NATIONAL EXAMS DECEMBER 2005

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 model. 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.

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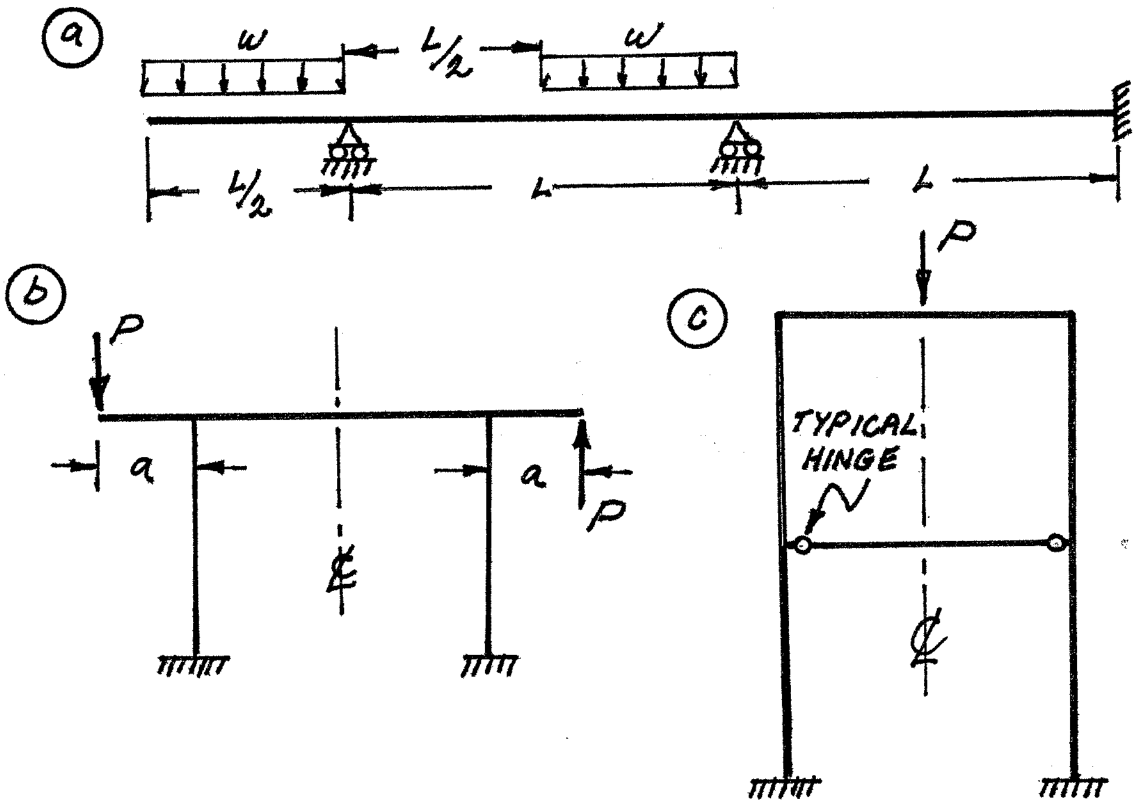
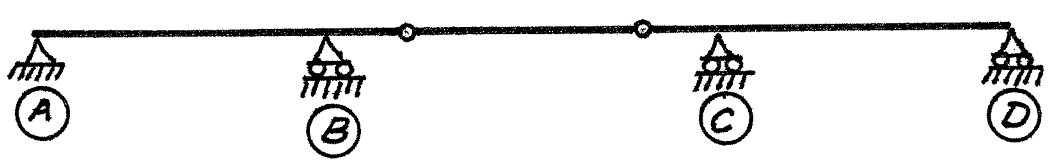
QUESTIONS #1 AND #2 MUST BE ANSWERED.

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

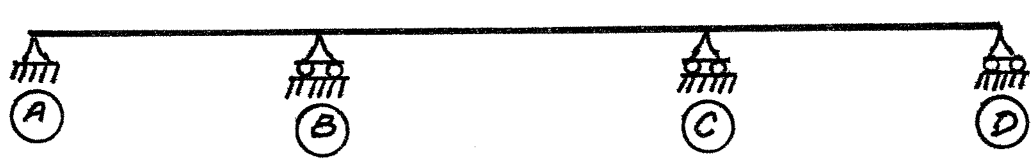



(8) 2. For the two beam structures shown below, schematically show the influence lines for shear forces immediately left of supports B . Note that structure a) is determinate and b) is indeterminate. Show the value of the ordinate with the maximum absolute value on each influence line.

a)

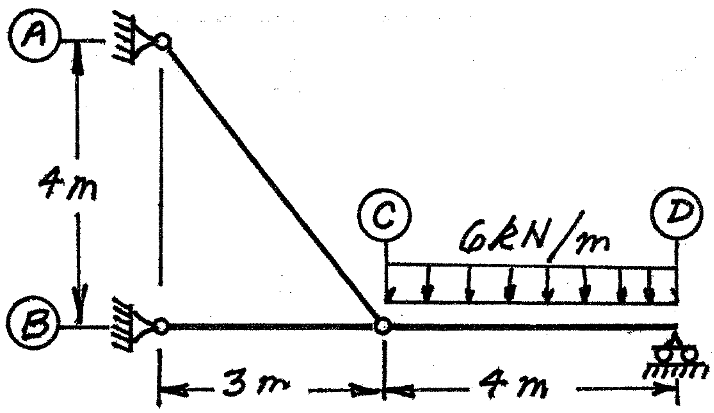



b)

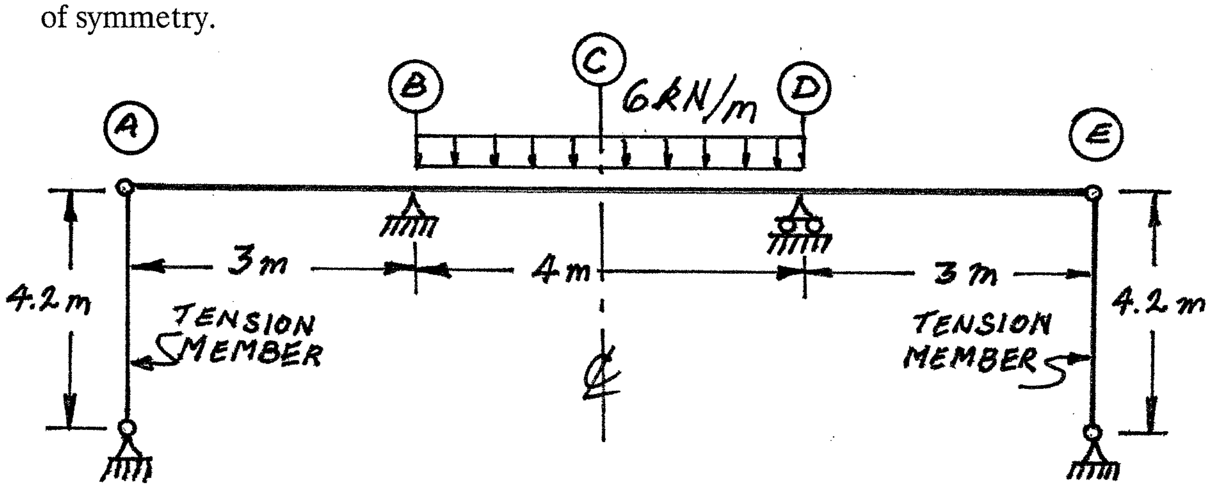


SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5.

(18) 3. Use Castigliano's theorem to determine the vertical deflection at the mid span of beam Ⓒ–Ⓓ. The EI value for the beam is 10000 kN.m$^2$ and both members Ⓐ–Ⓒ and Ⓑ–Ⓒ have EA = 2000 kN.

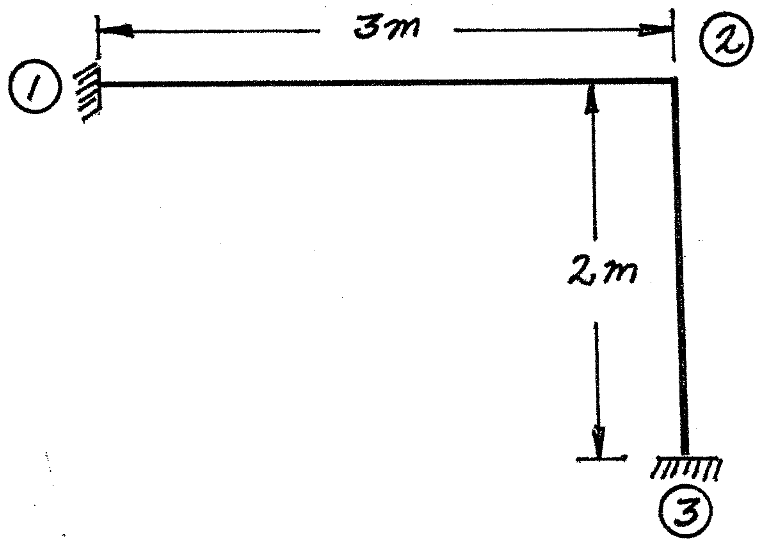



(18) 4. Use Castigliano's theorem (the least work theorem) to analyze the structure shown. Draw shear force and bending moment diagrams for the continuous beam from Ⓐ to Ⓔ. On both diagrams, for each member, label the maximum and minimum ordinates. (Minimum ordinates are frequently negative.) All beam members have EI = 10000 kN.m$^2$ and both tension members have EA= 2000 kN. Take advantage of symmetry.



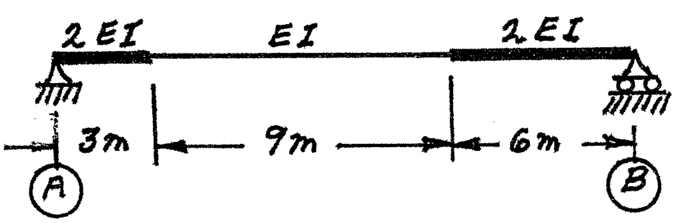
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 3, 4, OR 5

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




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

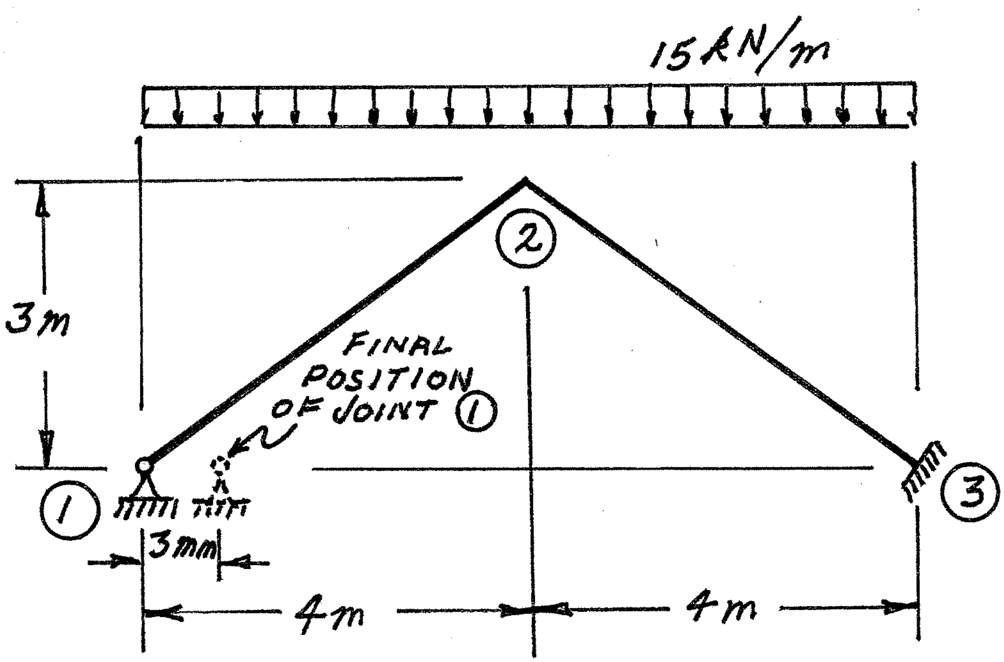
(22) 6. Using a flexibility (force) method, determine the terms for the blank stiffness matrix shown beside the straight, non-prismatic beam below. The M's are member end moments and the Ø's are member end slopes.




$$\begin{Bmatrix} M_A \\ M_B \end{Bmatrix} = EI \begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix} \begin{Bmatrix} \phi_A \\ \phi_B \end{Bmatrix}$$

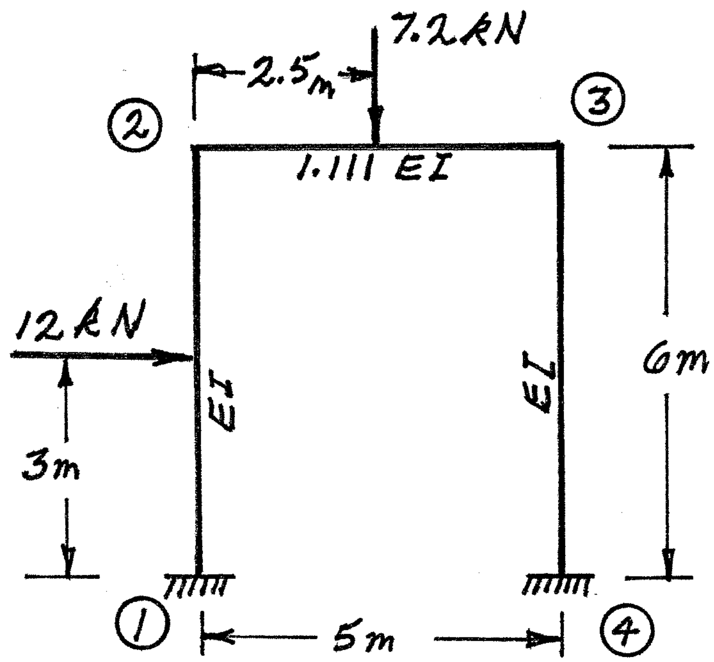
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(22) 7. Using the slope-defection method or the moment-distribution method, analyze the structure shown below. In addition to the loading shown on the sketch below, after erection, joint (1) was moved (jacked) horizontally a distance of 3 mm toward joint (3). 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 values.) Both members are inextensible and have the same EI value which is 10000 kN.m$^2$.



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

(22) 8. Using the slope-defection method, analyze the structure shown. 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.) Relative EI values are shown and all members are inextensible.



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

(22) 9. a) For the frame shown, derive the equilibrium equation for translation at joint (3). Neglect the effects of axial strain. Relative EI values are shown on each member.

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 the direction shown)

$\theta_2$ = rotation of joint (2)

$\theta_3$ = rotation of joint (3) - the end slope of member (2)-(3).
(Both above joint rotations are to be counter clockwise positive.)