NATIONAL EXAMS DECEMBER 2016

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.

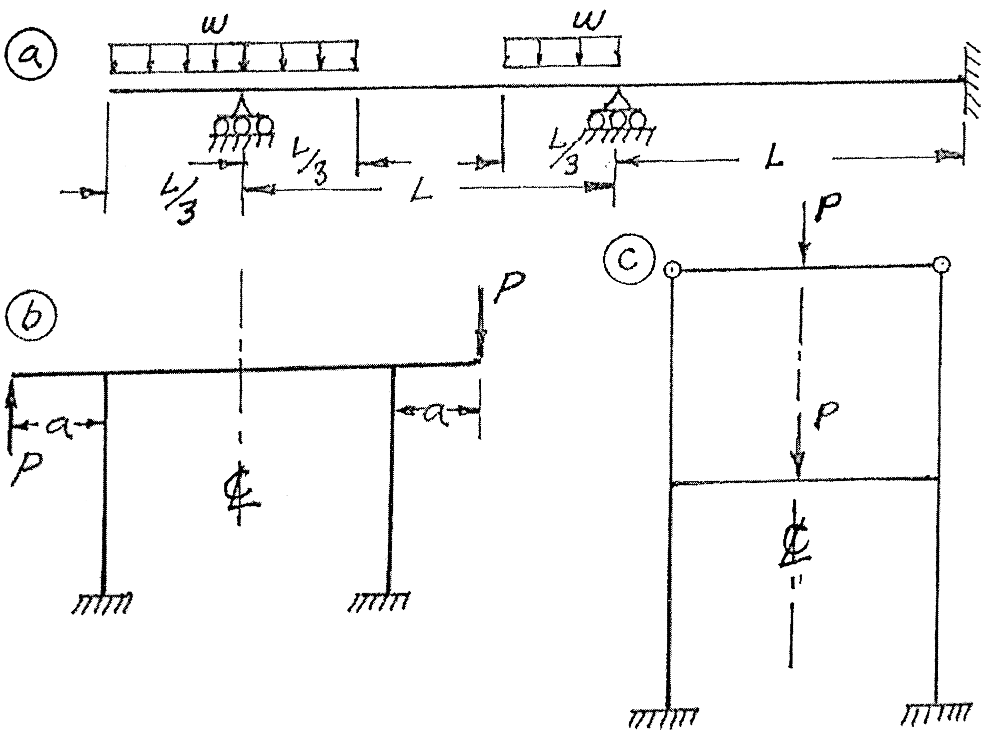
2 Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.

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.

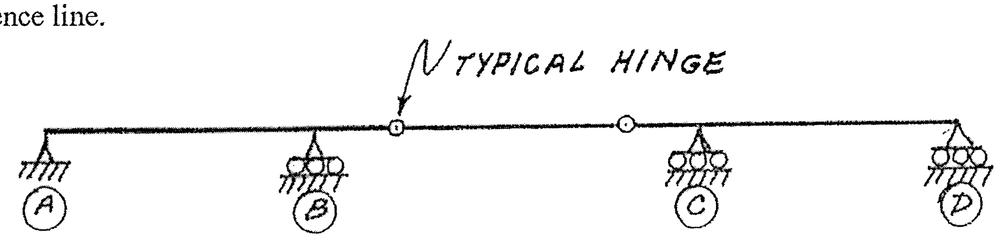
QUESTIONS #1 AND #2 MUST BE ANSWERED.

(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. For the beam structures shown below, schematically show the influence lines for shear forces immediately left of support Ⓒ. Note that structure a) is determinate and b) is indeterminate. Show the value of the ordinate with the maximum absolute value on each influence line.

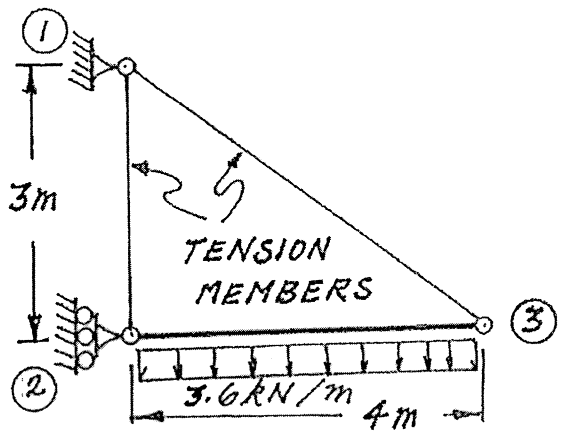
a)



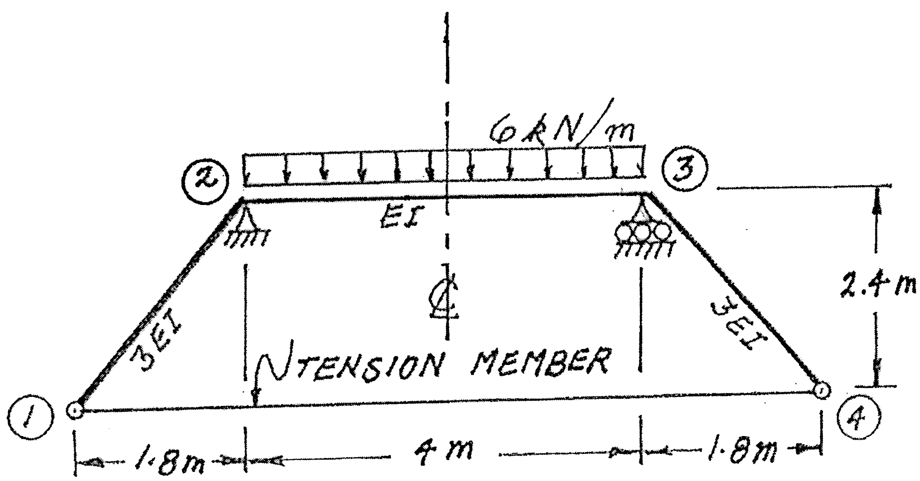
b)

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

(18) 3. Use Castigliano's second theorem to determine the vertical defection at mid span of beam ② – ③ shown below. The beam is inextensible and has EI = 6000 kN.m^2. Both tension members have EA = 1900 kN.

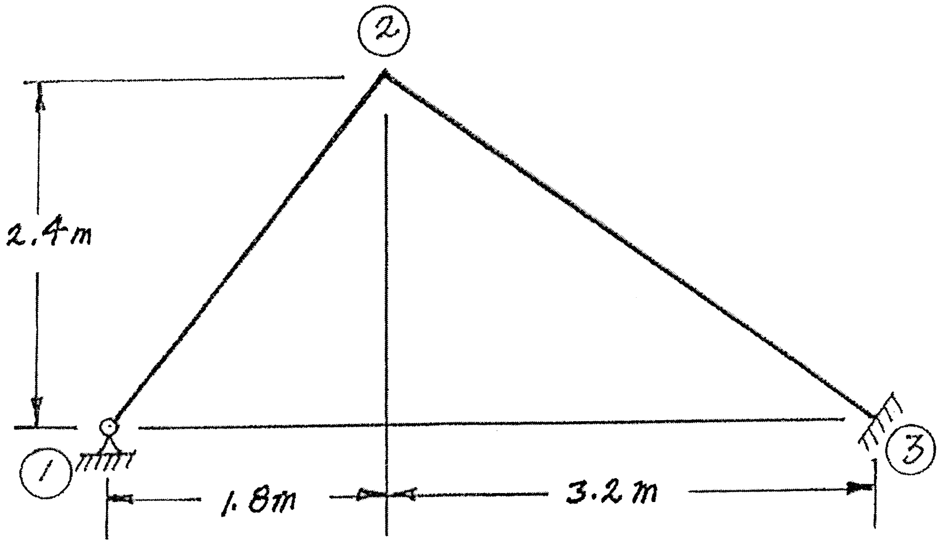


(18) 4. Use Castigliano's first theorem (the least work theorem) to analyse the structure shown. Calculate the maximum bending moment in the horizontal beam. All three beams are inextensible and have the relative EI values shown; for beam ② – ③ the value of EI = 9280 kN.m^2. The tension member has EA= 1900 kN. To minimize calculations, take advantage of the symmetry.



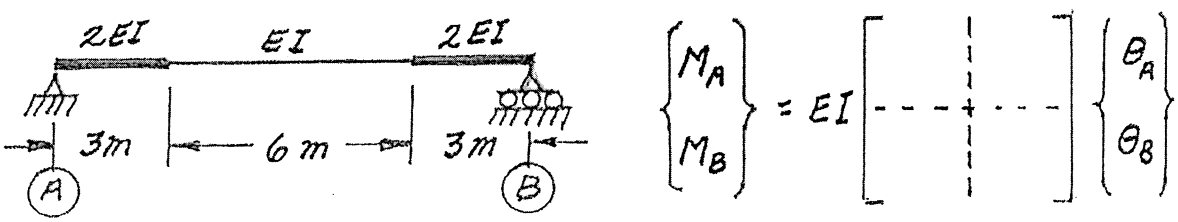
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS #3, #4, OR #5.

(18) 5. Use the slope-defection method or the 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 (Minimum ordinates are frequently negative values). There are no loads on the structure, but after erection, because of temperature increase, member ①–② became longer by 2.4 mm and member ②–③ became longer by 3.2 mm. Both members have the same EI value which is 1.8×10^5 $kN.m^2$. Neglect the effects of axial strain caused by axial stress.



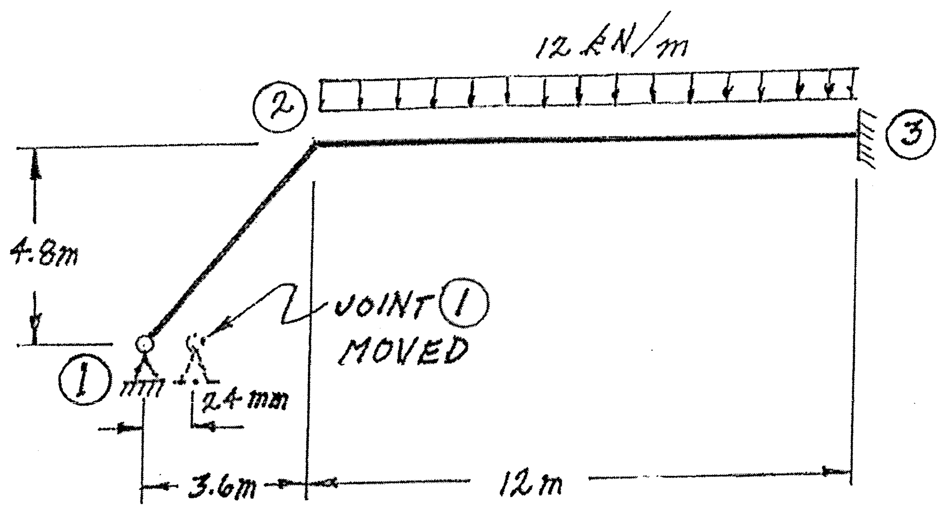
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS #6, #7, #8, OR #9.

(22) 6. Using either a force or a displacement 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 **θ**'s are member-end slopes.



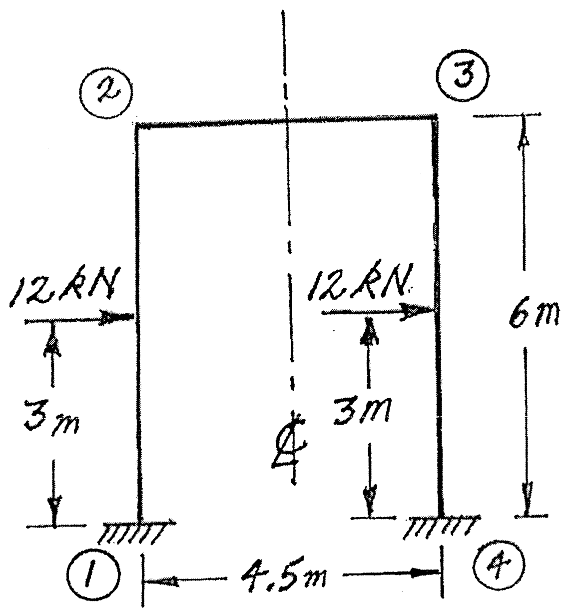
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS #6,#7 #8 OR #9.

(22) 7. Using the slope-defection method or the moment-distribution method, analyse the structure shown below. In addition to the loading shown on the structure, after erection, joint (1) was moved (jacked) horizontally a distance of 24 mm to the right. Draw shear force and bending moment diagrams. On each diagram for each member, indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). Both members are inextensible and have the same EI value; EI = 20000 kN.m^2.



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

(22) 8. Using the slope-defection method, analyse the structure shown below. Draw shear force and bending moment diagrams. On each diagram for each member, indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are often negative values). All members are inextensible and have the same EI value. To minimize calculations, take advantage of anti-symmetry.



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

(22) 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 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:

δ = translation at joint ③ (positive to the right)

θ_2 = rotation of joint ②

(counter clockwise positive)

θ_3 = rotation of joint ③