

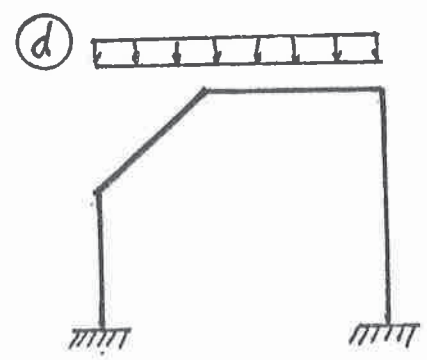
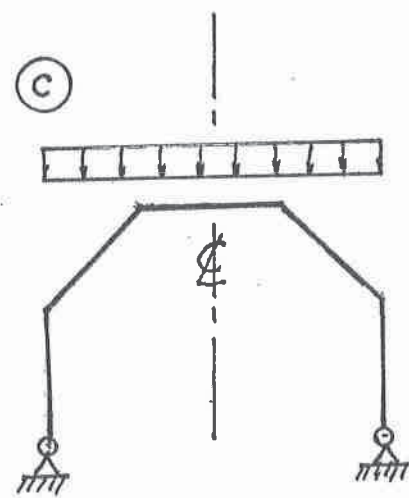
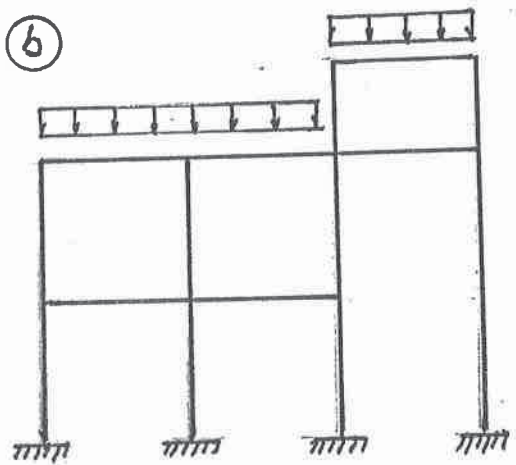
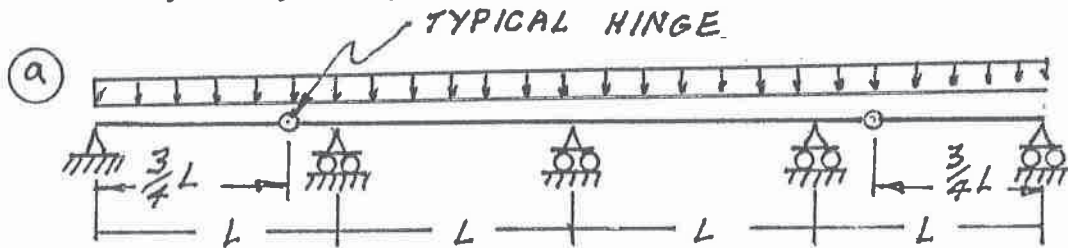
**NATIONAL EXAMS DECEMBER 2017**  
**07-STR-A4**  
**ADVANCED STRUCTURAL ANALYSIS**  
**3 HOURS DURATION**

NOTES:

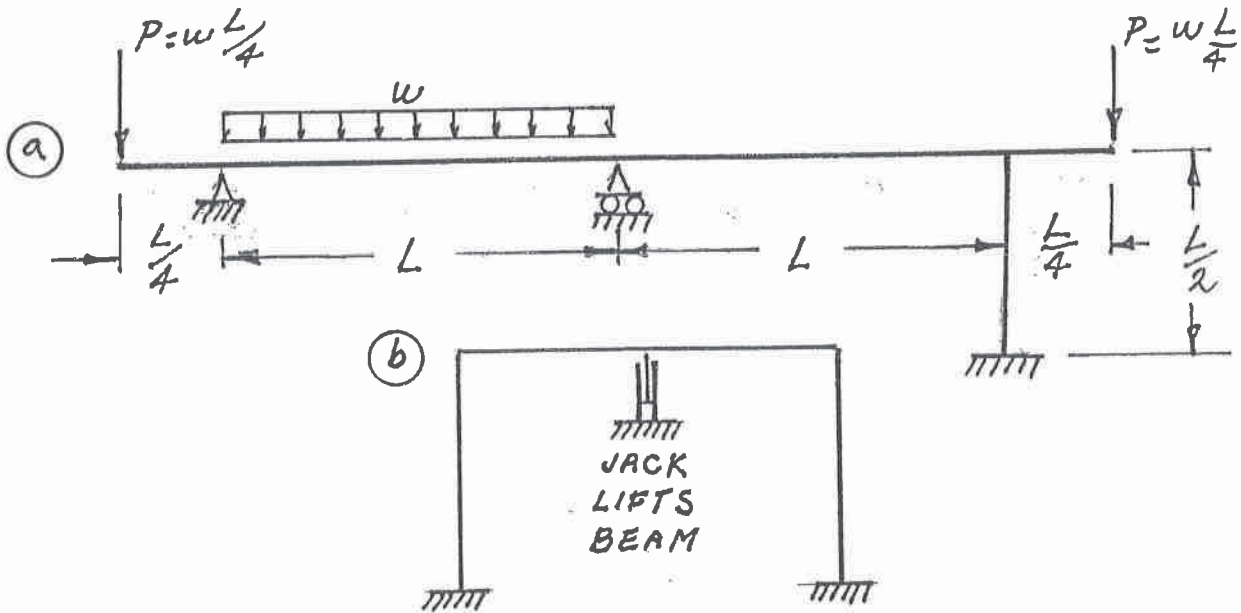
1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.
2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.
3. Answer BOTH questions #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,  $k$ , 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.

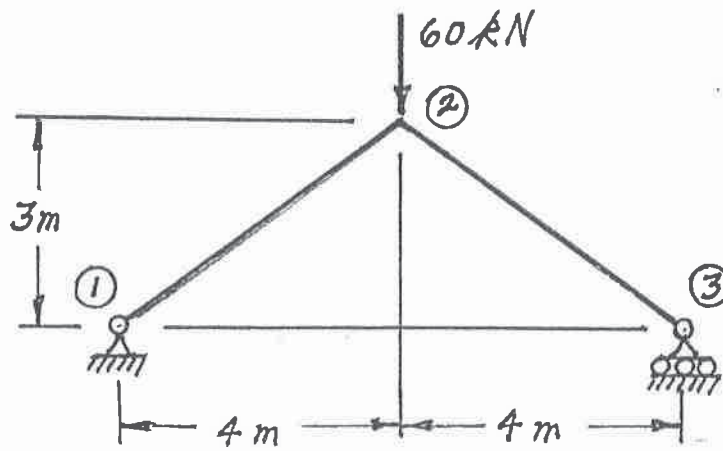


- (12) 2. Schematically show the shear force and bending moment diagrams for the following structures. All members have the same EI and are inextensible.



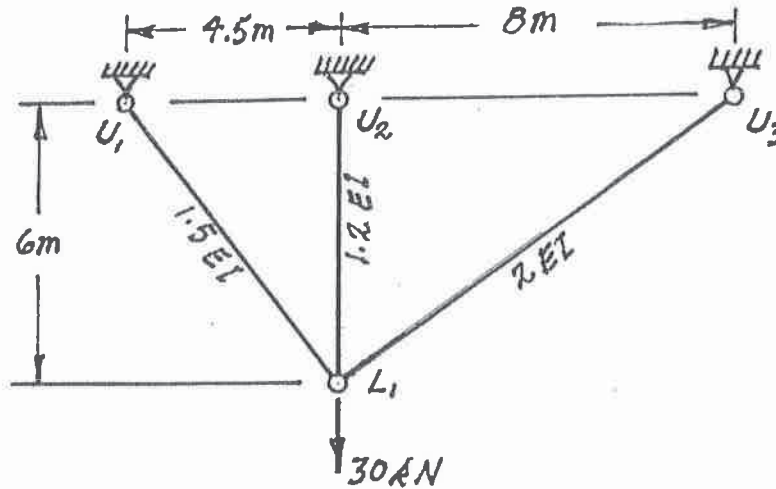
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

- (16) 3. Use Castigliano's theorem to determine the horizontal deflection at joint ③ of the frame shown below. Both members are inextensible and have an EI value of  $2.0 \times 10^4 \text{ kN.m}^2$ . Take advantage of symmetry.

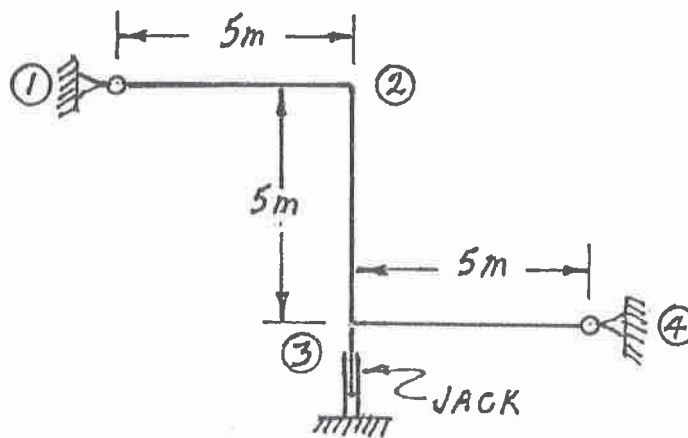


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4, OR 5.

- (16) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown below. Calculate the forces in each of the three truss members. For each member, the relative EA value is shown on the diagram.

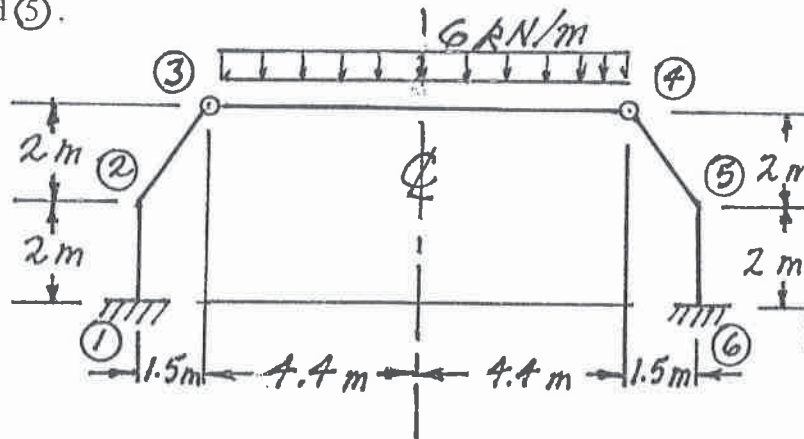


- (16) 5. Use the slope-deflection method or the moment-distribution method to analyze the frame structure shown. Draw shear and bending moment diagrams. Indicate on both diagrams, for each member, the magnitude of maximum and minimum ordinates (Minimum ordinates are frequently negative). There are no loads on the structure, but the jack under joint ② lifts both joints ② and ③  $0.02\text{ m}$ . All members of the structure are inextensible and have an  $EI = 2.5 \times 10^4\text{ kN.m}^2$ .

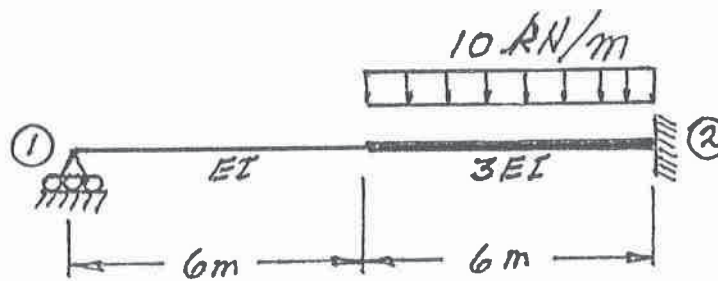


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

- (24) 6. Using the slope-deflection method, analyze the structure shown below. Draw shear force and bending moment diagrams. On each diagram for each member, indicate the magnitudes of maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members have the same EI value and are inextensible. Take advantage of symmetry to simplify your work. Horizontal motion is NOT prevented at joints ② and ⑤.

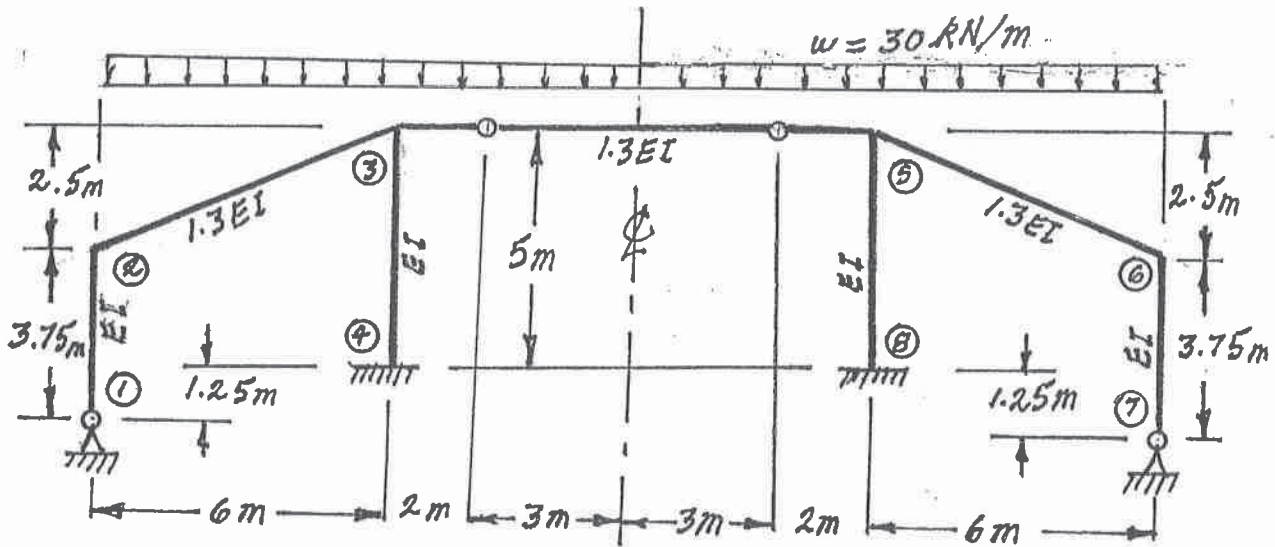


- (24) 7. Using a flexibility (force) method, determine the fixed-end moment for the right end of the non-prismatic beam shown below.



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

- (24) 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 for each member, indicate the magnitudes of maximum and minimum ordinates (Minimum ordinates are frequently negative values). Each member has the relative EI value shown on the diagram and is inextensible. Take advantage of symmetry to simplify your work.



- (24) 9. a) For the frame shown, derive the equilibrium equation for the translation shown 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 direction shown)

$\theta_2$  = rotation of joint ②

(counter clockwise positive)

$\theta_3$  = rotation of joint ③

