NATIONAL EXAMS MAY 2015

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 ONE of questions #6, or #7. Answer ONLY ONE of questions #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.

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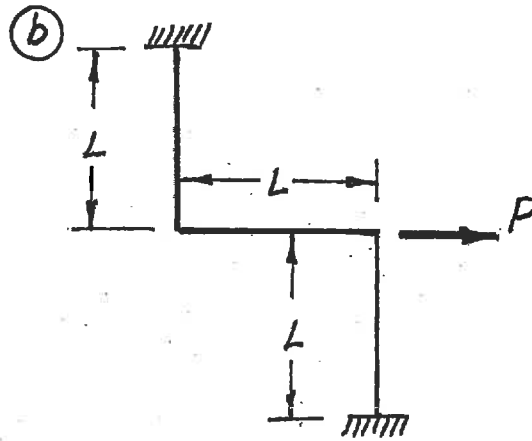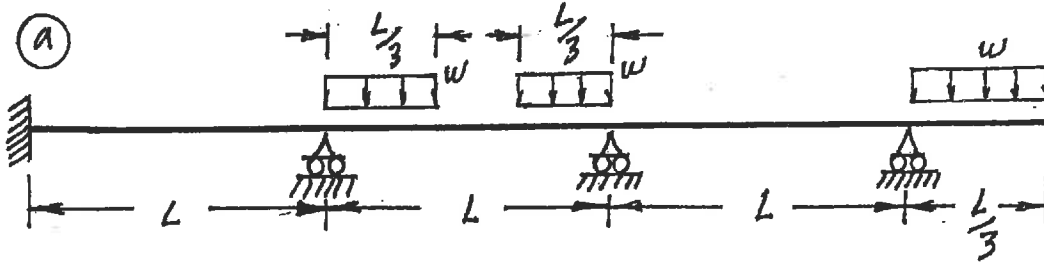

(9)   2. For loading moving on beams at the top chord of the pin-jointed truss shown below,
         schematically show the influence line for the force in the following members:
            a) $U_2 - L_2$
   b) $U_3 - L_2$
            c) $L_2 - L_3$
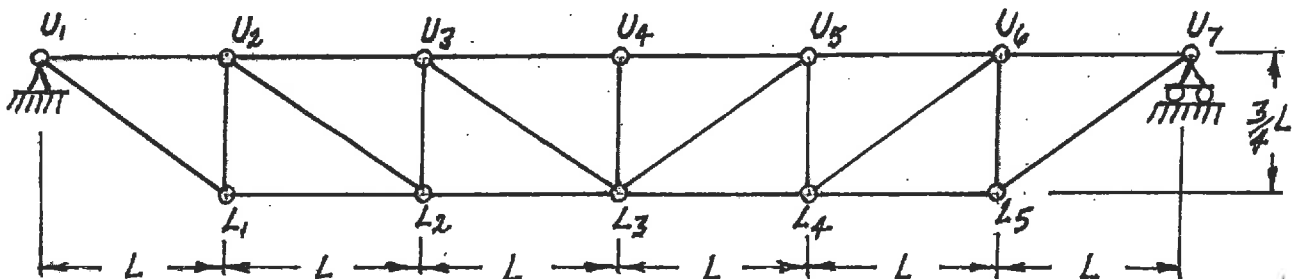
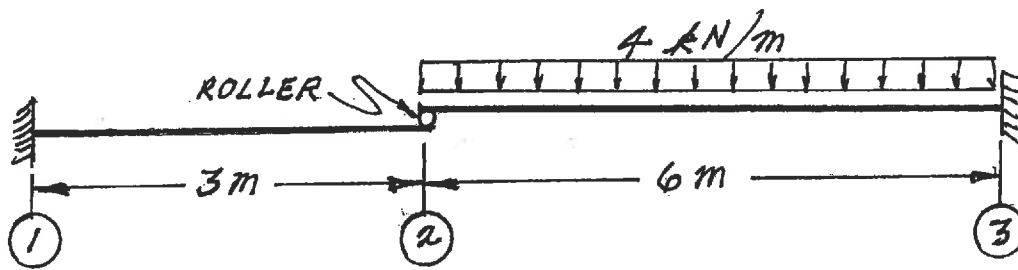SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS #3, #4, OR #5.

(18)   3.   Using a flexibility (force) method, determine the fixed-end moments at the ends of the
fixed-end, non-prismatic beam shown below. Take advantage of symmetry.
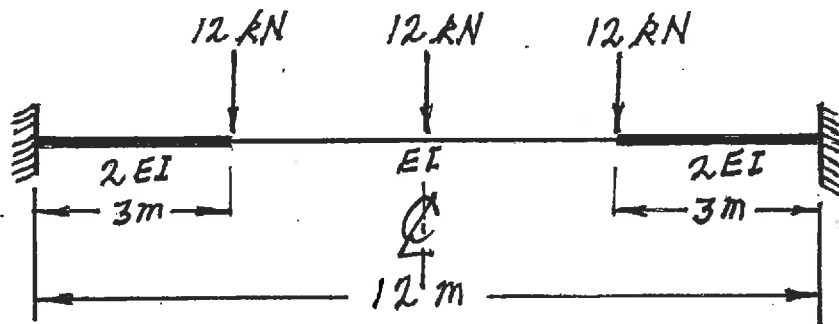
(18) 4.   Using the slope-deflection method or the moment-distribution method, analyze the
structure shown below. There are no loads on the structure, but joint ② is pulled down
exactly 0.04 m. Plot shear force and bending moment diagrams. On each diagram for
each member, calculate and label the maximum and minimum ordinates (Minimum
ordinates are frequently negative values).   All members are inextensible and have the
same EI value; EI = 18000 kN.m^2.
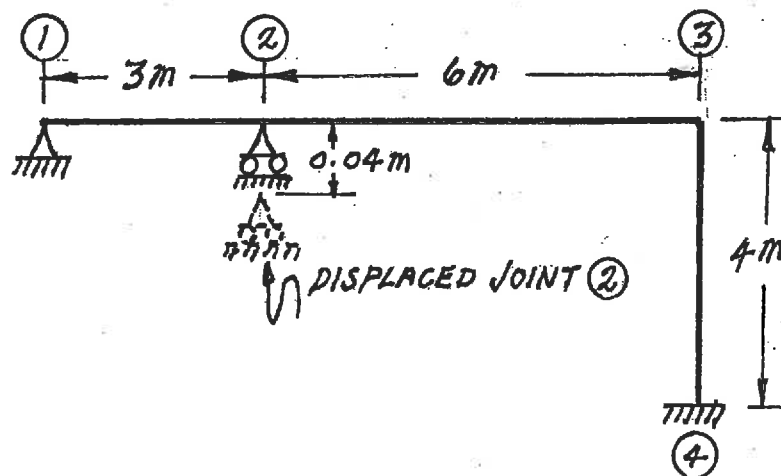
(18)   5.   Use Castigliano's theorem (the "least work" theorem) to analyse the two-beam structure
              shown. Calculate and plot the shear force and bending moment diagrams for both beams.
              On each diagram, calculate and label the maximum and minimum ordinates (Minimum
              ordinates are frequently negative values). Both beams are inextensible and have the same
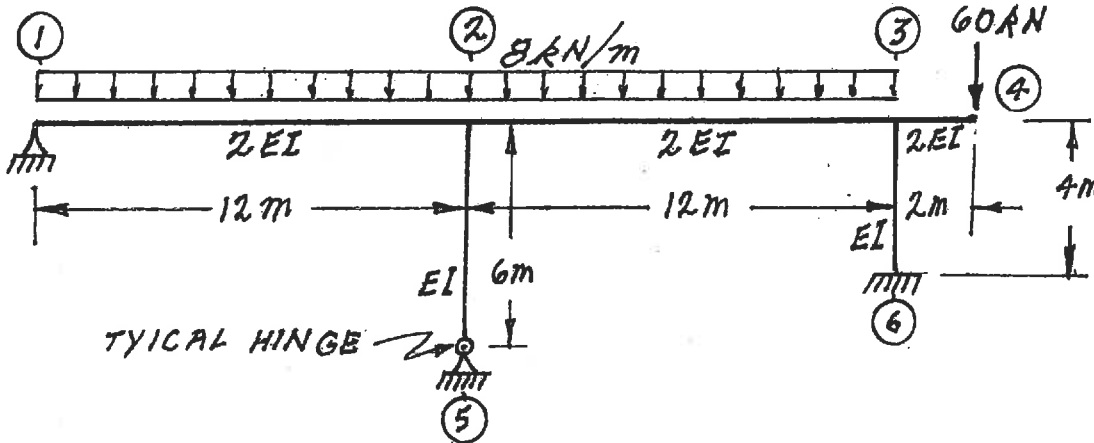   EI value.

SELECT AND ANSWER ONE QUESTION ONLY FORM QUESTIONS #6, OR #7.

(24) 6. Using the slope-defection method or the moment-distribution method, analyse the structure shown below. Plot shear force and bending moment diagrams. On each diagram for each member, label the maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members are inextensible and have the same EI value; EI = 5400 kN.m². **In addition to the loading shown on the structure, joint ②settles (moves downward) 0.01 m.**
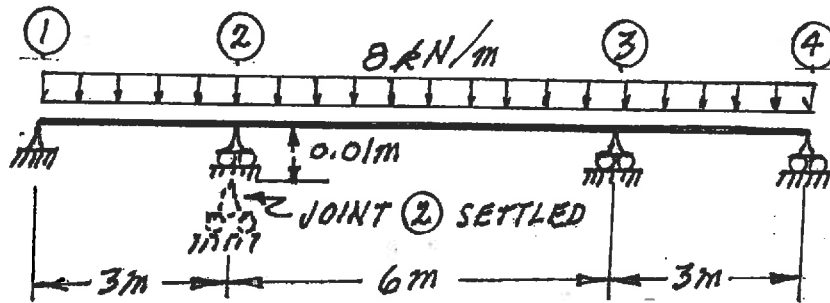

(24) 7. Using the slope-defection method or the moment-distribution method, analyse the structure shown below. Plot shear force and bending moment diagrams. On each diagram for each member, label the maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members are inextensible and have the relative EI values shown on the structure.

SELECT AND ANSWER ONE QUESTION ONLY FROM QUESTIONS #8 OR #9.

(24) 8. Using the slope-defection method, analyse the structure shown. Draw shear force and
         bending moment diagrams. On each diagram for each member, calculate and label the
         maximum and minimum ordinates (Minimum ordinates are frequently negative values).
         Both members are inextensible and have the relative EI values shown on the structure.
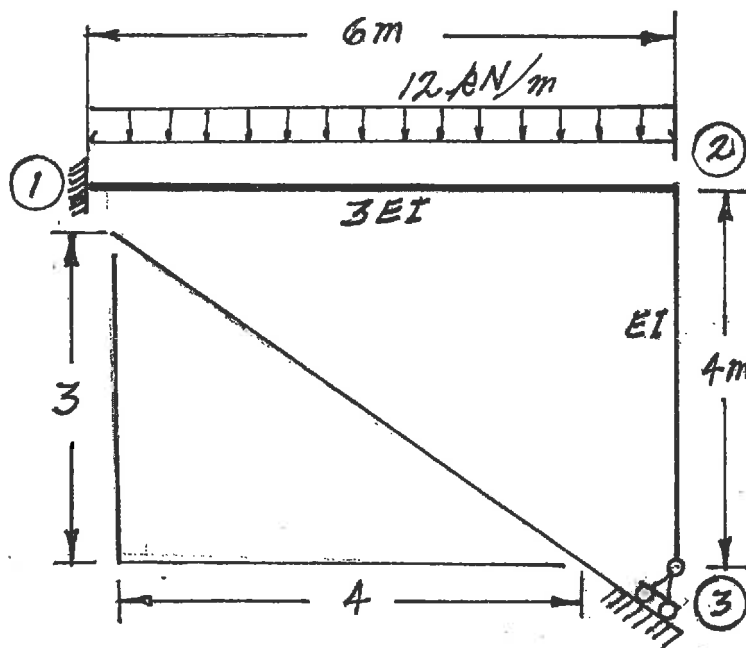
(24)   9.   a)   For the frame shown, derive the equilibrium equation for the translation shown at joint ③. Neglect the effects of axial strain. EI has the same value for all members.

        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:

δ = translation at joint ③ (positive in direction shown)

θ_2 = rotation of joint ②

θ_3 = rotation of joint ③   (counter clockwise positive)