NATIONAL EXAMS - DECEMBER 2018

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.

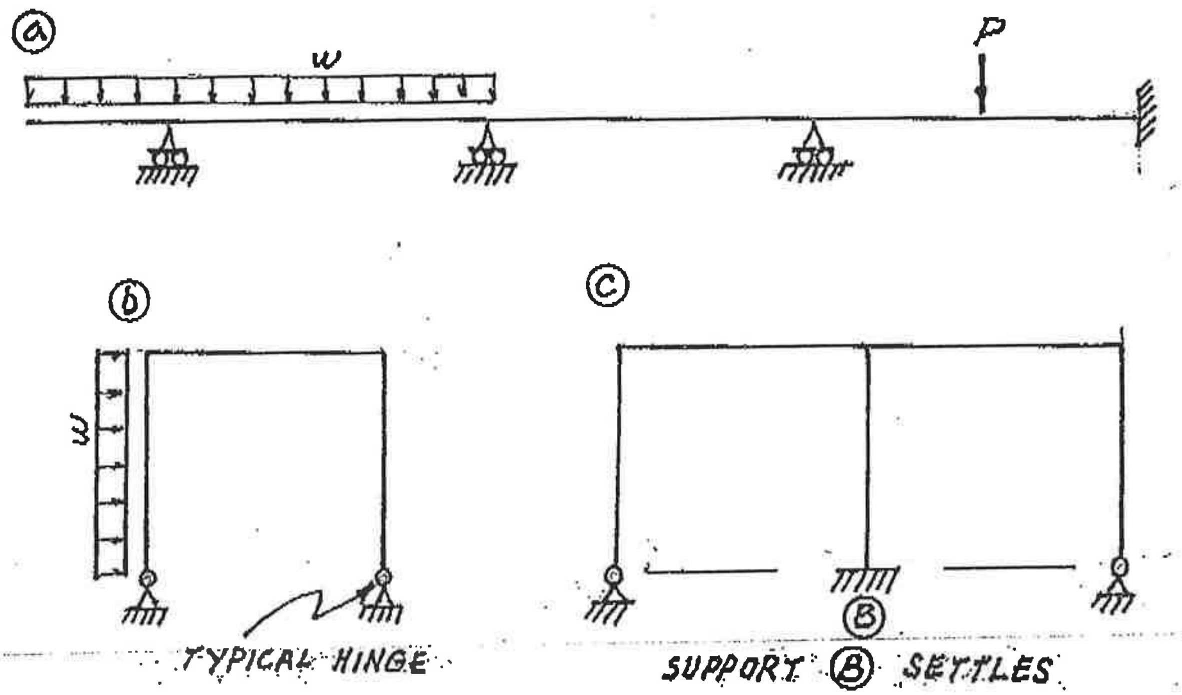
2. Each candidate may use an approved model of a Casio or Sharp calculator; otherwise, this is a CLOSED BOOK Examination.

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.

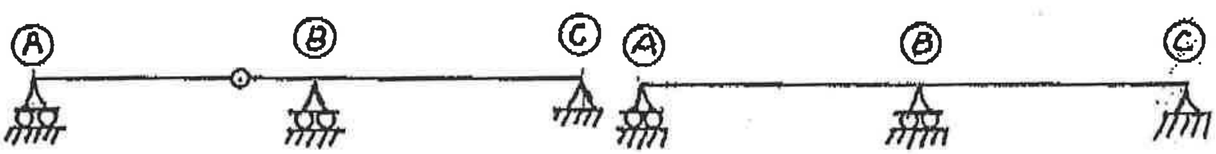
QUESTIONS #1 AND #2 MUST BE ANSWERED.

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



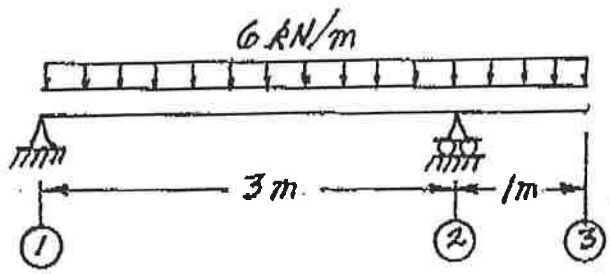
(8) 2. For each beam structure shown below, schematically show the influence line for the shear force immediately left of support (B). Note that structure a) is determinate and b) is indeterminate. Calculate and label the ordinate with the maximum absolute value on each influence line.

a) b).

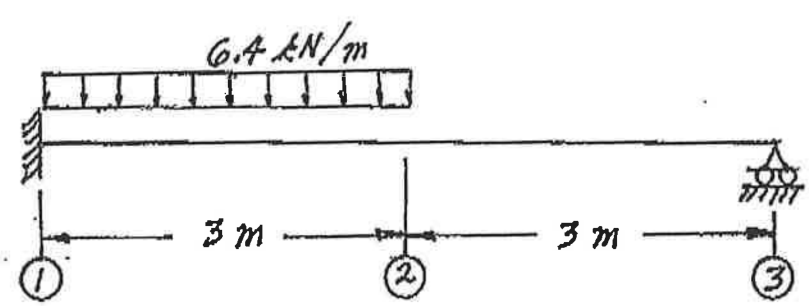


SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3,4 OR 5.

(18) 3. Use Castigliano's theorem to determine the vertical deflection at location (3) of the beam structure shown below. The EI value for both segments is 250 kN.m^2.

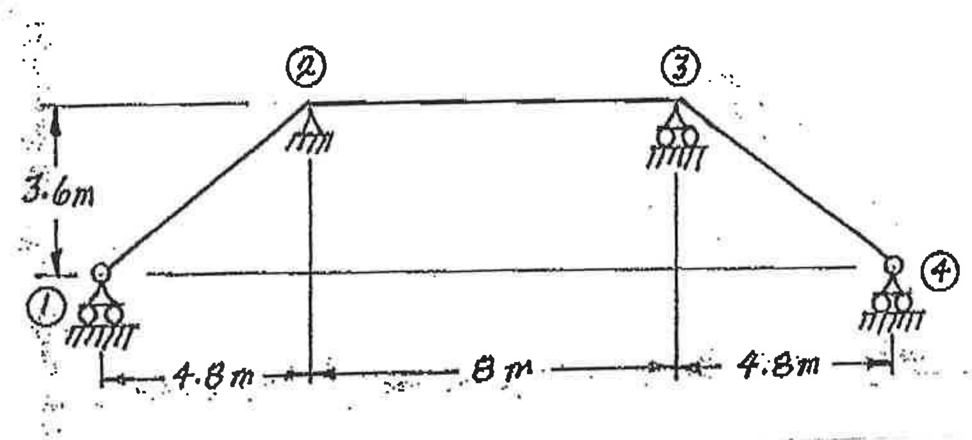


(18) 4. Use Castigliano's theorem (the least work theorem) to analyze the prismatic beam shown. Draw shear force and bending moment diagrams from point (1) to point (3). On both diagrams label the maximum and minimum ordinates. (Minimum ordinates are frequently negative values).



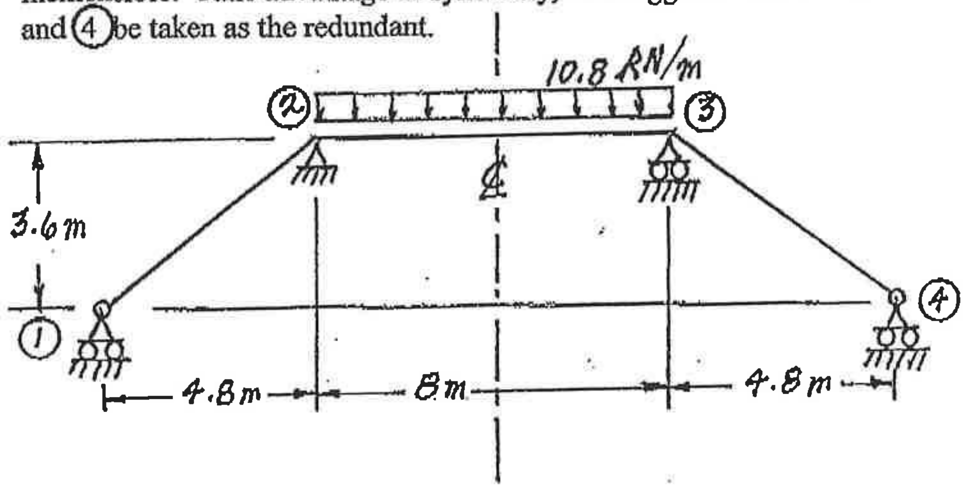
SELECT AND ANSWER TWO QUESTION ONLY FROM QUESTIONS 3, 4 OR 5.

(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 (Minimum ordinates are frequently negative). There are no loads on the structure, but joint (3) settles (moves downward) exactly 12.0 mm. All members are inextensible and have the same EI value which is 3.6×10^5 kN.m^2.



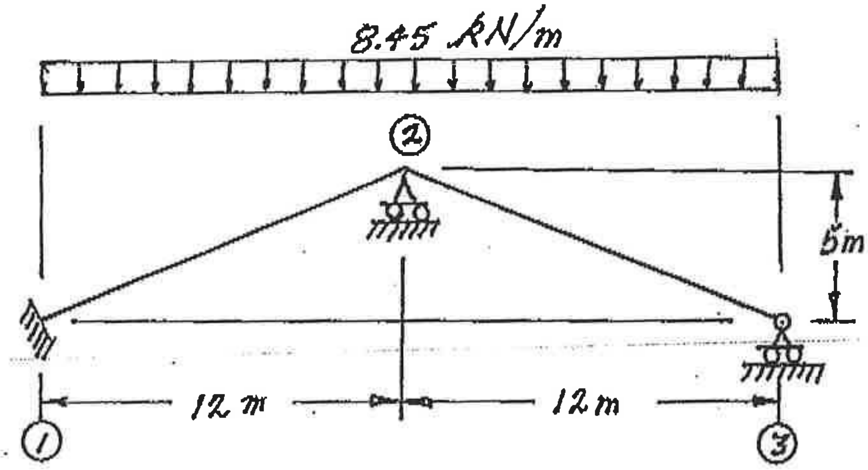
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(22) 6. Use a flexibility (force) method to analyse 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). All members are inextensible. Take advantage of symmetry; it is suggested that the reaction at support (1) and (4) be taken as the redundant.



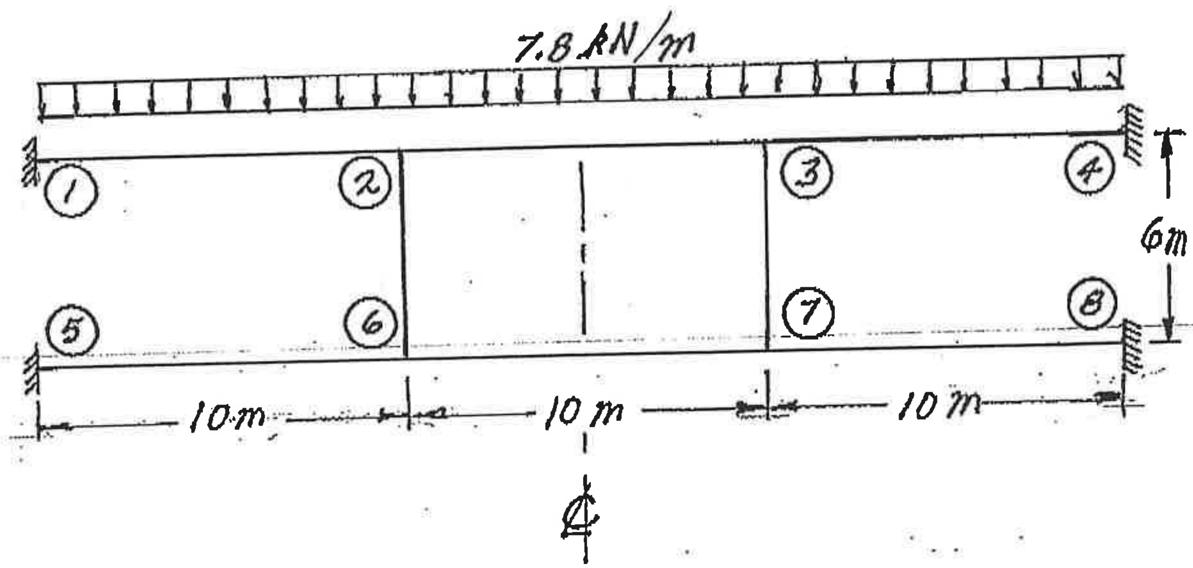
SELECT AND ANSWER TWO QUESTIONS ONLY FROM QUESTIONS 6, 7, 8 OR 9.

(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, joint (2) settles (moves downward) 12 mm. Plot shear force and bending moment diagrams. For each member on each diagram, calculate and 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 5.33×10^4 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. Draw shear force and bending moment diagrams. For each member on each diagram, calculate and indicate the maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members have the same EI and are inextensible. Take advantage of symmetry and/or anti-symmetry where applicable.
Note that the loading is on beams ①-②, ②-③ and ③-④ ONLY.



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 translation shown at Joint ③ below. 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 the direction shown)

θ_2 = rotation of joint ②

(counter clockwise positive)

θ_3 = rotation of joint ③