

NATIONAL EXAMS DECEMBER 2004

98-CIV-B1 ADVANCED STRUCTURAL ANALYSIS

3 HOURS DURATION

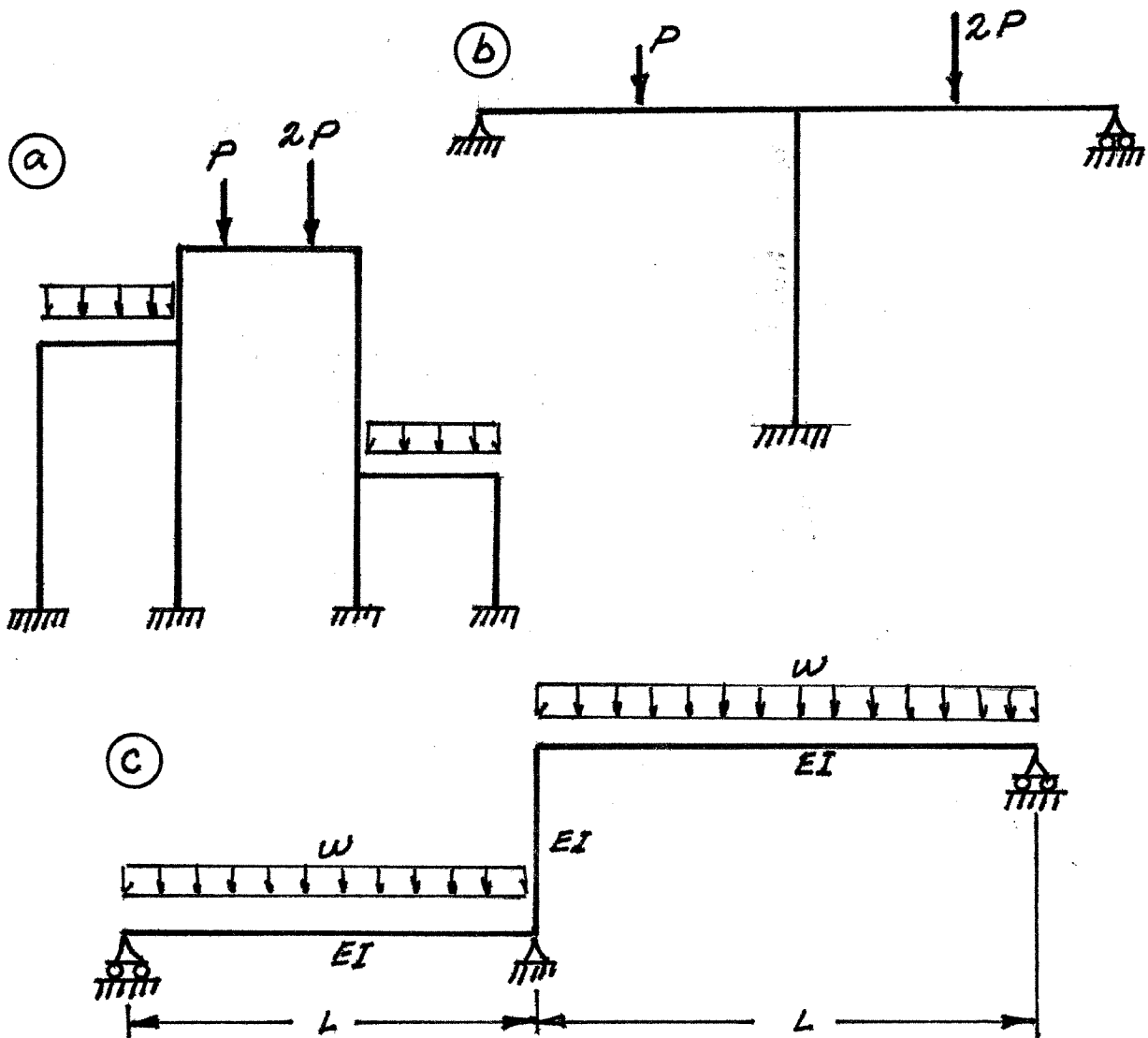
NOTES:

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 or Sharp approved models. 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.

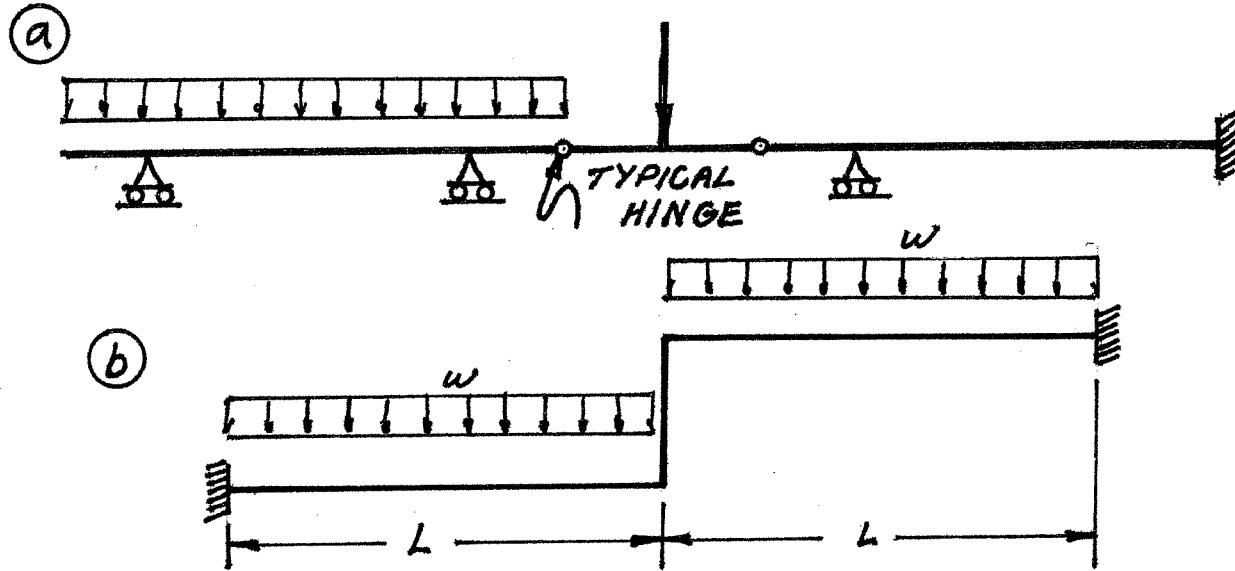
FRONT PAGE

QUESTION #1 MUST BE ANSWERED.

- (8) 1. a) Determine the statical indeterminacy,  $r$ , of the structures shown below.
- b) Indicate with arrows (↻ a rotation; → a translation) on each structure and list beside each structure the number of structural degrees of freedom,  $k$ , that are required to do an analysis by the slope-deflection 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.

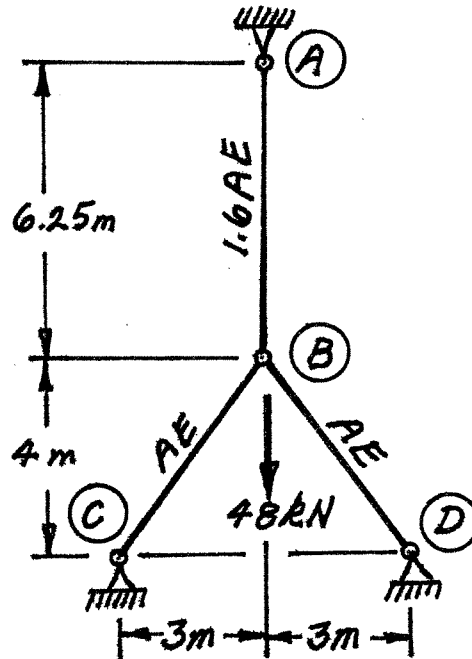


- (12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same  $EI$  and are inextensible.



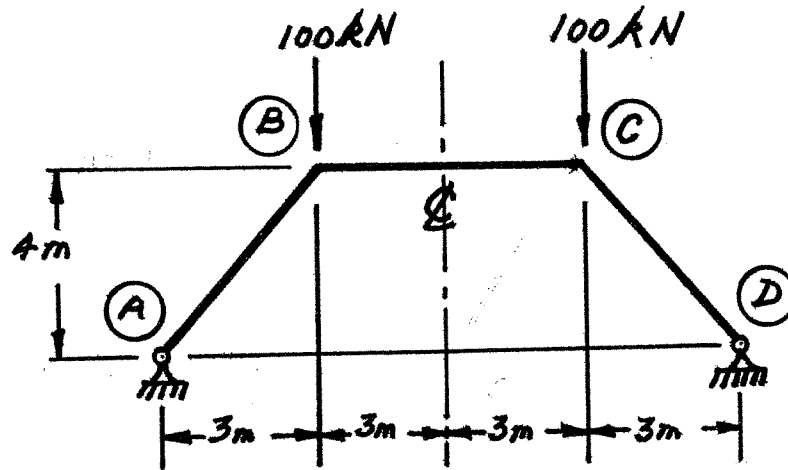
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

- (16) 3. Use Castigliano's theorem (the least work theorem) to analyze the truss structure shown. As a result of the analysis, list the force in each member and indicate whether it is in tension or compression. The members have the  $AE$  values shown.

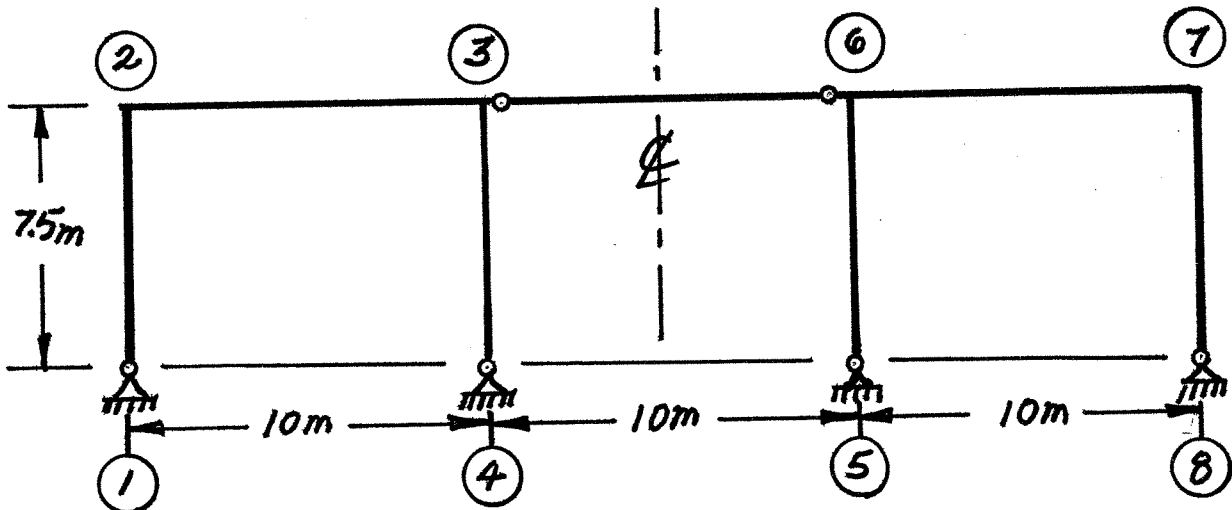


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

- (16) 4. Use Castigliano's theorem to determine the vertical deflection at point B on the frame structure shown.  $EI = 2.0 \times 10^5 \text{ kN.m}^2$  for all three members. Take advantage of symmetry.

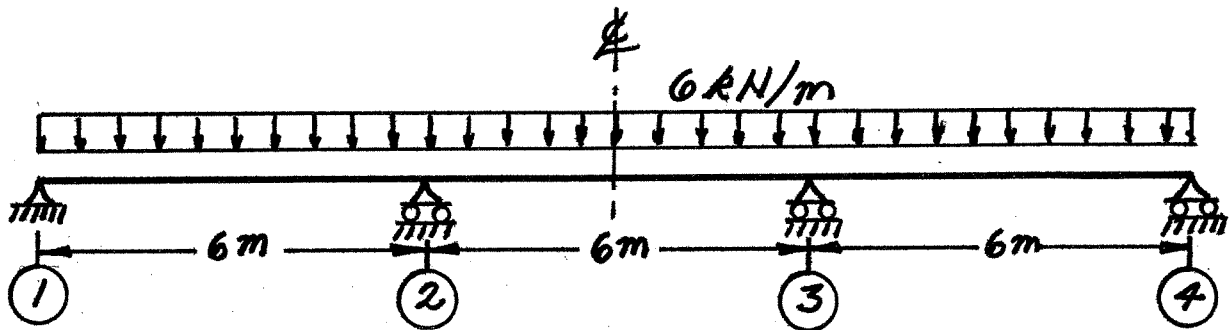


- (16) 5. Use the slope-deflection method or moment-distribution method, to analyze the structure shown below. Calculate and plot the shear force and moment diagrams. There are no loads on the structure, but member ③-⑥ was fabricated 30 mm too long and forced into place; the rest of the structure was already erected. All members have the same  $EI$  and are inextensible;  $EI = 5.0 \times 10^5 \text{ kN.m}^2$ . Use symmetry and anti-symmetry when and where they apply.

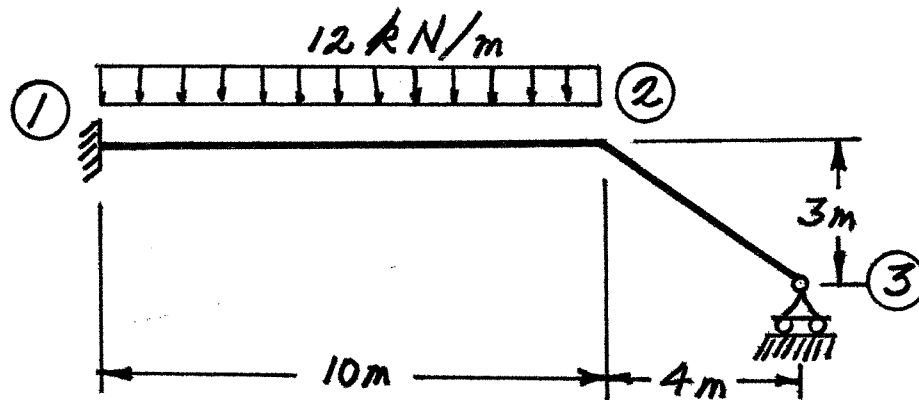


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

- (24) 6. Use the slope-deflection method or the moment-distribution method to analyze the three-span beam shown. Draw shear and bending moment diagrams. Indicate on both diagrams the magnitudes of maximum and minimum ordinates for each member. In addition to the effects of the loads shown on the structure, stresses and strains are caused because both supports ② and ③ are 36 mm below the elevation of the two end supports. The continuous, three-span beam is straight and inextensible; it has  $I = 6.25 \times 10^8 \text{ mm}^4$  and  $E = 32000 \text{ MPa}$ .

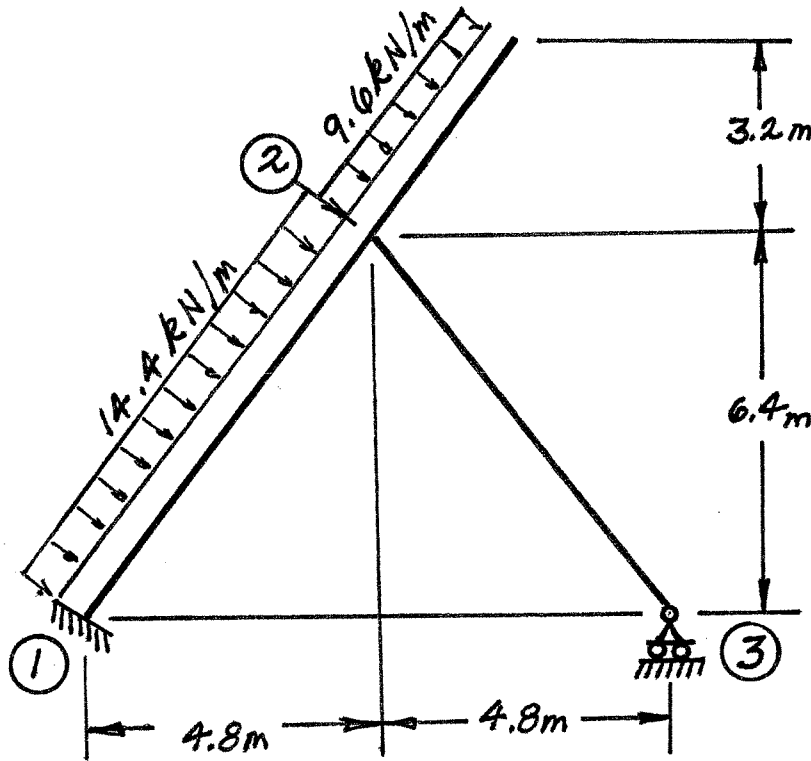


- (24) 7. Using a flexibility (force) method, analyze the frame structure shown. Both members have the same EI value and are inextensible. Draw shear and bending moment diagrams. On each diagram indicate the magnitudes of the maximum and minimum ordinates for each member.



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

- (24) 8. Using the slope-deflection method or the moment-distribution method, analyze the frame 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. All members are inextensible and have the same EI value.



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

$\delta$  = translation at joint ② (positive in the direction indicated)

$\theta_2$  = rotation of joint ②  
 $\theta_3$  = rotation of joint ③

(positive counter clockwise)

