NATIONAL EXAMS DECEMBER 2012

07-Str-A4 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.

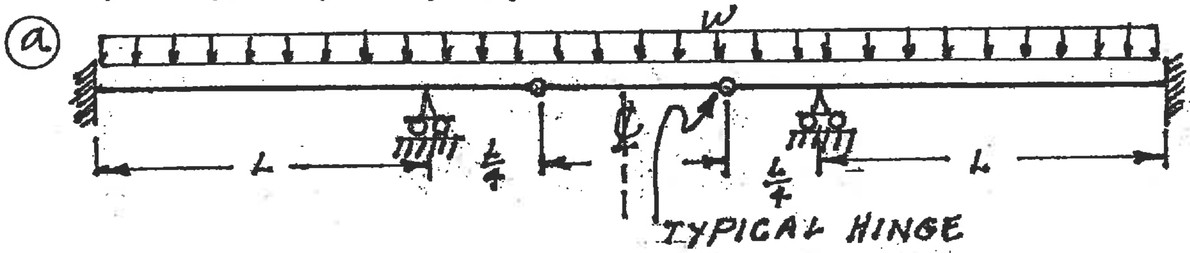
2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.

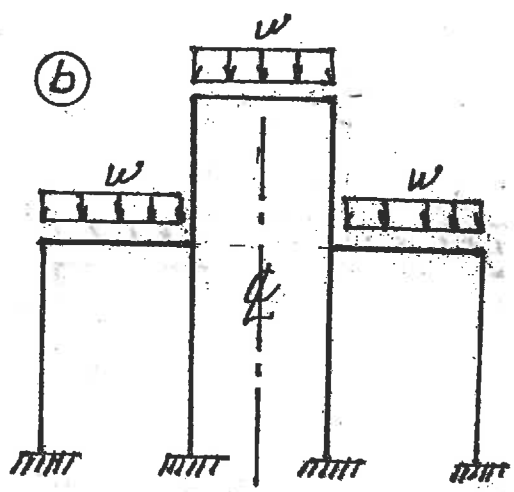
3. Answer BOTH questions #1, and #2. Answer ONLY TWO of questions #3, #4, or #5. Answer ONLY TWO of questions #6, #7, #8 OR #9. SIX questions constitute a complete paper.

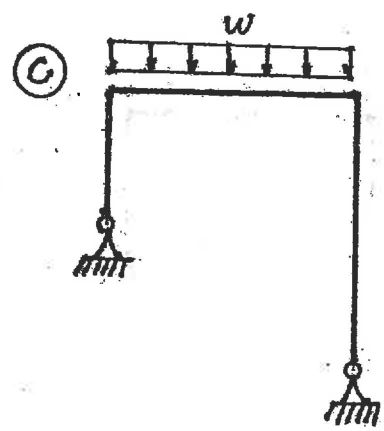
4. The marks assigned to each question are shown in the left margin.

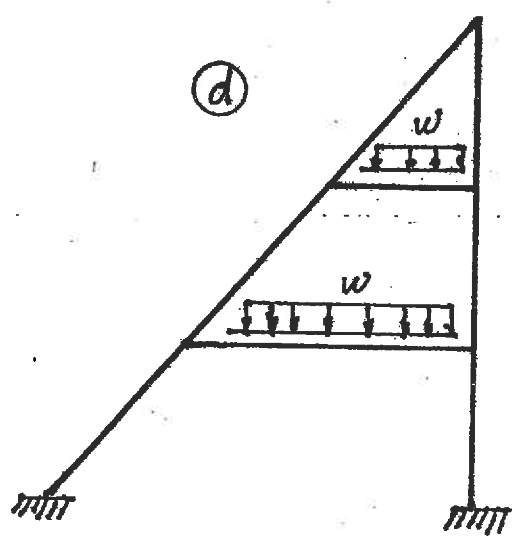
QUESTION #1 MUST BE ANSWERED.

(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.

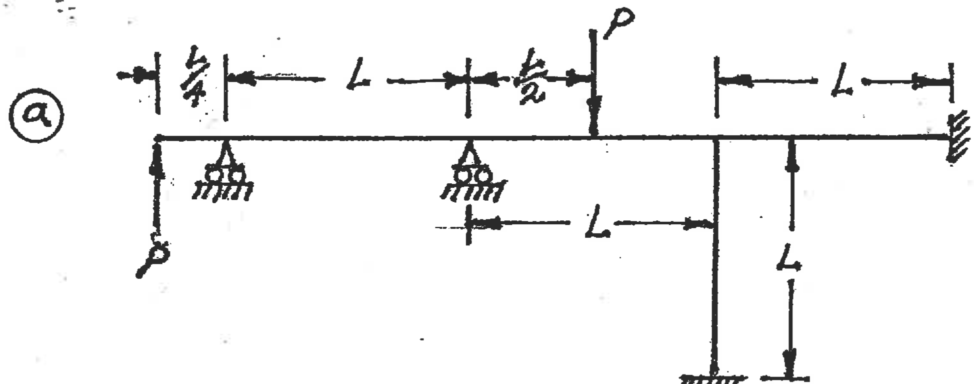


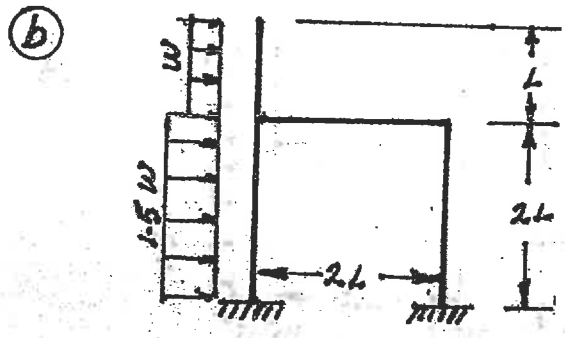






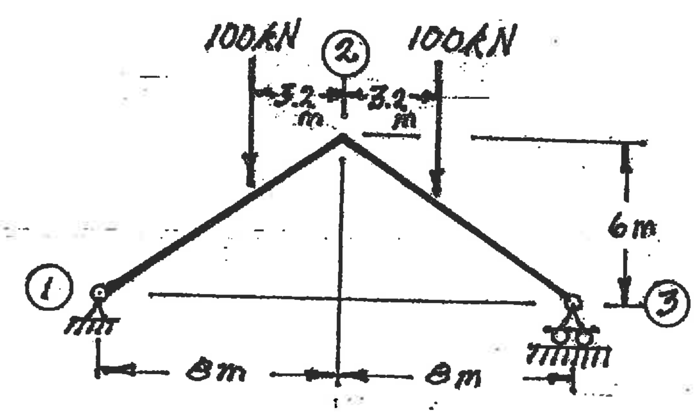
(12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same EI and are inextensible.



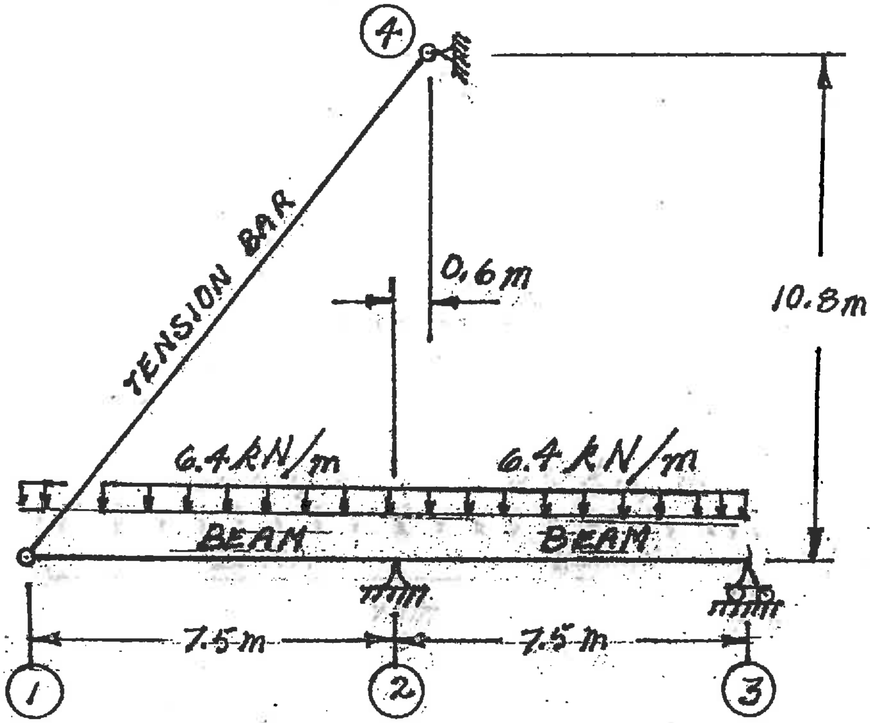


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

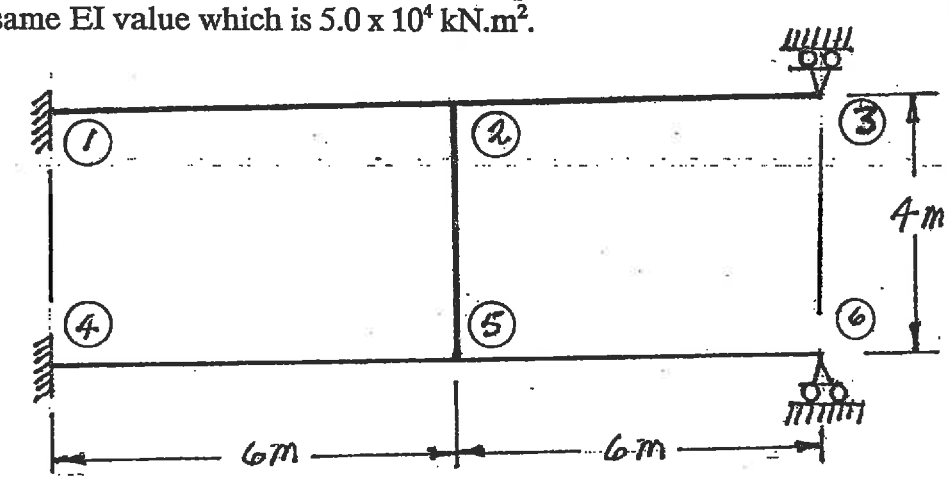
(16) 3. Use Castigliano's theorem to determine the vertical deflection at joint (2) of the frame shown below. The EI value for both members is 4.4×10^5 kN.m^2. Both members are inextensible.



(16) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Calculate the maximum and minimum bending moments on the beams (Minimum moments are frequently negative values). The beams have EI = 1.0×10^5 kN.m^2. and are inextensible. The tension bar has EA= 5.0×10^3 kN.

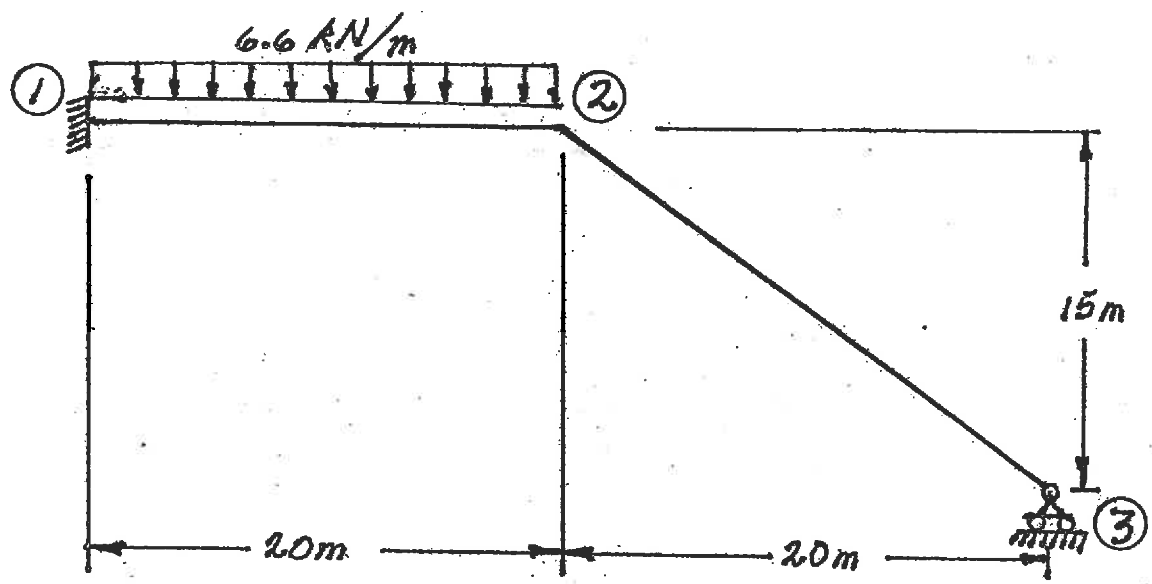


(16) 5. Use the slope-defection method to analyze the frame structure shown. Draw shear and bending moment diagrams. Indicate on both diagrams the magnitude of maximum and minimum ordinates (Minimum ordinates are frequently negative values). There are no loads on the structure, but member ②–⑤ was fabricated 0.048 m too long; 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.

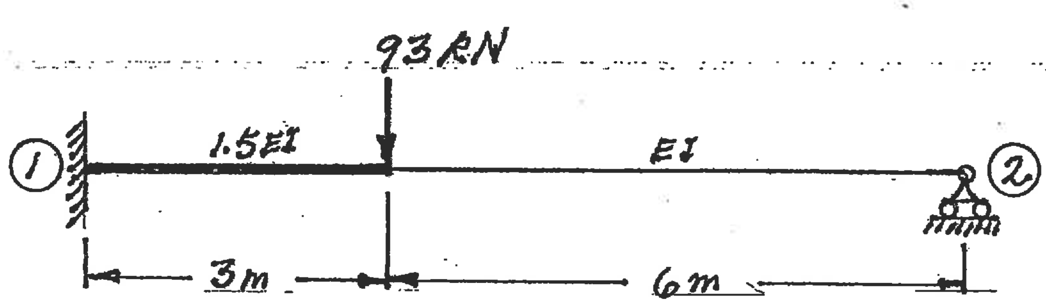


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(24) 6. Using the slope-defection method or the moment-distribution method, analyze the structure shown. Draw shear force and bending moment diagrams. On each diagram indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). Both members have the same EI and are inextensible.

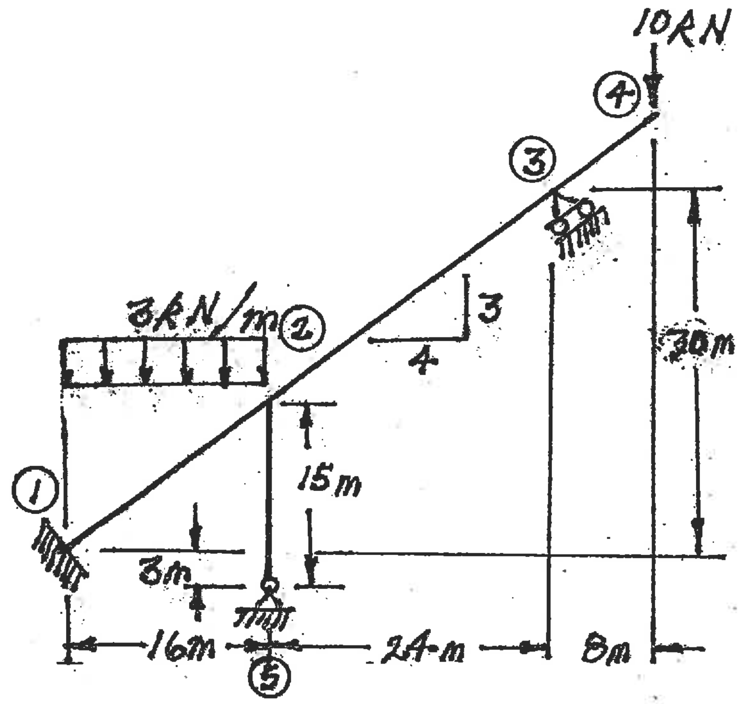


(24) 7. Using a flexibility (force) method, determine the moment at the left end of the fixed-ended, non-prismatic beam shown below.



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. Plot shear force and bending moment diagrams. For each member on each diagram, 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.



(24) 9. a) For the frame shown, derive the equilibrium equation for horizontal motion at joint ②. 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 ② (positive to the left)

θ_2 = rotation of joint ② } (counter clockwise positive)

θ_3 = rotation of joint ③