

NATIONAL EXAMS DECEMBER 2019

16-CIV-A1 ELEMENTARY

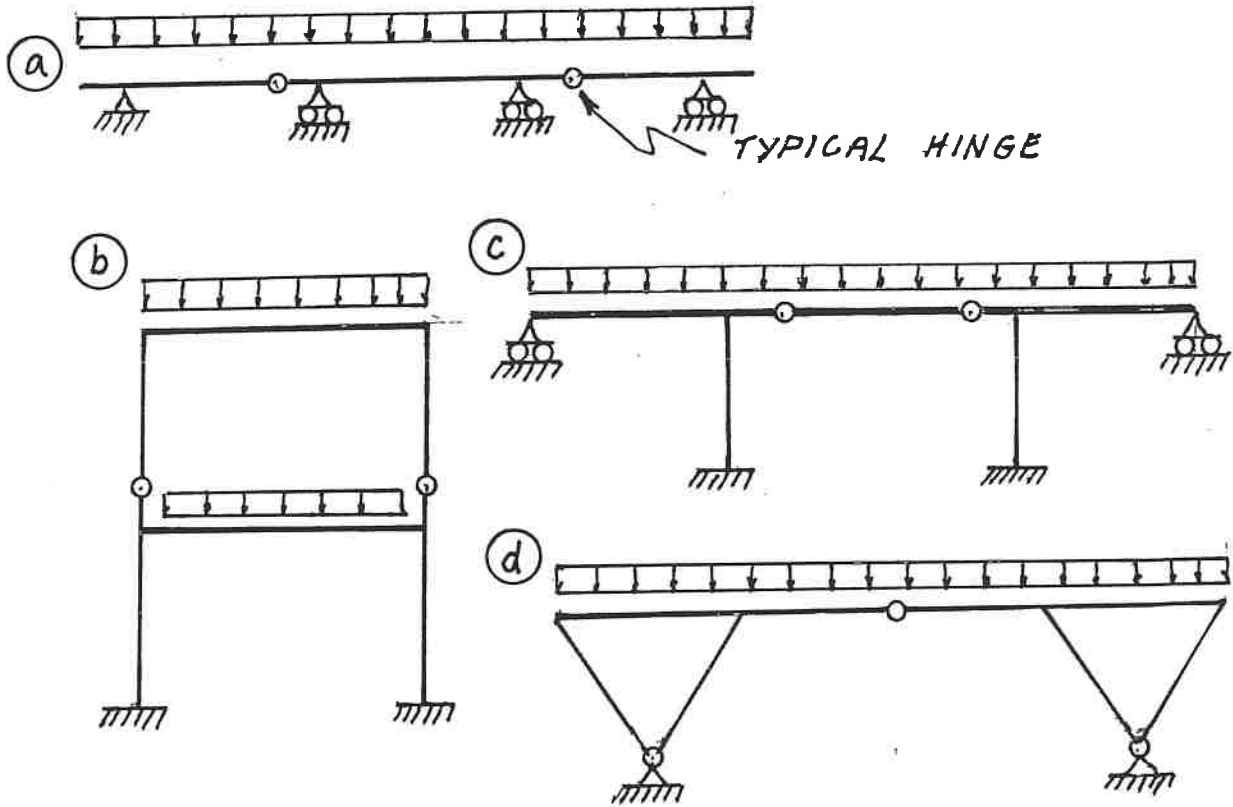
STRUCTURAL ANALYSIS

3 HOURS DURATION

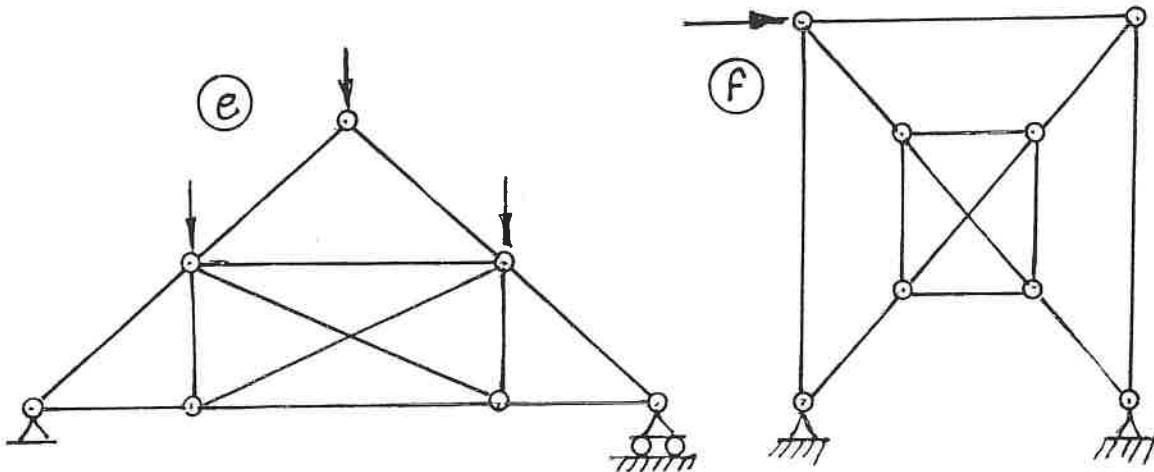
NOTES:

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. Six questions constitute a complete paper. Answer ALL questions #1 through #5; answer ONLY ONE of #6, #7 or #8.
4. The marks assigned to each question are shown in the left margin.

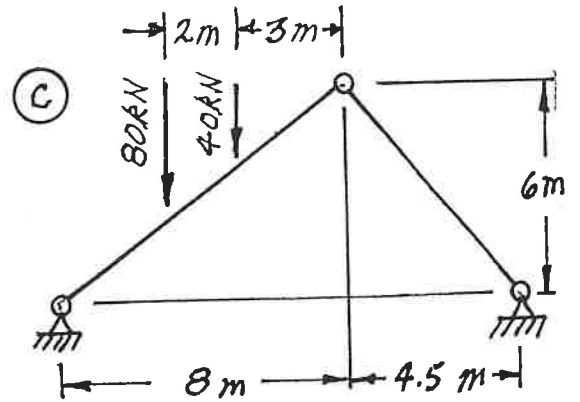
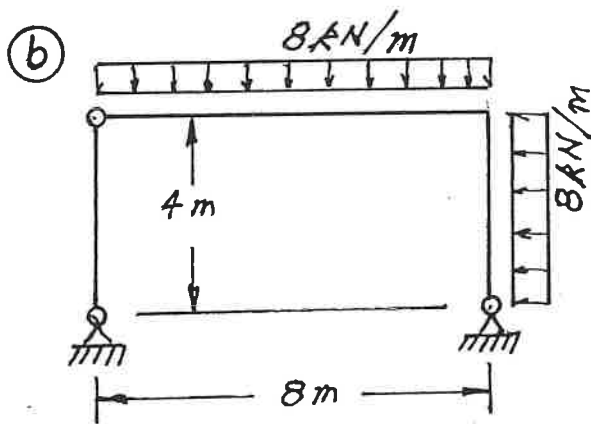
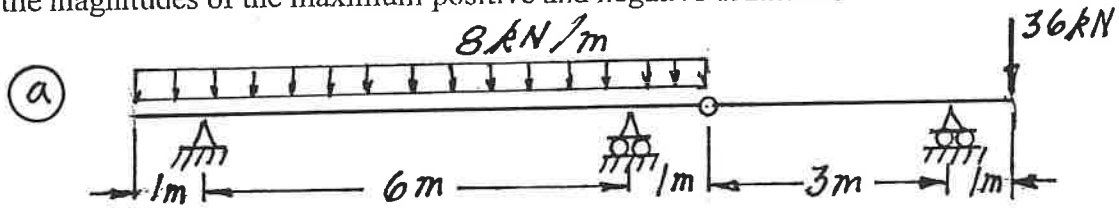
- (6) 1. For each of the structures shown state whether it is unstable, statically determinate, or statically indeterminate. If the structure is statically indeterminate, state the degree of indeterminacy. Structures a) through d) have beam-type members.



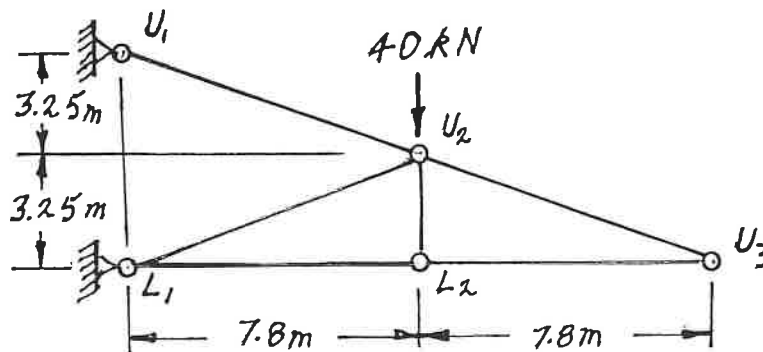
Structures e) through f) have truss-type members. Diagonals are not connected where they cross.



- (22) 2. For each structure shown, compute the reactions and draw shear and bending moment diagrams. Indicate which are positive and which are negative segments of each bending moment diagram. For each shear and bending moment diagram, calculate and indicate the magnitudes of the maximum positive and negative ordinates.

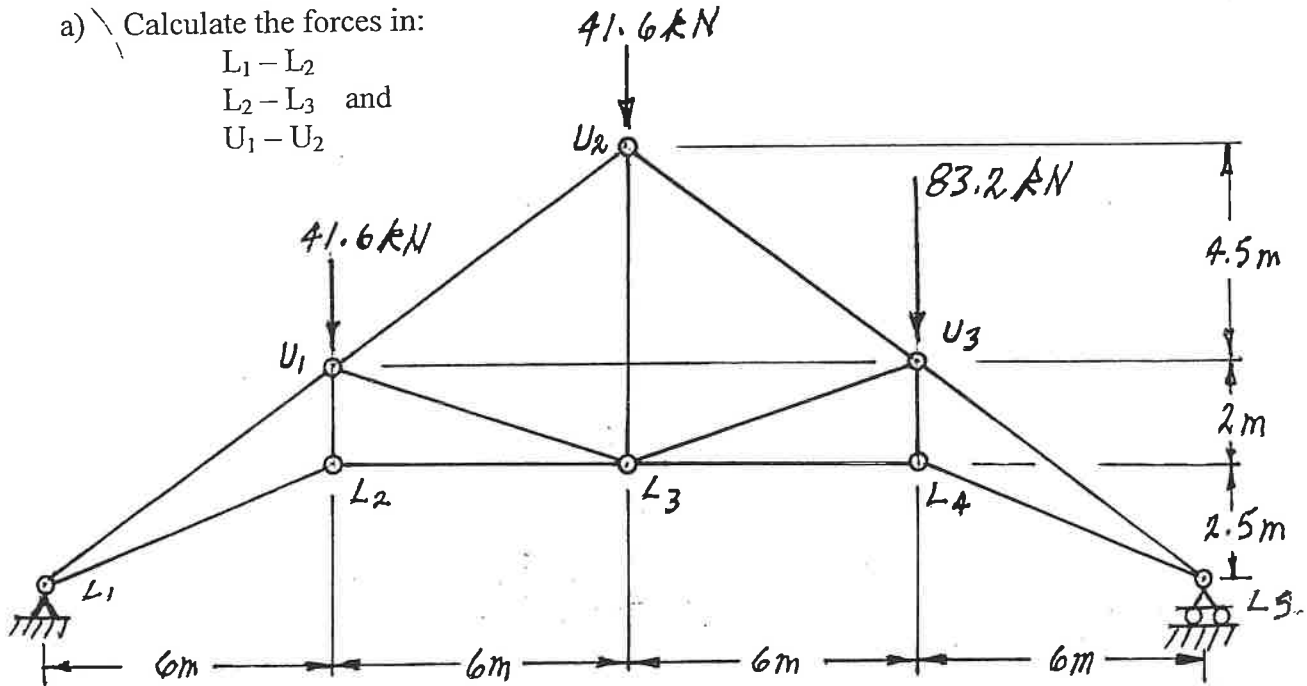


- (14) 3. (a) Calculate the vertical deflection at joint  $U_3$  on the truss shown below.  $AE = 84.5 \times 10^3 \text{ kN}$  for all members.  
 (b) If the 40 kN vertical load were at joint  $U_3$  instead of joint  $U_2$ , what would be the vertical deflection be at joint  $U_2$ ?

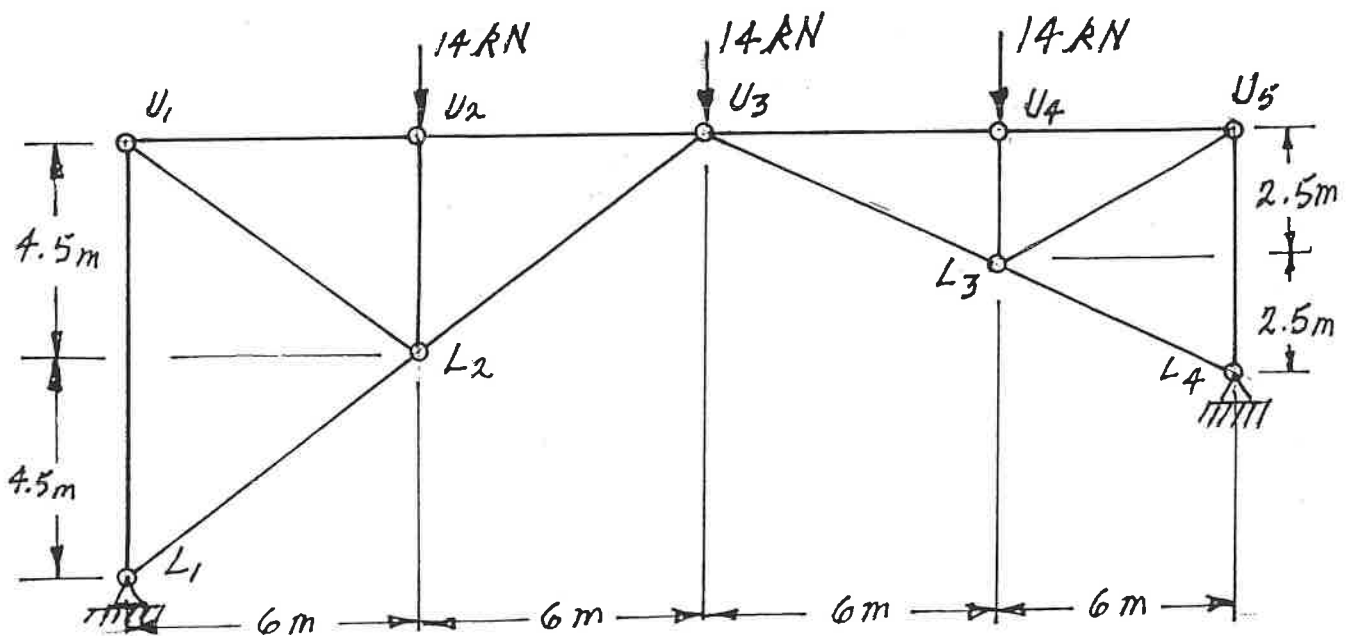


- (18) 4. For the trusses shown below, calculate the forces in the members that are listed. For each force, indicate whether it is tension or compression.

- a) Calculate the forces in:  
 $L_1 - L_2$   
 $L_2 - L_3$  and  
 $U_1 - U_2$



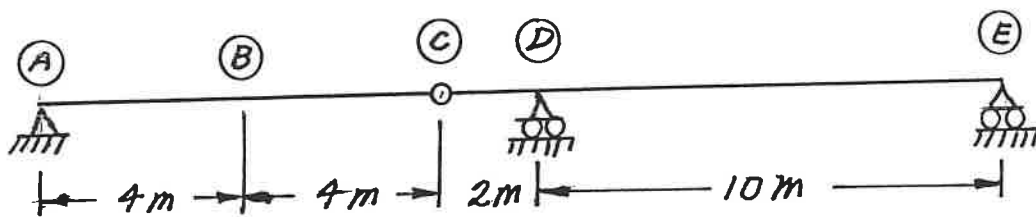
- b) Calculate the forces in:  
 $U_3 - L_3$   
 $L_3 - U_4$  and  
 $L_3 - U_5$



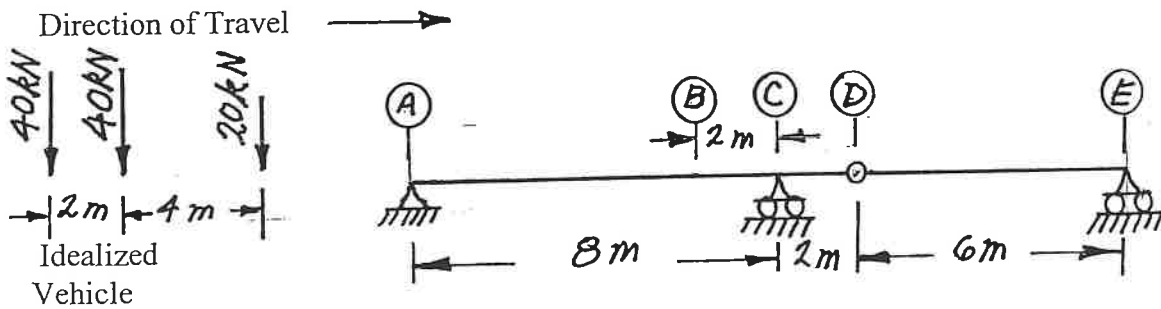
(18) 5. a) For the beams shown below, draw the influence lines from points (A) through (E) for:

- i) bending moment at point (B)
- ii) shear force immediately left of point (C), and
- iii) bending moment at point (D)

For each influence line, calculate and indicate the value of the influence coefficient that has the maximum absolute value.

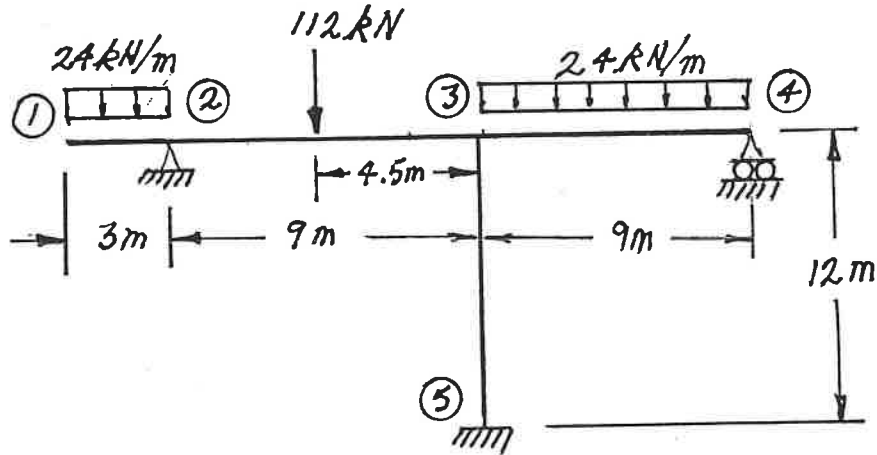


5. b) A vehicle, which is idealized as three point loads shown on the left below, moves across the beam structure shown. Calculate and show the influence line for shear force at point (B). Also calculate the largest shear force at the point (B) that would occur while the idealized vehicle crosses the structure.



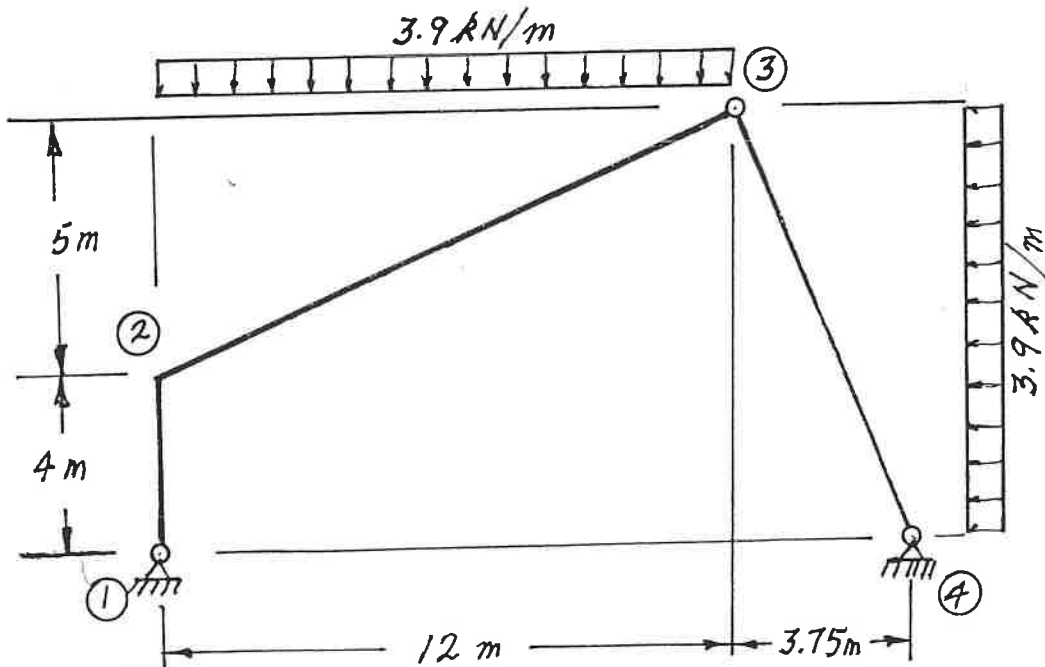
Select and answer ONE QUESTION ONLY from Question #6, #7 or #8.

- (22) 6. For the frame shown below, using the moment-distribution method or the slope-deflection method, calculate and plot the shear force and bending moment diagrams. On both diagrams, for each member, calculate and label the maximum and minimum ordinates (Minimum ordinates are frequently negative values). All members have the same EI value and are inextensible.



Select and answer ONE QUESTION ONLY from Question #6, #7 or #8.

- (22) 7. For the structure shown below, compute the reactions and draw shear and bending moment diagrams. On both diagrams, for each member, calculate and label the maximum and minimum ordinates (Minimum ordinates are frequently negative values).



Select and answer ONE QUESTION ONLY from Question #6, #7 or #8.

- (22) 8. Use the principle of virtual work to calculate the vertical deflection at point (B) on the two-beam structure shown below. Both beams have the same EI value which is  $8.1 \times 10^3 \text{ kN.m}^2$ .

