

NATIONAL EXAMS MAY 2010

98-CIV-B1 ADVANCED STRUCTURAL ANALYSIS

3 HOURS DURATION

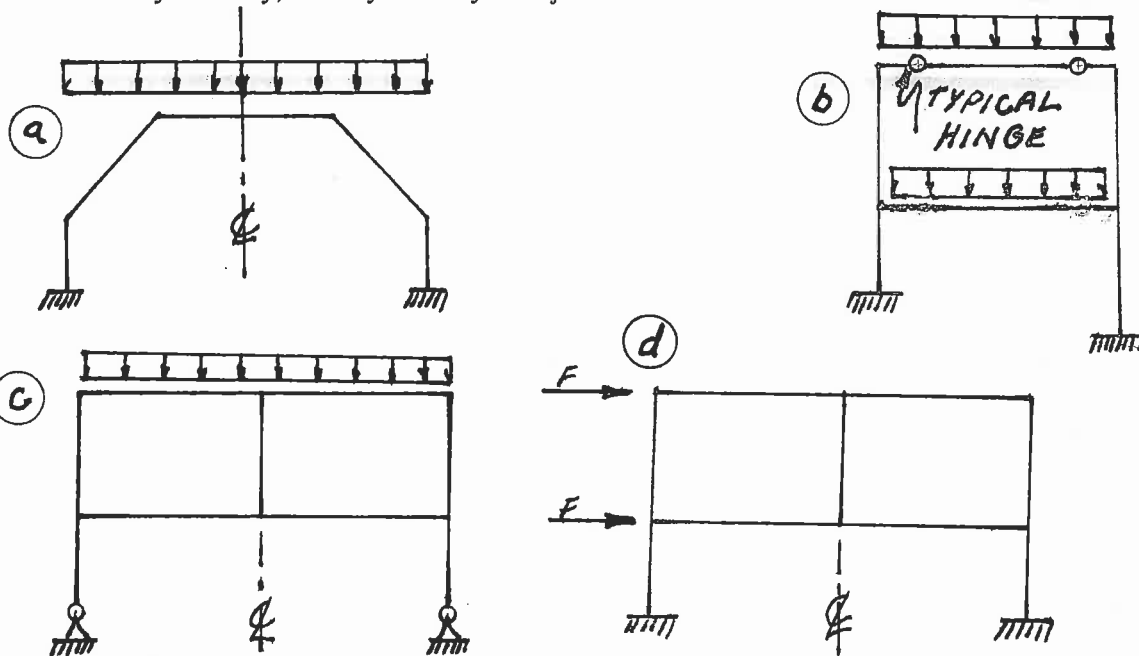
NOTES:

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 ALL questions #1, #2 and #3. Answer ONLY TWO of questions #4, #5 or #6. Answer ONLY TWO of questions #7, #8, #9 or #10. SEVEN questions constitute a complete paper.
4. The marks assigned to each question are shown in the left margin.

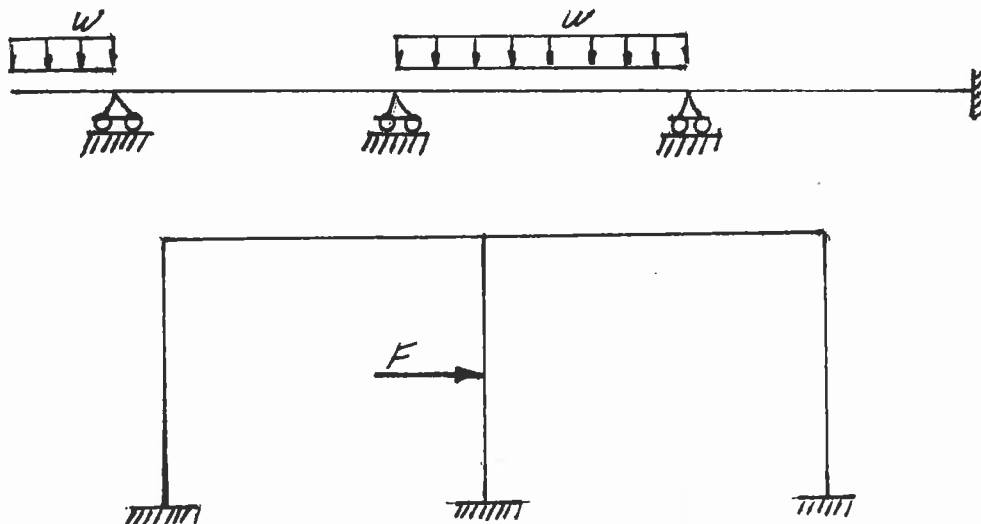
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QUESTIONS #1, #2 AND #3 MUST BE ANSWERED.

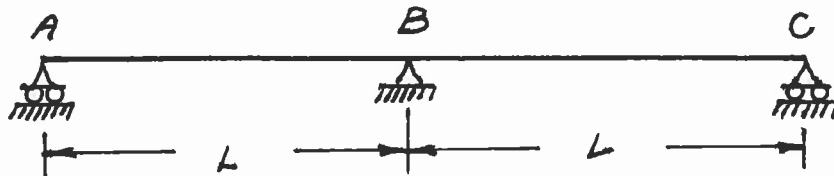
- (8) 1. Indicate with arrows (⤵ a rotation; → a translation) on each structure and list beside each structure the number of structural degrees of freedom,  $k$ , that are required to do an analysis by the slope-deflection method. In each case, use the minimum number of structural degrees of freedom; where they occur, take into account symmetry, anti-symmetry and joints that are known to have zero moments.



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

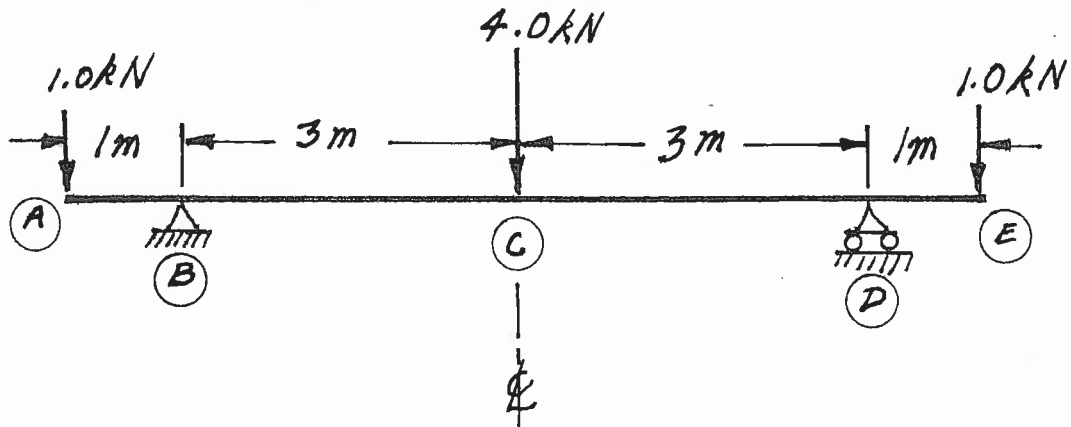


- (8) 3. Sketch the following influence lines for the two-span, prismatic, continuous beam shown below:
- Reaction at support A
  - Moment at the middle of span AB
  - Deflection at the middle of span AB
  - Shear immediately left of support B.



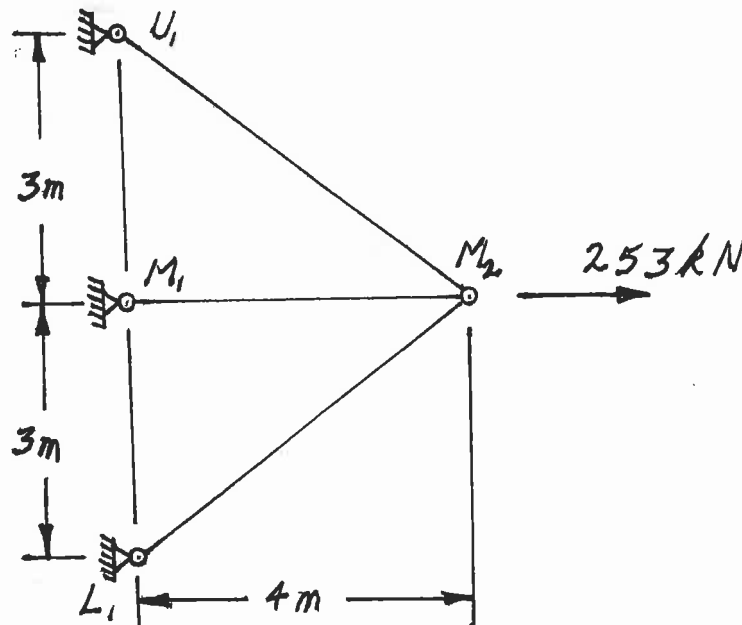
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 4, 5 OR 6.

- (16) 4. Use Castigliano's theorem to determine the vertical deflection at point (C), the centre of the continuous beam shown. All beams have the same EI value which is  $2.7 \times 10^3 \text{ kN.m}^2$ . Take advantage of symmetry.

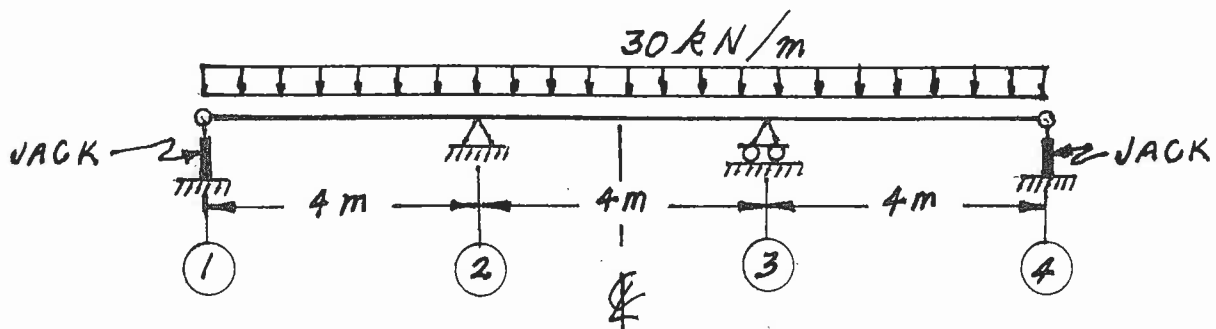


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 4, 5, OR 6.

- (16) 5. Use Castigliano's theorem (the least work theorem) to analyze the truss shown. Calculate the force in each of the three truss members.  $EA$  is the same for all members.

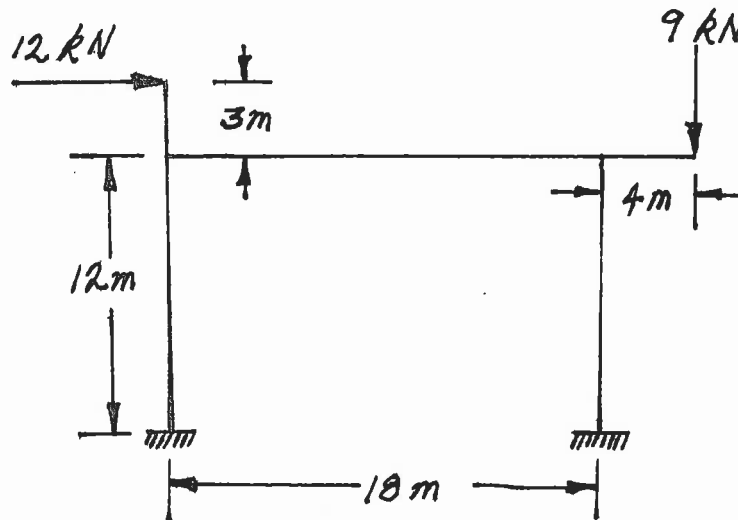


- (16) 6. For the three, prismatic, continuous, straight beams shown below, using the slope-deflection or moment-distribution methods, calculate and plot the shear force and moment diagrams. For each member on each diagram, indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative). In addition to the loading shown on the beams, at both points ① and ④ the beams are jacked upward 0.016 m. All members are inextensible and have the same  $EI$  which is  $5.0 \times 10^4 \text{ kN.m}^2$ .

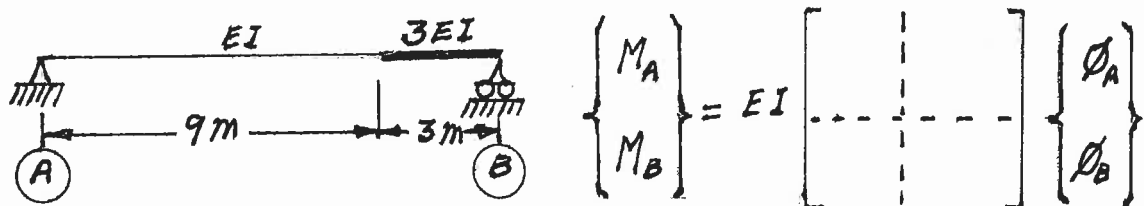


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 7, 8, 9 OR 10.

- (22) 7. Using the slope-deflection 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 (Minimum ordinates are frequently negative). All members are inextensible and have the same  $EI$  value. Sidesway is not prevented.



- (22) 8. Using a flexibility (force) method, determine the terms for the blank stiffness matrix shown beside the straight non-prismatic beam below. The  $M$ 's are member end moments and the  $\phi$ 's are member end slopes.



SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 7, 8, 9 OR 10.

- (22) 9. a) For the frame shown, derive the equilibrium equation for translation at joint (3). 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:

$$[K] \begin{Bmatrix} \delta \\ \theta_2 \\ \theta_3 \end{Bmatrix} = \{P\}$$

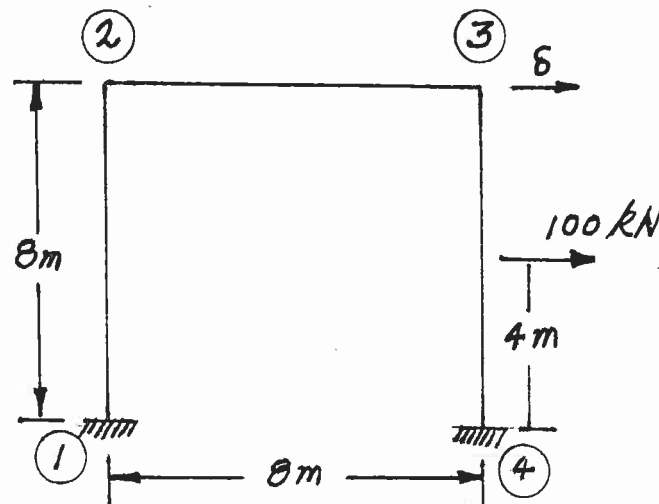
**DO NOT SOLVE THE EQUATIONS.**

The unknowns of the problem shall be:

$\delta$  = translation at joint (3) (positive to the right)

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

$\theta_3$  = rotation of joint (3)



SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 7, 8, 9 OR 10.

- (22) 10. a) For the frame shown, derive the equilibrium equation for vertical translation at joint (2). Neglect the effects of axial strain.  $EI$  has the same value for both 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:

$\delta$  = vertical translation at joint (2) (positive downward)

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

$\theta_3$  = rotation of joint (3)

