MAY 2019 NATIONAL EXAMS

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.

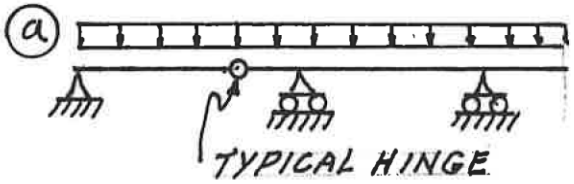
2. Each candidate may use an approved model of Sharp or Casio calculator; otherwise, this is a CLOSED BOOK Examination.

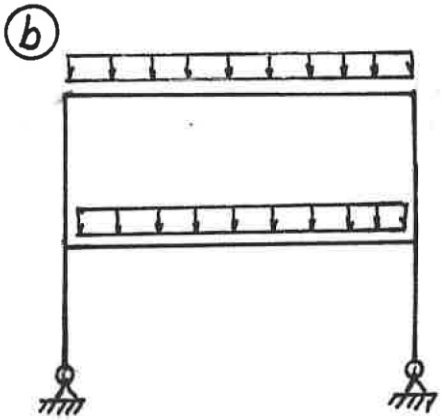
3. Six questions constitute a complete paper. Answer ALL questions #1 through #5; answer ONLY ONE of #6, #7 or #8.

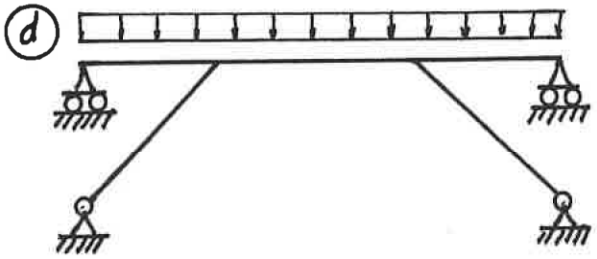
4. The marks assigned to each question are shown in the left margin.

FRONT PAGE

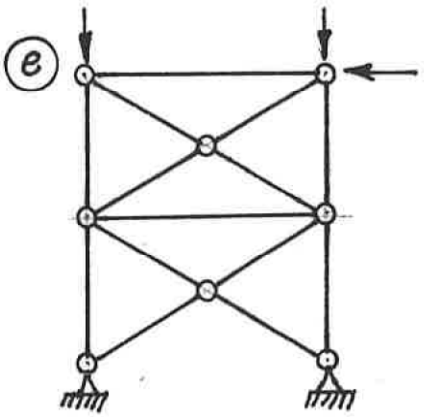
(6) 1. For each of the structures shown state whether it is unstable, statically determinate, or statically indeterminate. If the structure is statically indeterminate, state the degree of indeterminacy. Structures a) through d) have beam-type members.

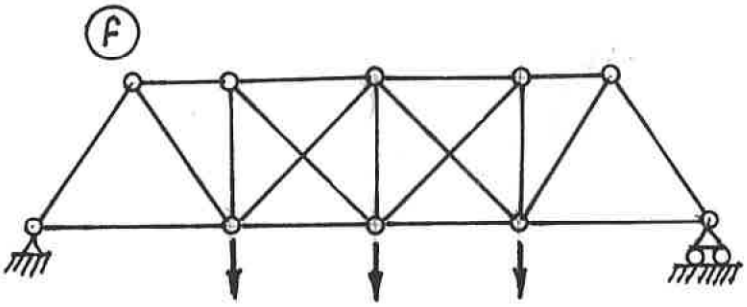




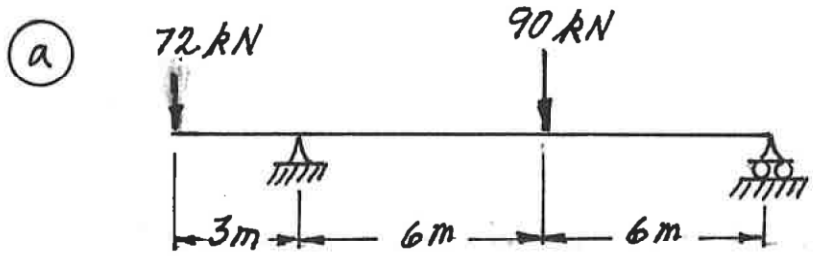


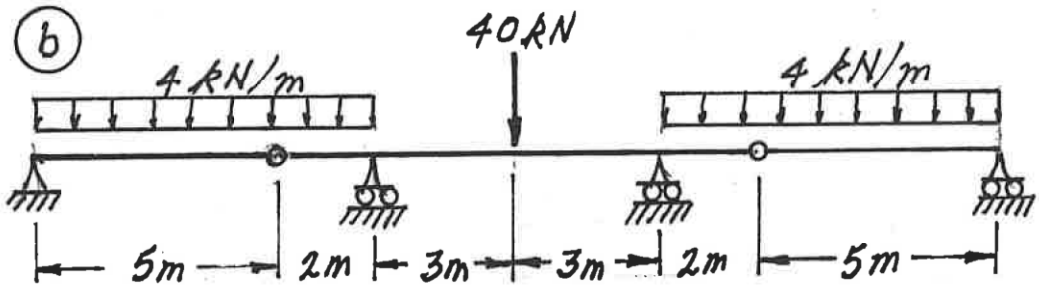
Structures e) and f) have truss-type members.
Diagonals in f) are not connected where they cross.

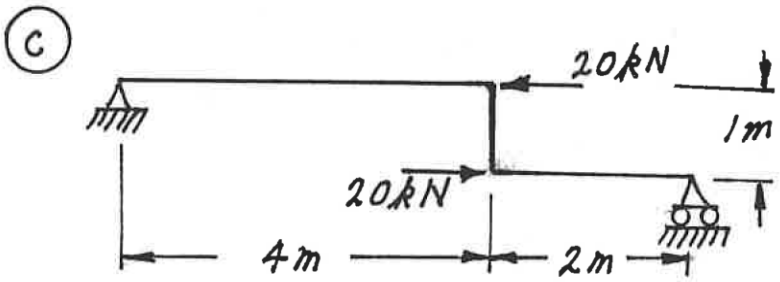




(24) 2. For each structure shown, compute the reactions and draw shear and bending moment diagrams. Indicate which are positive and which are negative segments of each bending moment diagram. For each shear and bending moment diagram, calculate and indicate the magnitudes of the maximum positive and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



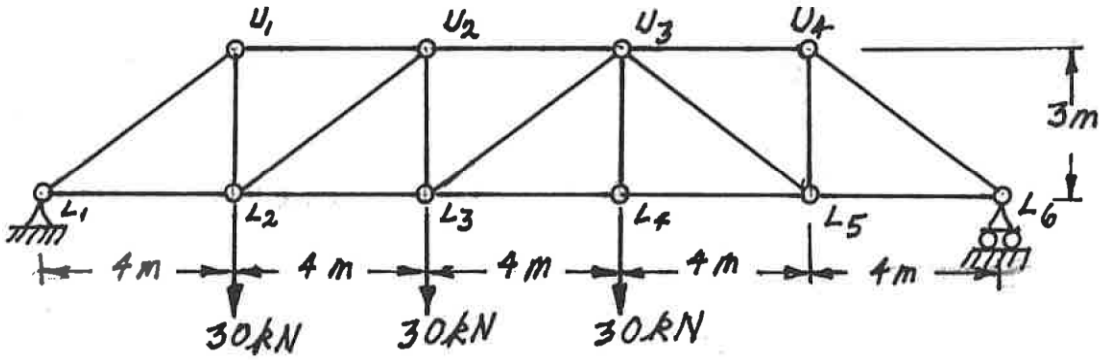




(16) 3. For the truss shown below, calculate the forces in the members that are listed. For each force, indicate whether it is tension or compression.

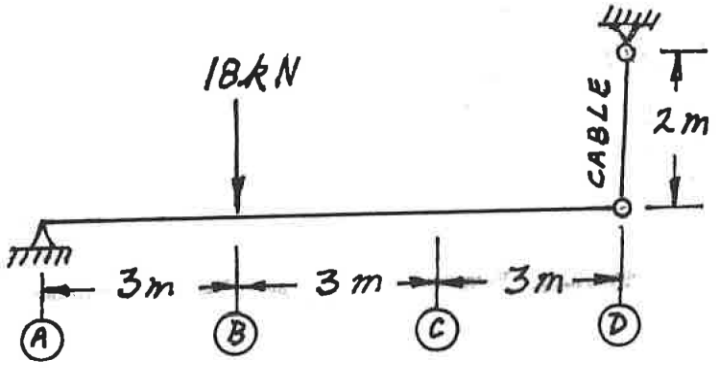
Calculate the forces in:

$L_1 - U_1$
$L_2 - L_3$
$L_2 - U_2$ and
$L_2 - U_1$



(16) 4. a) At point (C) calculate the vertical deflection of the beam below with the one load shown at point (B). For the beam, EI = 21000 kN.m^2; for the cable AE = 2000 kN.

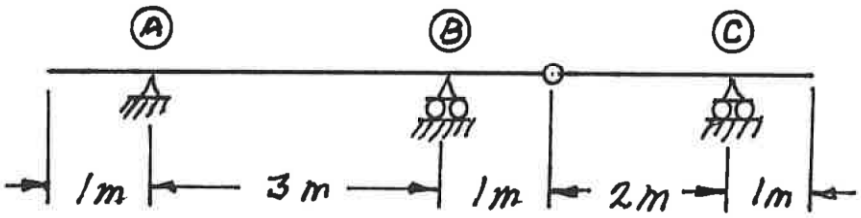
b) Without doing further calculations, if the 18 kN vertical load were at point (C) **instead** of at (B), what would be the vertical deflection at point (B)? What theorem supports your answer?



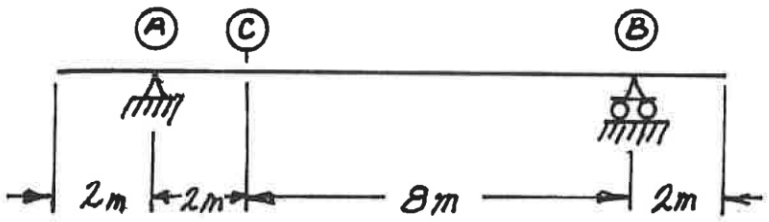
(6) 5. a) For the determinate beams shown, draw the influence lines for:

i) bending moment over support (B)
ii) shear immediately left of support (B).

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

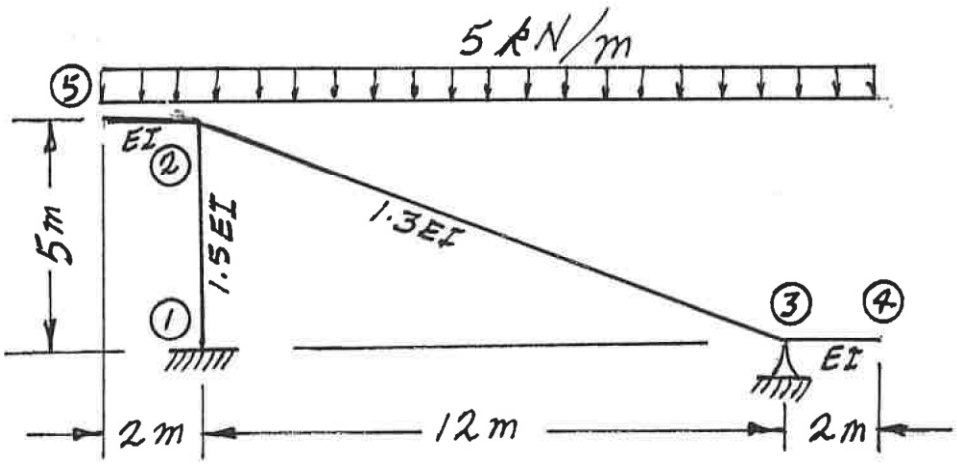


(10) b) For the beam shown below, determine the maximum absolute values of **moment** and **shear** at point (C) caused by two loadings **combined**:
i) a uniformly distributed load of 6 kN/m placed over any **portion** or **portions** of the total beam length AND
ii) two 30 kN concentrated loads that must remain 2 m apart and can be placed anywhere along the total beam length.



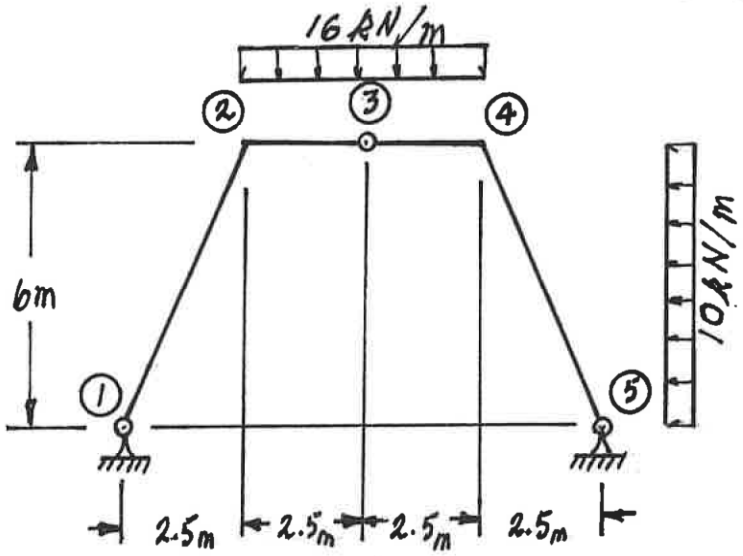
Select and answer ONE QUESTION ONLY from Questions #6, #7 or #8.

(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, label the maximum and minimum ordinates (Minimum ordinates are frequently negative values.). All members are inextensible and relative values of EI are shown on the sketch below.



Select and answer ONE QUESTION ONLY from Questions #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 magnitude of the maximum and minimum ordinates (Minimum ordinates are frequently negative values). The horizontal loading is applied to member (4)–(5) only.



(22) 8. Use the **principle of virtual work** to calculate the horizontal deflection at joint (2) on the frame shown. All members are inextensible and have EI = 1.8×10^5 kN.m^2.