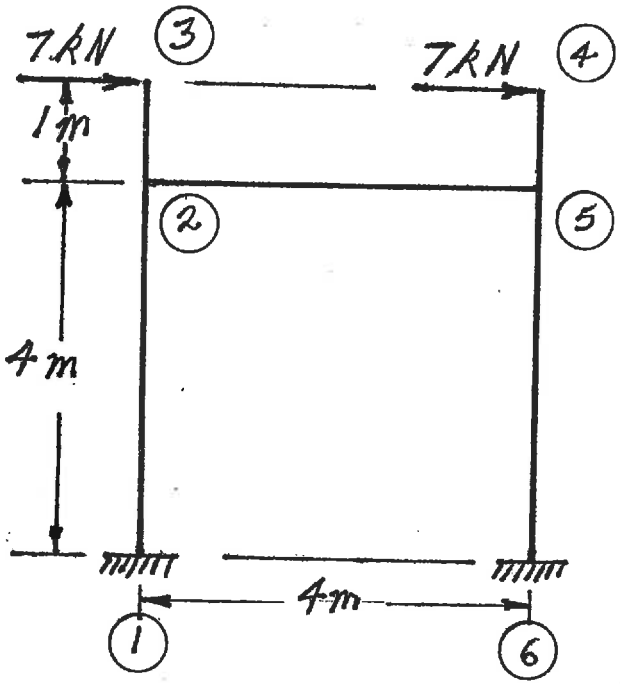


(24) 7. Using a **flexibility (force) method**, analyze the frame structure shown. Both members have the same EI value and are inextensible. Draw shear force and bending moment diagrams. For each diagram and both members, calculate and indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative values).



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

(24) 8. Using the slope-defection method, analyze the frame structure shown below. Plot shear force and bending moment diagrams. For each member on each diagram, calculate and indicate the magnitude of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members are inextensible and have the same EI value. Sidesway is **not** prevented.



(24) 9. a) For the frame shown, derive the equilibrium equation for translation at joint (2). Neglect the effects of axial strain. All members have the same EI value.

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 the direction shown)

θ_2 = rotation of joint (2)

θ_3 = rotation of joint (3)

(counter clockwise positive)