

NATIONAL EXAMS DECEMBER 2017

16-CIV-A1 ELEMENTARY

STRUCTURAL ANALYSIS

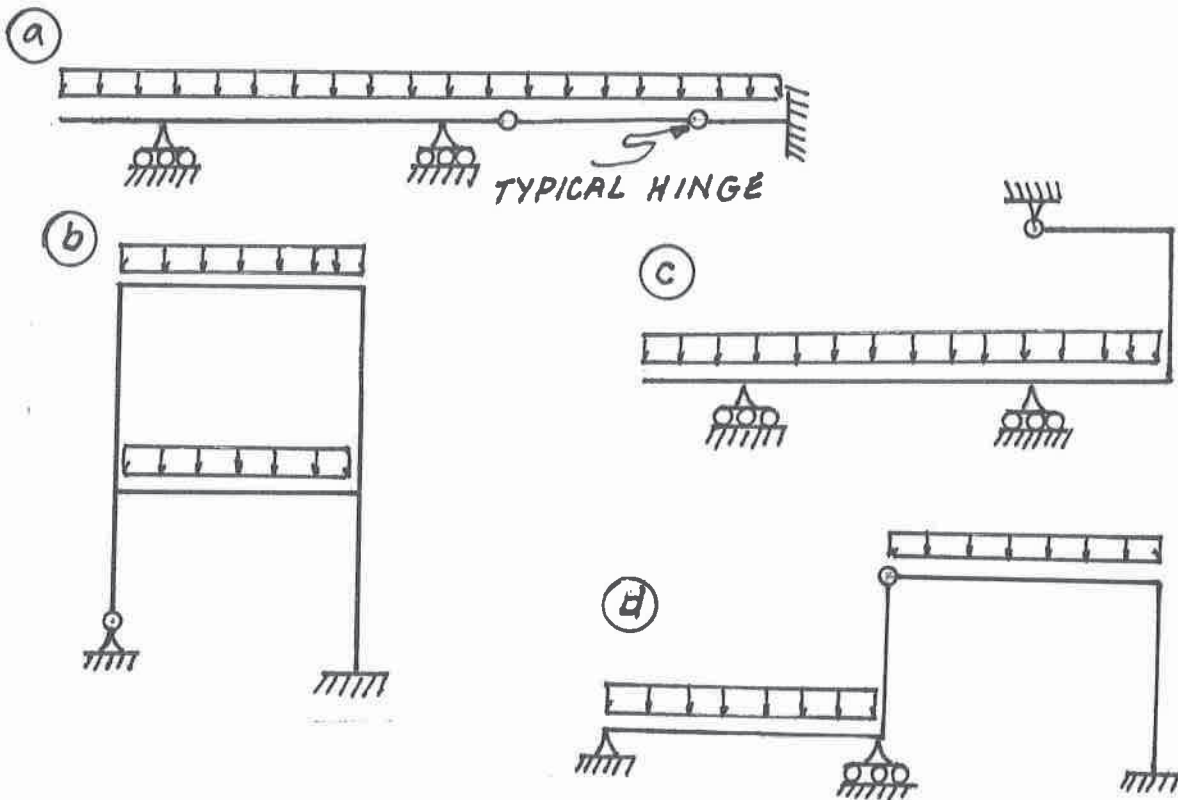
3 HOURS DURATION

NOTES:

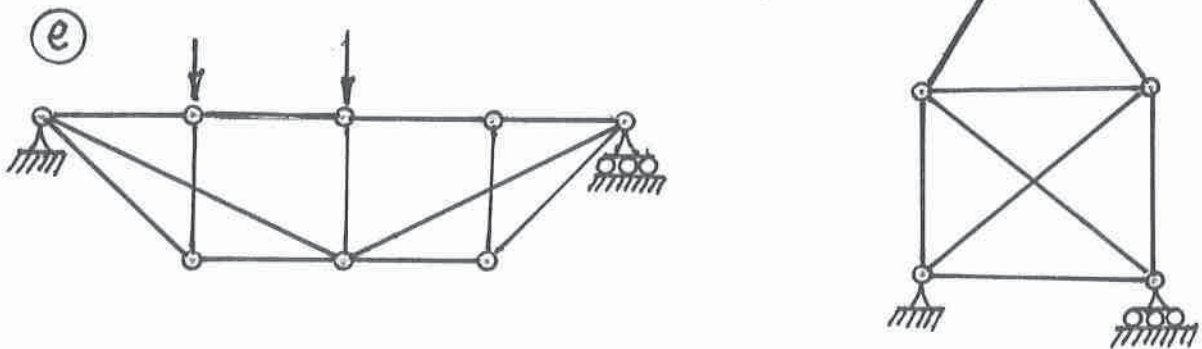
1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.
2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.
3. Six questions constitute 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.

FRONT PAGE

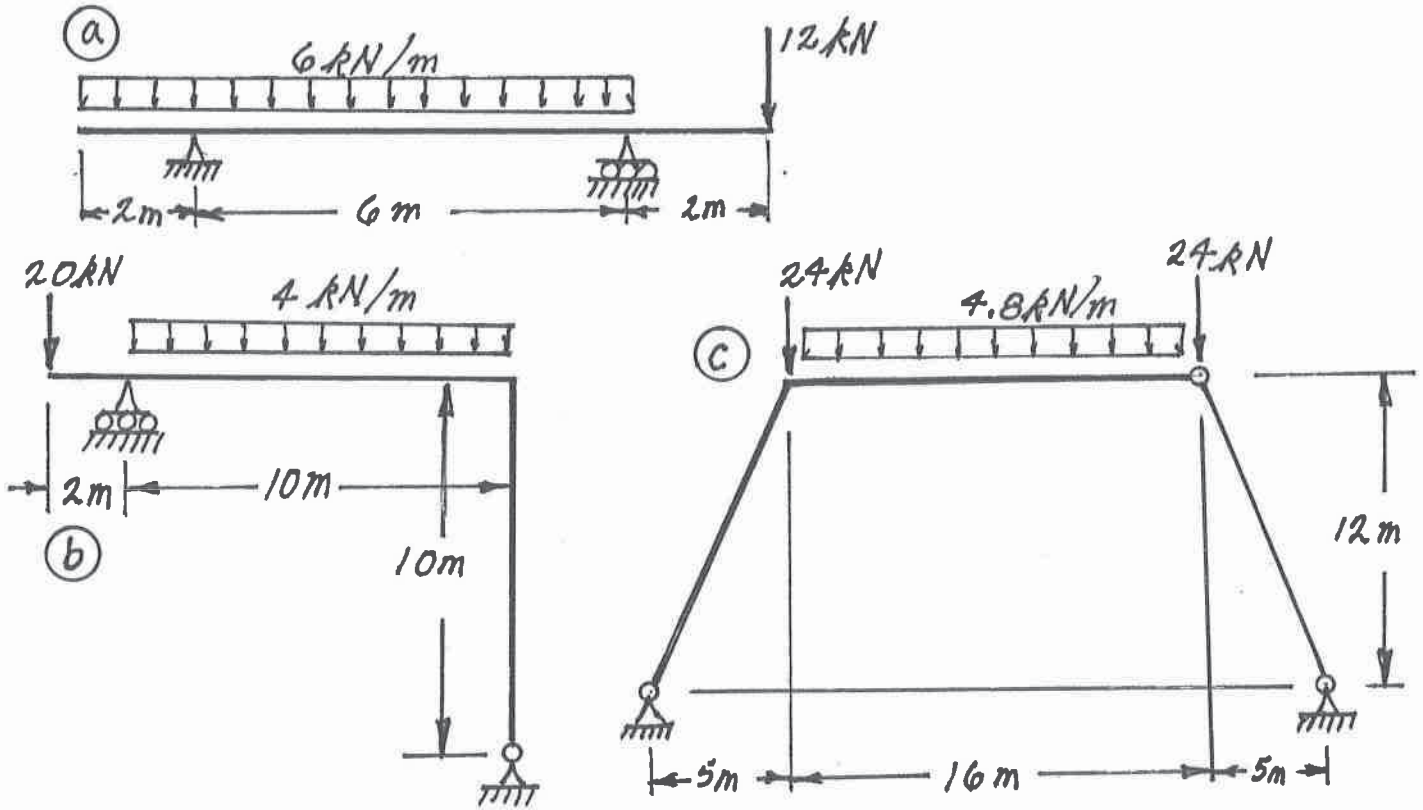
- (6) 1. For each of the structures shown state whether it is unstable, statically determinate, or statically indeterminate. If the structure is statically indeterminate, state the degree of indeterminacy. Structures a) through d) have beam-type members.



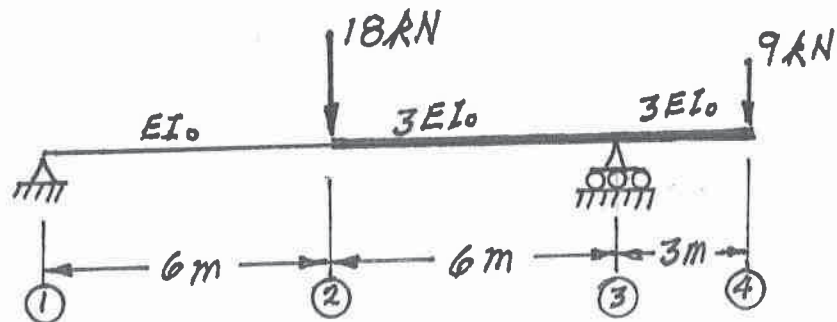
Structures e) and f) have truss-type members. Diagonals are not connected where they cross.



- (18) 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 member on the shear and bending moment diagrams, calculate and indicate the magnitudes of the maximum and minimum ordinates (Minimum ordinates are frequently negative.).



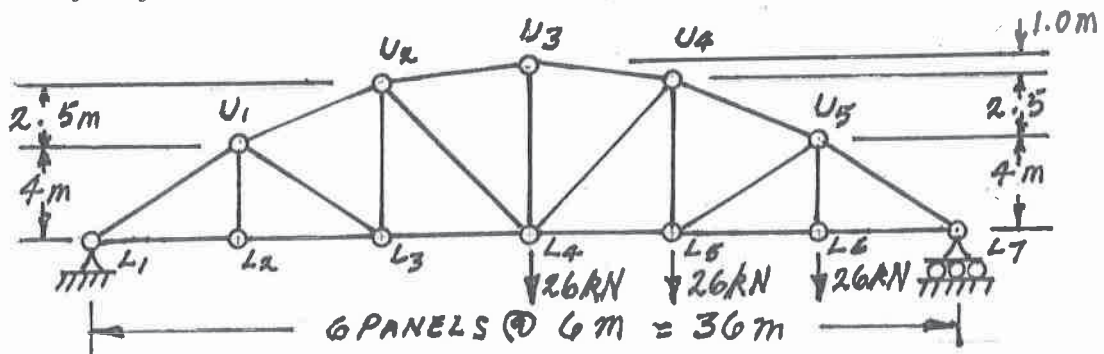
- (18) 3. Calculate the vertical deflection at point ② on the continuous beam shown below.  
 $EI_0 = 9000 \text{ kN}\cdot\text{mm}^2$ .



(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.

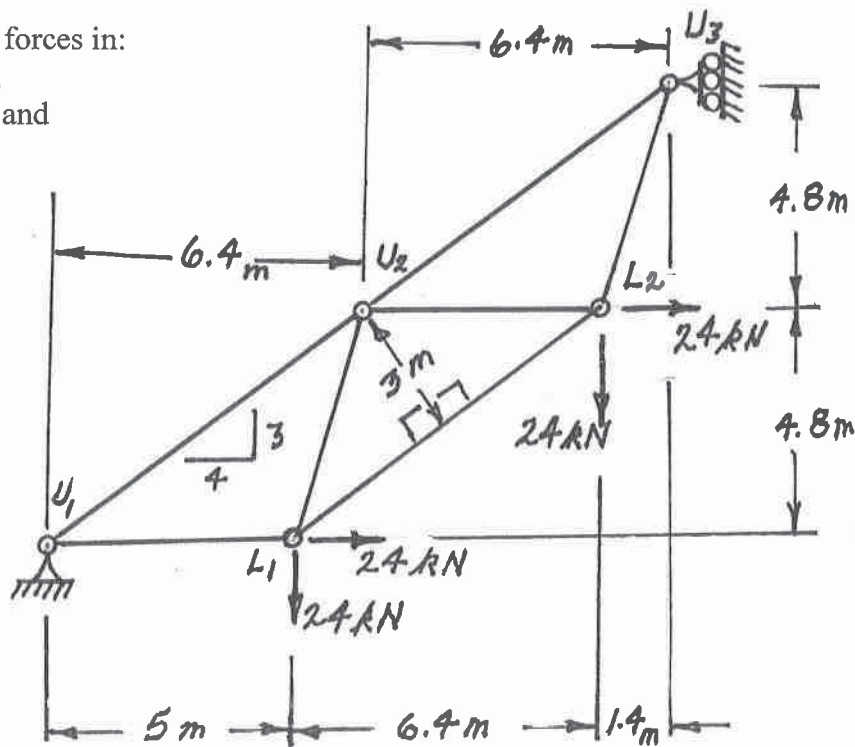
a) Calculate the forces in:

- $U_4 - U_5$ ,
- $L_4 - L_5$  and
- $L_5 - U_5$



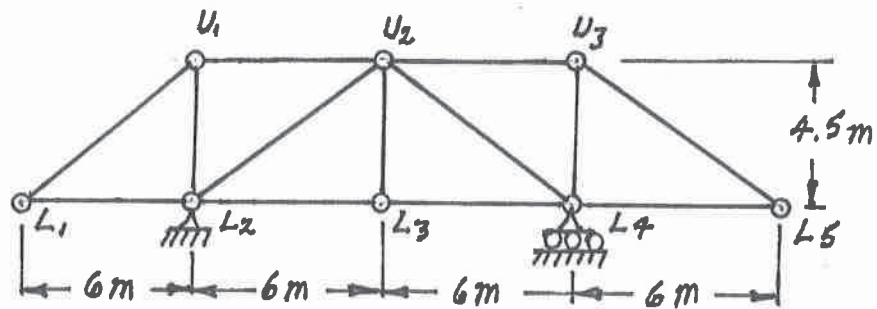
b) Calculate the forces in:

- $L_1 - L_2$ ,
- $U_2 - U_3$  and
- $U_2 - L_2$



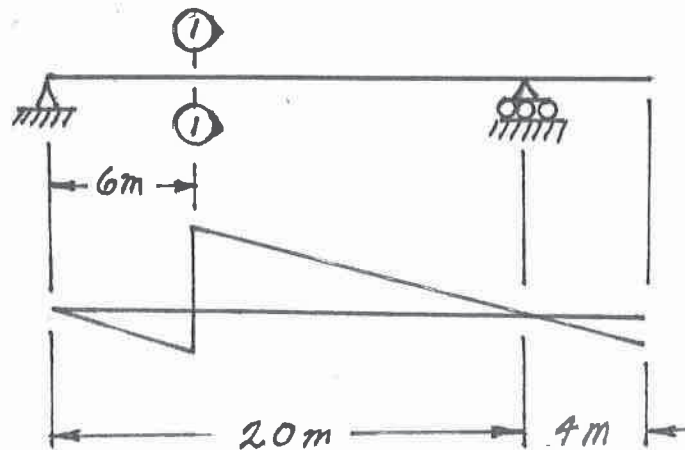
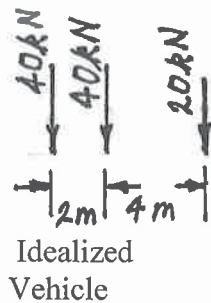
- (18) 5. a) Loads move along beams at the bottom chord level of the truss shown. Draw influence lines for forces in the three members listed above the truss. For each influence line, calculate and indicate the values of the influence coefficients that have the maximum tension and compression values.

Members  $U_1-U_2$ ,  $U_2-L_3$  and  $U_2-L_4$



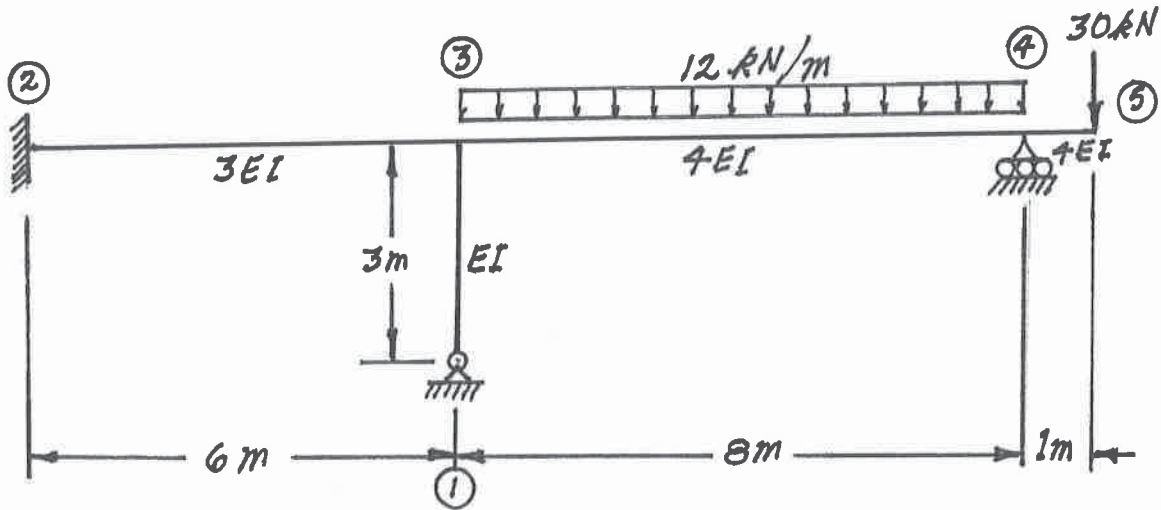
- b) A vehicle, which is idealized as three point loads shown on the left below, moves across the beam structure shown. The shape of the influence line for shear at Section ①-① is shown below. Calculate and show the ordinates of the influence line. Also calculate the maximum shear force at Section ①-① as the idealized vehicle crosses the structure.

Direction of Travel  $\longrightarrow$

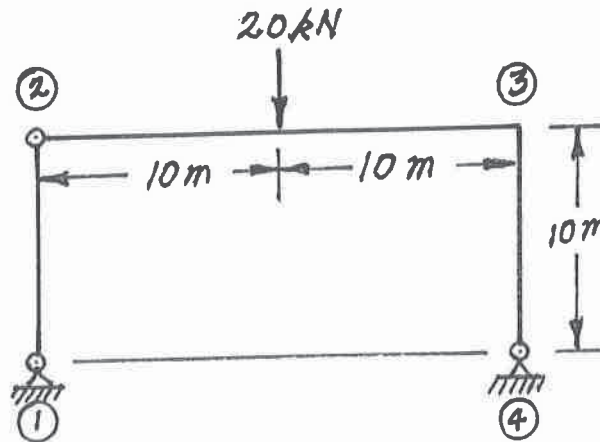


Select and answer ONE QUESTION ONLY from Questions #6, #7 or #8.

- (22) 6. For the frame shown below, use the slope-deflection method to analyse the structure; calculate and plot the shear force and bending moment diagrams. On both diagrams, for each member, label the maximum and minimum ordinates. (Minimum ordinates are frequently negative values.) Members have the relative EI values shown and are inextensible.



- (22) 7. Use the principle of virtual work to calculate the horizontal deflection at point ③ on the structure shown below. Consider only flexural strain. All members are prismatic and have the same EI value;  $EI = 2.0 \times 10^5 \text{ kN.m}^2$ .



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

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

