

NATIONAL EXAMS DECEMBER 2003

98-CIV-B1 ADVANCED STRUCTURAL ANALYSIS

3 HOURS DURATION

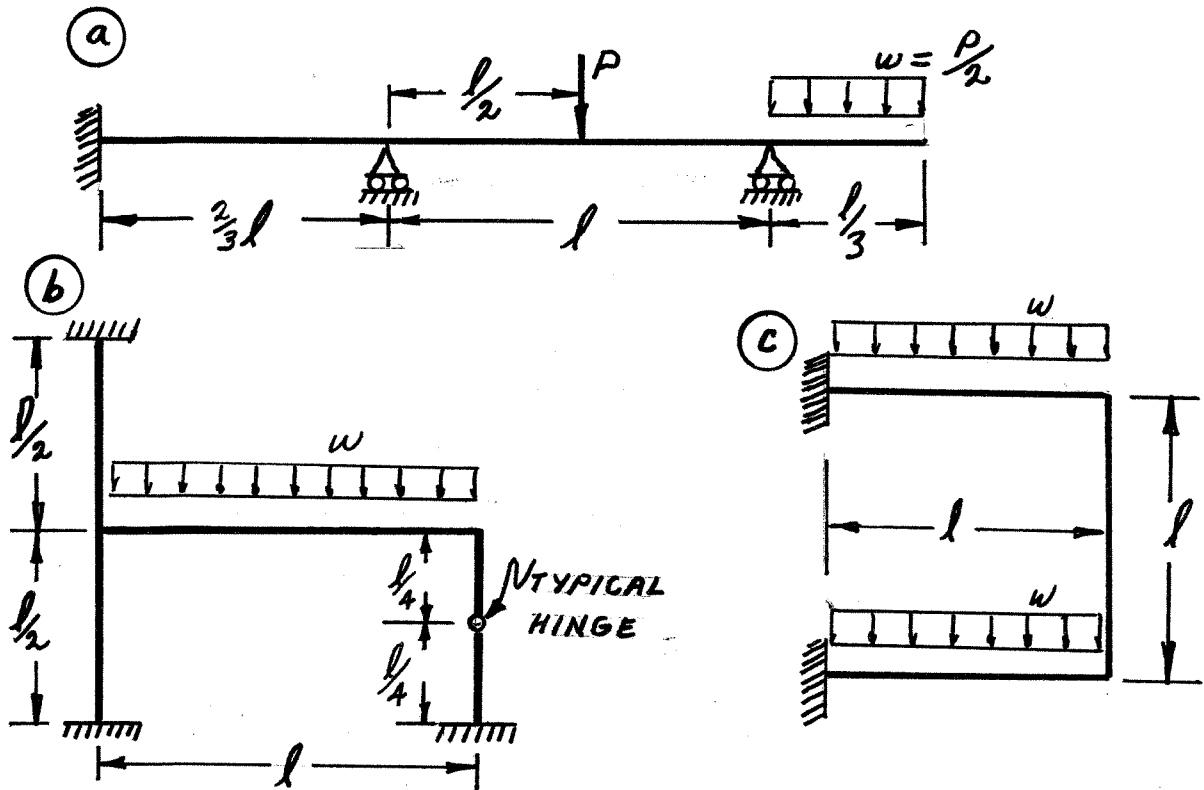
NOTES:

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. Candidates may use one of two calculators, a Casio FX-991 or a Sharp EL-540; 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.

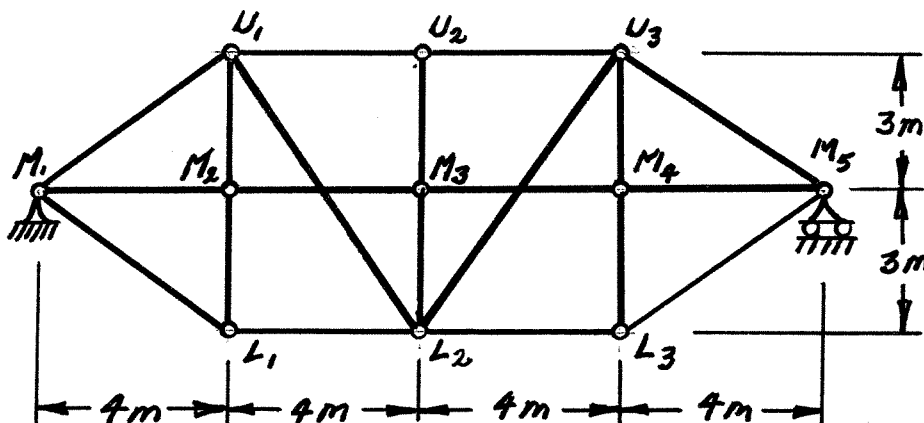
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QUESTIONS #1 AND #2 MUST BE ANSWERED.

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

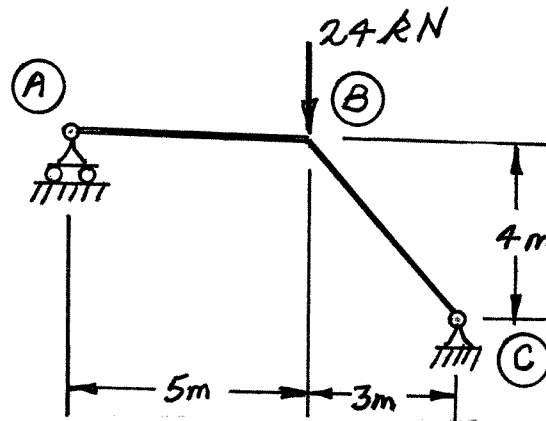


- (8) 2. Loads move across the truss shown below on beams at the mid-height level, joints  $M_1$  through  $M_5$ . Diagonals are not connected at the mid-height level. Schematically show the influence lines for the forces in the following members: a)  $M_1 - L_1$  and b)  $U_1 - L_2$ . Calculate and label the ordinate with the maximum absolute value on each influence line and indicate whether the ordinate is tension or compression.

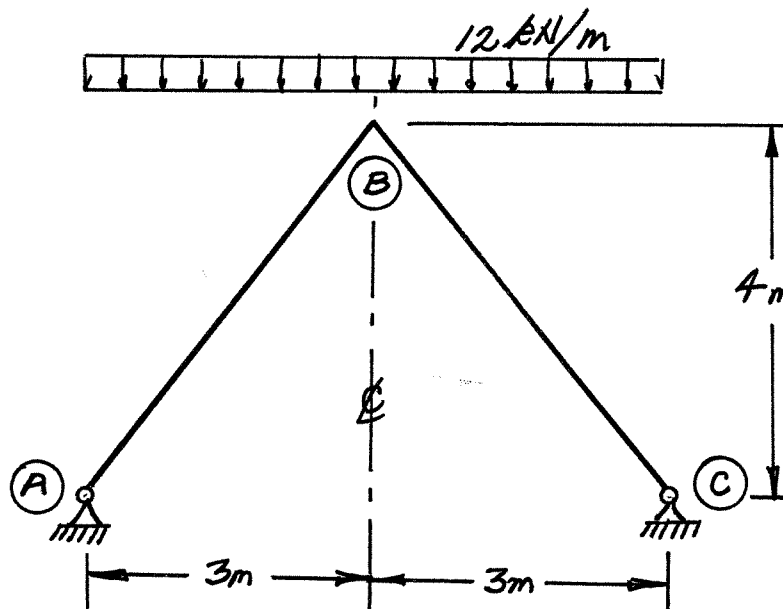


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5.

- (18) 3. Use Castigliano's theorem to determine the horizontal deflection at joint B of the frame structure shown below. The  $EI$  value for both members is  $2.5 \times 10^{10}$  kN.mm<sup>2</sup> and both are inextensible.

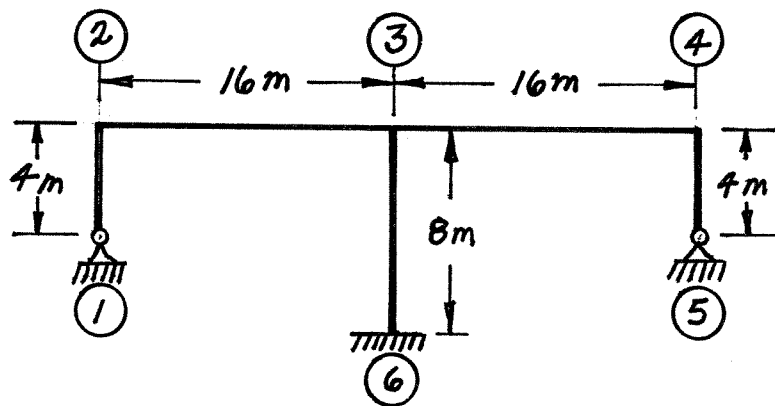


- (18) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Calculate the bending moment at joint B and the shear force through the beam immediately left of joint B. The beams have  $EI = 10000$  kN.m<sup>2</sup> and are inextensible.



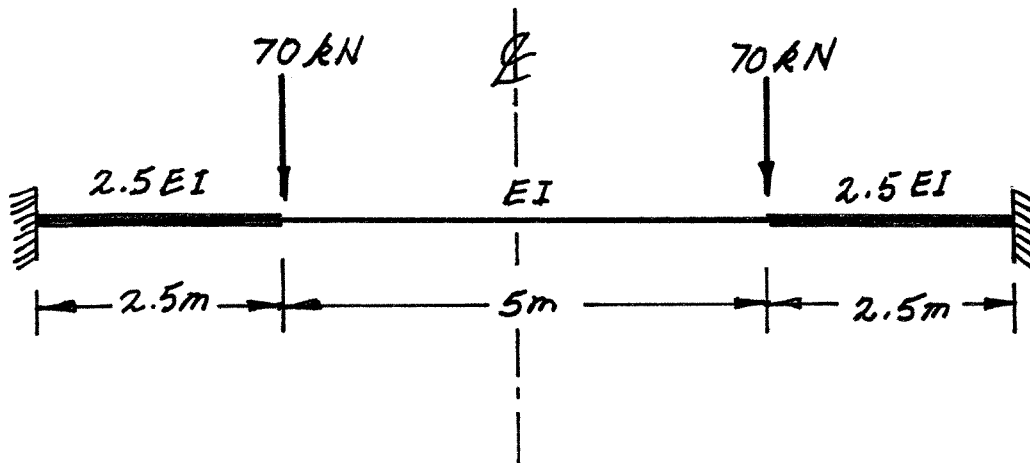
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5

- (18) 5. Use the slope-deflection or 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. There are no loads on the structure, but the member between joints 3 and 6 was manufactured 16 mm too long and it was forced into place below the horizontal top members. All members of the structure are inextensible and have the same  $EI$  value which is  $1.6 \times 10^6 \text{ kN.m}^2$ . Take advantage of the problem's symmetry.



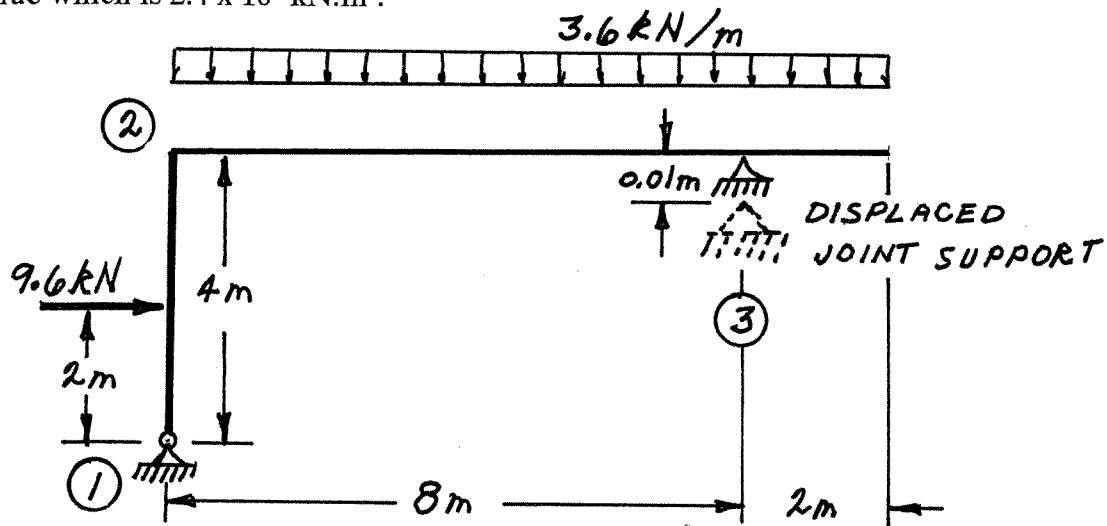
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

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

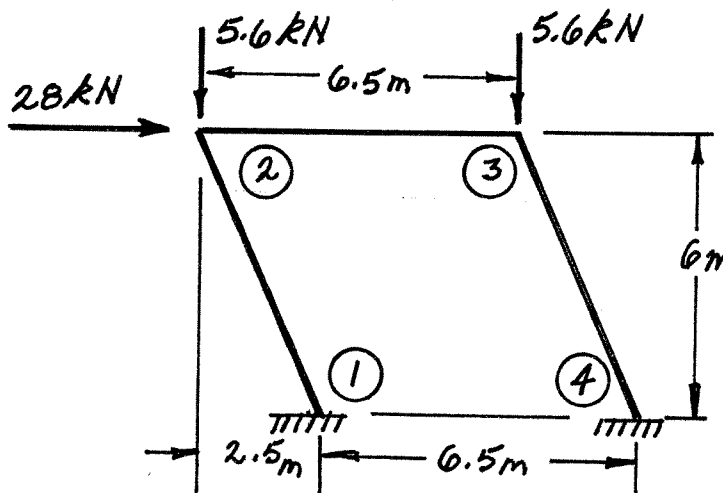


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

- (22) 7. Using the slope-deflection method or the moment-distribution method, analyze the structure shown below. In addition to the loads shown on the sketch below, joint #3 settles (moves downward) 0.01 m. Plot shear force and bending moment diagrams. For each member on each diagram, indicate the magnitude of the maximum positive and negative values. All members are inextensible and have the same EI value which is  $2.4 \times 10^4 \text{ kN.m}^2$ .



- (22) 8. Using the slope-deflection 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 positive and negative values for each member. All members have the same EI and are inextensible. The joint rotations at joints 2 and 3 are the same in magnitude and sign.



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 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:

$\delta$  = translation at joint 3 (positive in the direction shown)

$\theta_2$  = rotation of joint 2  
 $\theta_3$  = rotation of joint 3 } (counter clockwise positive)

