NATIONAL EXAMS DECEMBER 2009

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.

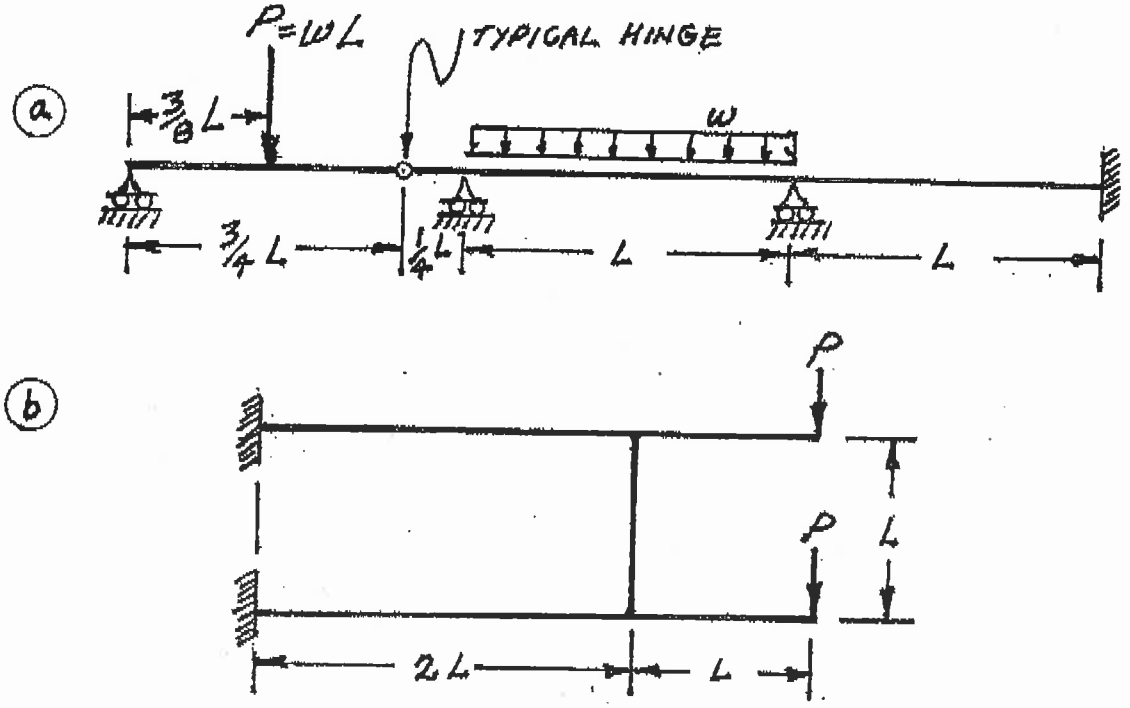
3. Answer BOTH questions #1, and #2. Answer ONLY TWO of questions #3, #4, or #5. Answer ONLY TWO of questions #6, #7, #8 OR #9. SIX questions constitute a complete paper.

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

FRONT PAGE

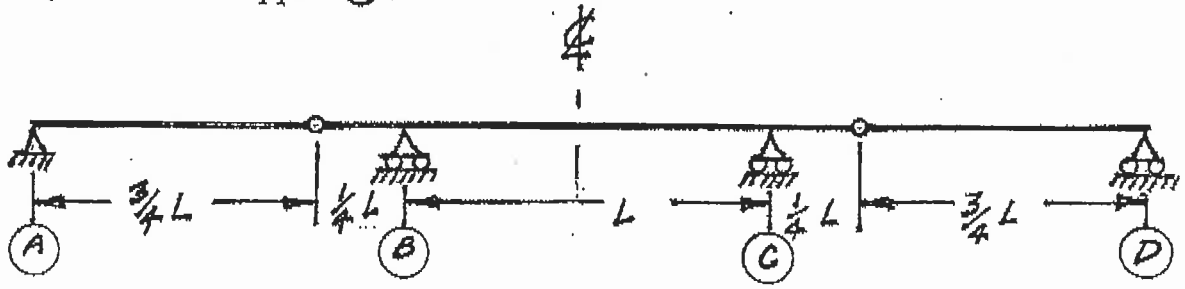
QUESTIONS #1 AND #2 MUST BE ANSWERED.

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



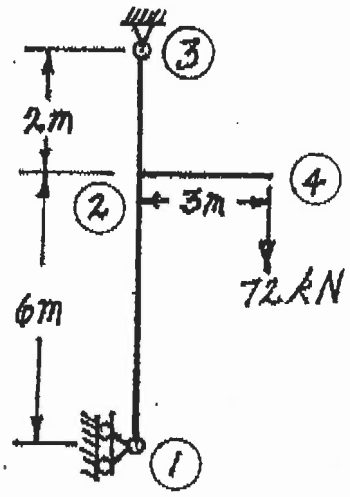
(12) 2. For the beam structure shown below, schematically show the influence lines for the bending moment, shear and reaction listed below as a), b) and c) respectively. For each influence line, calculate and indicate the magnitude of the ordinate with the maximum absolute value.

a) Bending moment at mid span of span Ⓑ – Ⓒ.
b) Shear force immediately left of support Ⓑ.
c) Reaction at support Ⓑ.

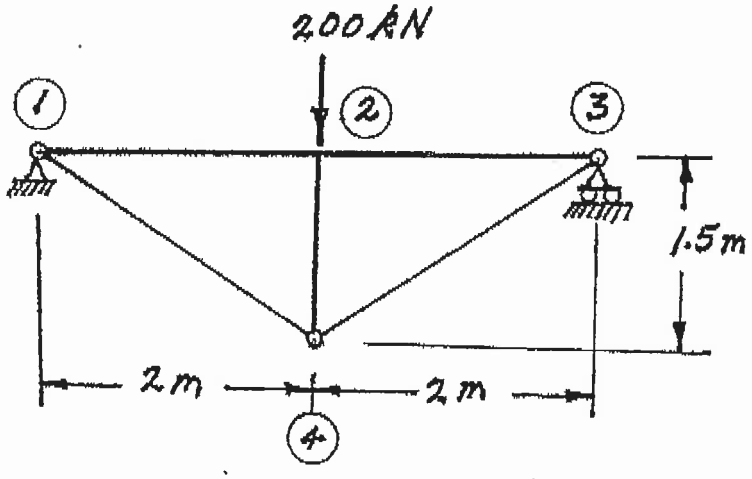


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5.

(18) 3. Use Castigliano's theorem to determine the horizontal deflection at joint (2) of the beam structure shown. The EI value for all members is 1.8×10^4 kN.m^2 and all members are inextensible.

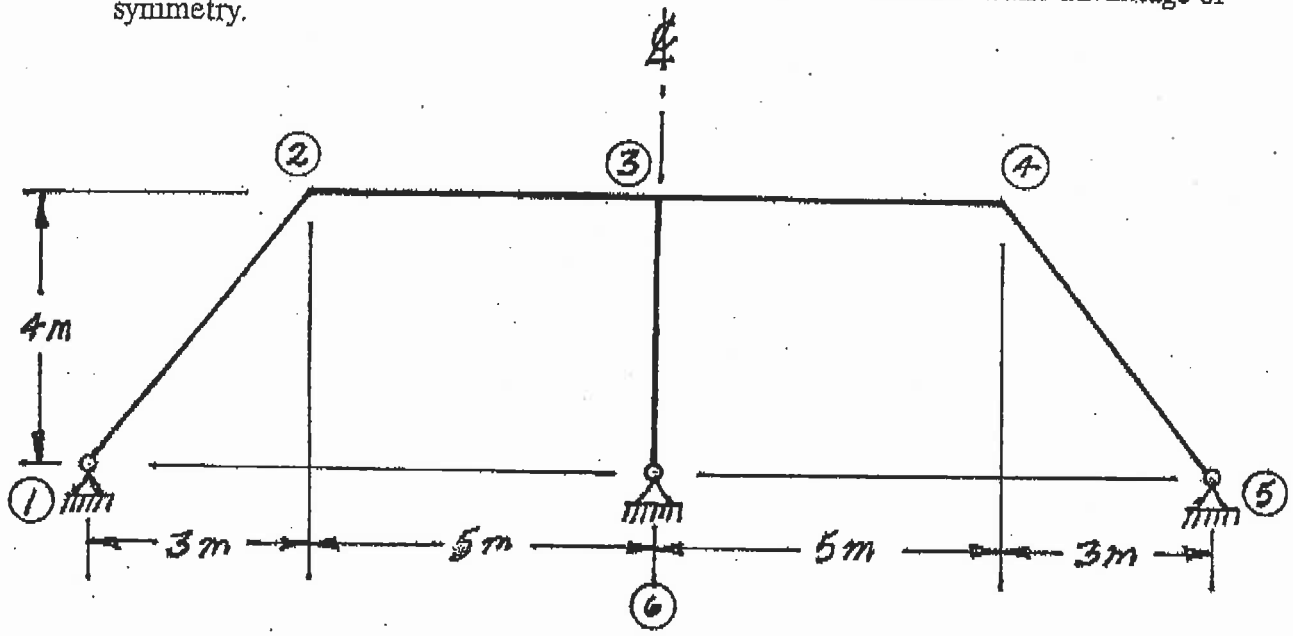


(18) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Calculate the maximum bending moment and shear in the beams. The beams have EI = 9600 kN.m^2 and they are continuous from (1) to (3). The beams and strut (2)–(4) are inextensible. The tension bars (1)–(4) and (4)–(3) have EA= 25000 kN.



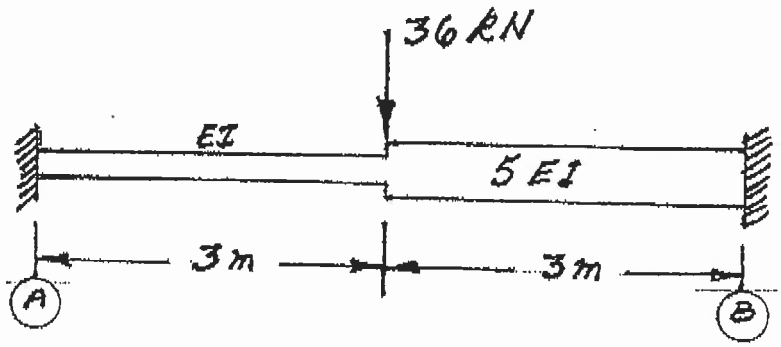
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5

(18) 5. Use the slope-defection or moment-distribution 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 values). There are no loads on the structure, but members (2)–(3) and (3)–(4) were each fabricated 20 mm too long and the structure was forced to fit the foundations. All members of the structure are inextensible and have the same EI value which is 1.4×10^5 kN.m^2. Take advantage of symmetry.



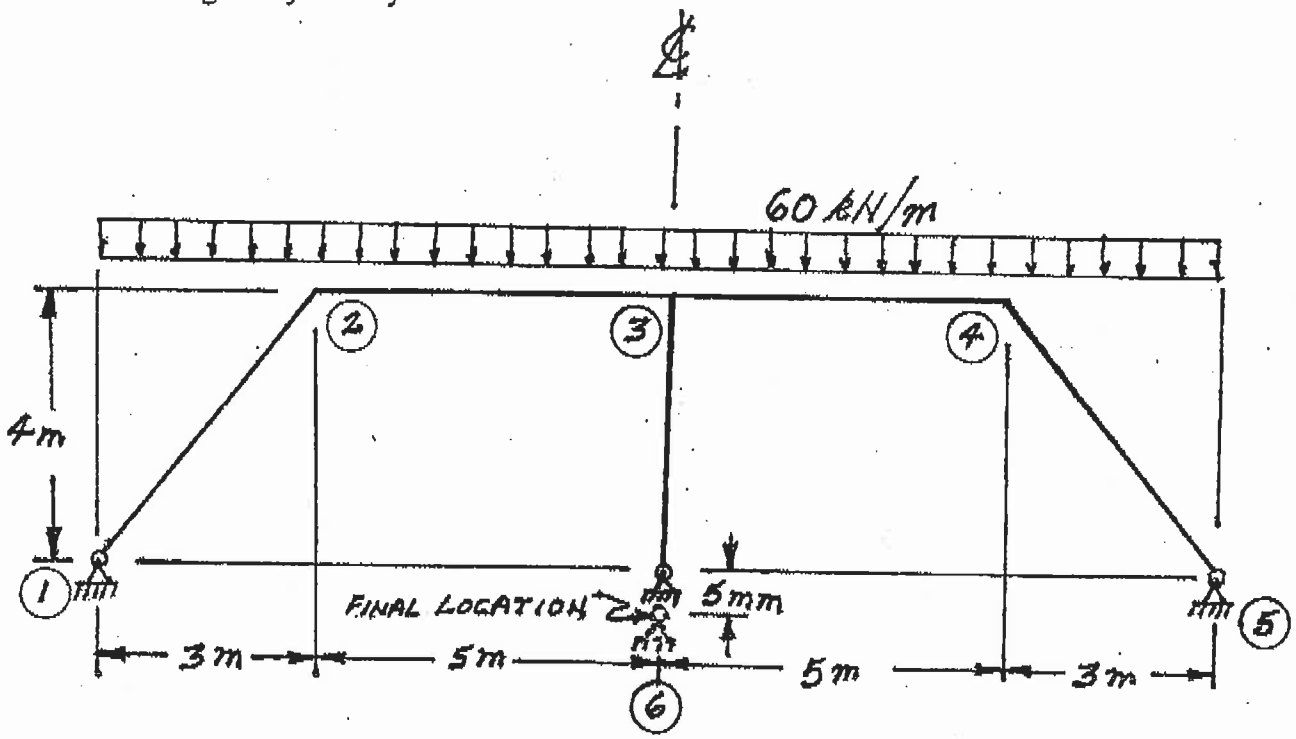
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(22) 6. Using a **flexibility (force) method,** determine the moments at the ends of the fixed-ended, non-prismatic beam shown below.



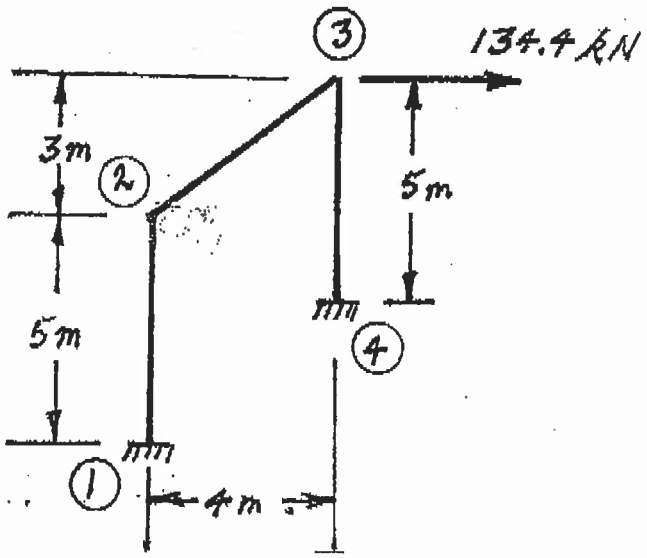
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(22) 7. Using the slope-defection method or the moment-distribution method, analyze the structure shown below. In addition to the loads shown on the sketch below, joint #6 settles (moves downward) 5 mm. 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 which is 1.4×10^5 kN.m^2. Take advantage of symmetry.



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

(22) 8. Using the slope-defection method or the moment-distribution 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). All members have the same EI value and are inextensible.



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

(22) 9. a) For the frame shown, derive the equilibrium equation for translation δ at joint (2). Neglect the effects of axial strain. Relative EI values are shown 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 in the direction shown)

θ_2 = rotation of joint (2)

θ_3 = rotation of joint (3)

(both counter clockwise positive)