NATIONAL EXAMS DECEMBER 2015

07-Str-A1   ELEMENTARY

STRUCTURAL ANALYSIS
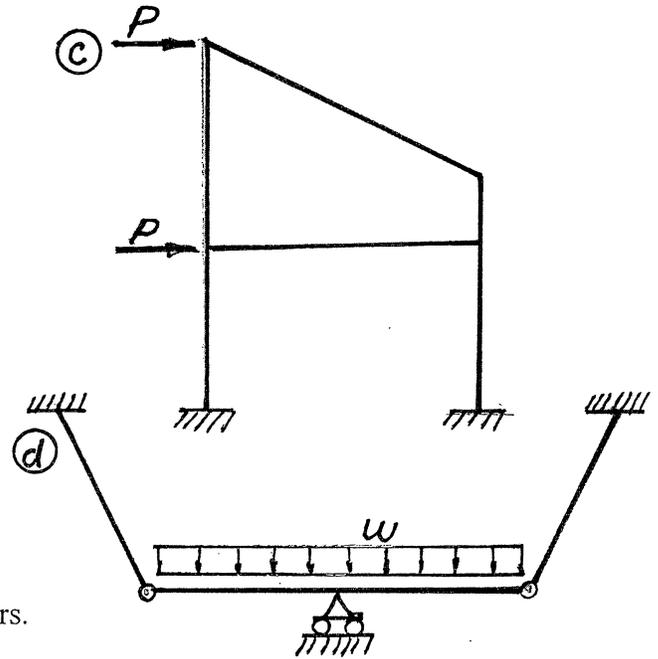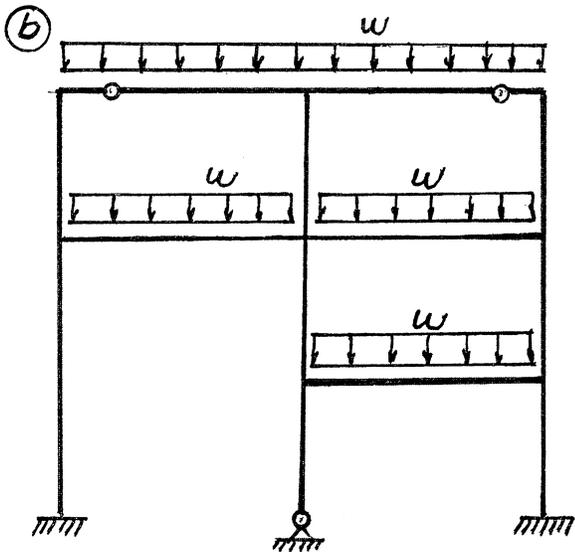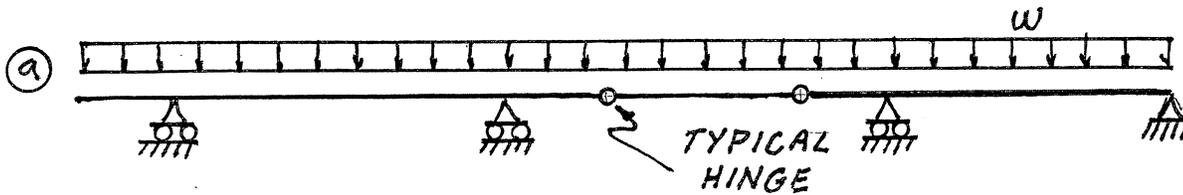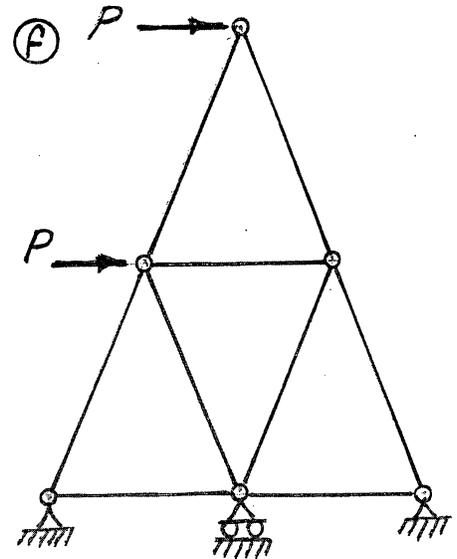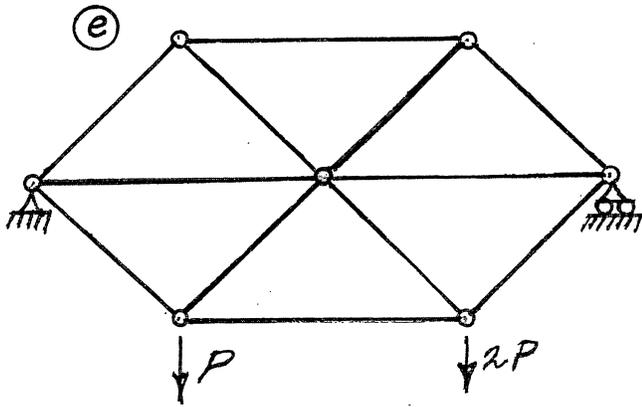
3 HOURS DURATION

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 #4; answer
      ONLY TWO of #5, #6, #7 or #8.

4.   The marks assigned to each question are shown in the left margin.
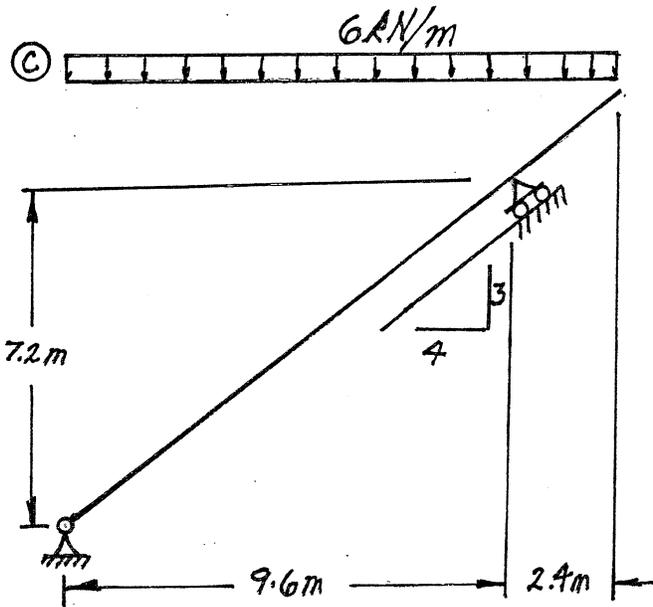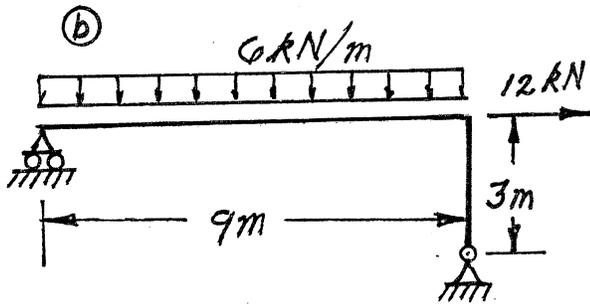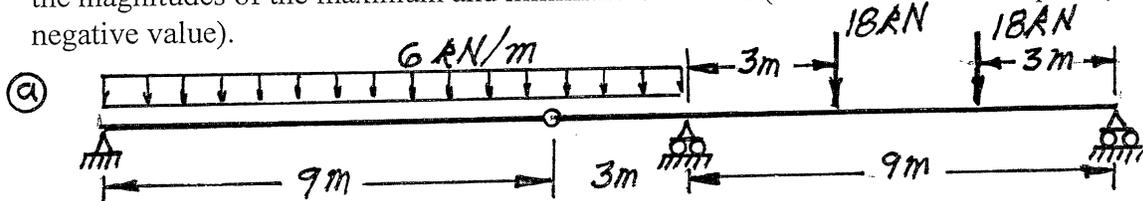
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(6)   1.   For each of the structures shown state whether it is unstable, statically determinate, or statically indeterminate. If the structure is statically indeterminate, state the degree of indeterminacy. Structures a) through d) have beam-type members.
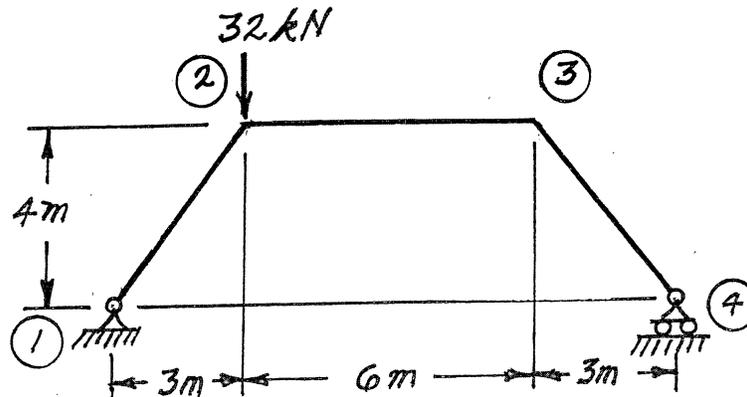

(a)

w

TYPICAL
HINGE

(b)

w

w w

w

(c)

P

P

(d)

w

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

(e)

P $2P$

(f)

P

P

(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 shear and bending moment diagram, calculate and indicate the magnitudes of the maximum and minimum ordinates (The minimum is frequently a negative value).
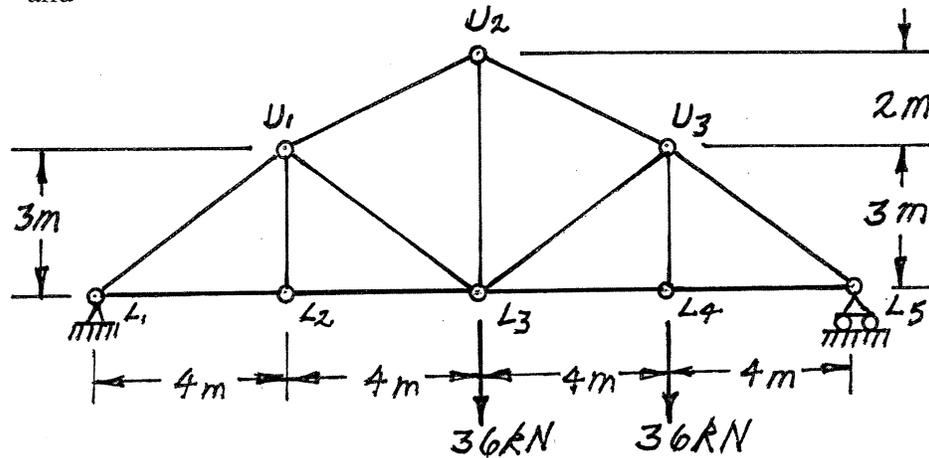

(18)   3.   (a)   Calculate the vertical deflection at point ③ on the structure shown below. $EI = 28.8 \times 10^3$ kN.m² for all members. Consider only flexural strain.

          (b)   If the 32 kN vertical load were at point ③ instead of point ②, what would be the vertical deflection be at point 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.
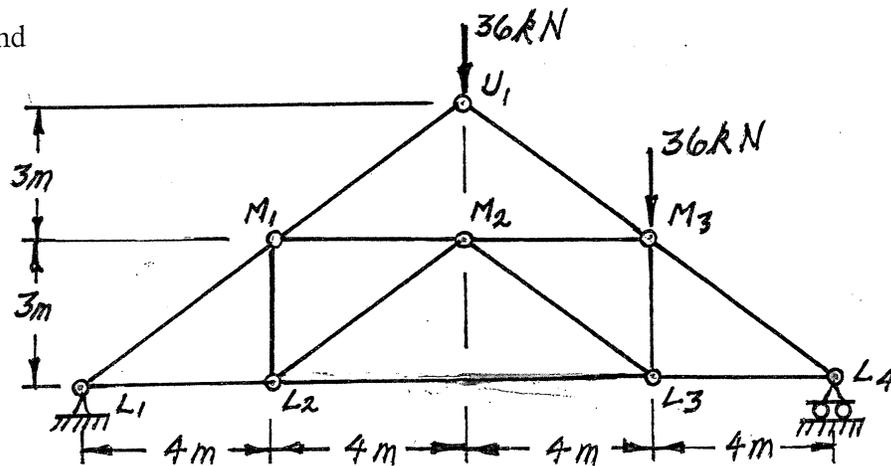
a)   Calculate the forces in:
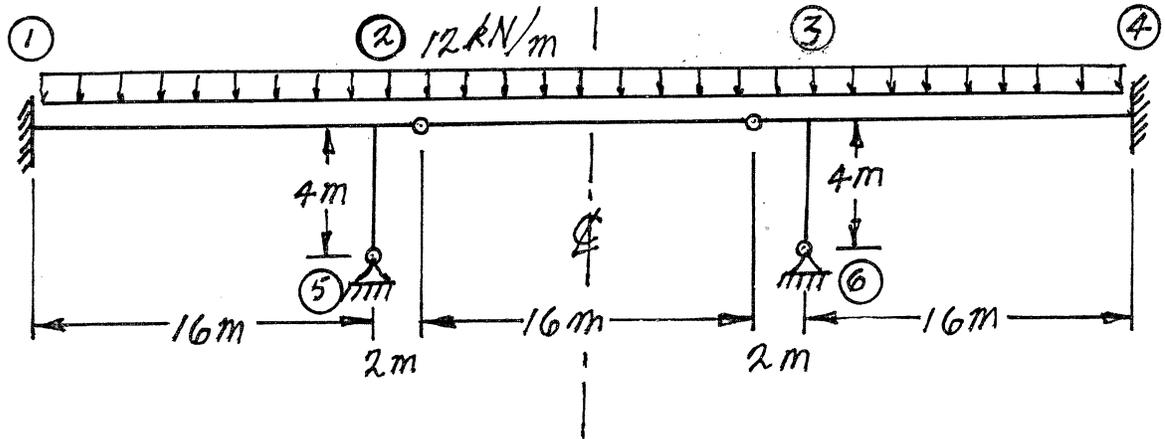 $L_1 - U_1$
        $U_1 - L_3$ and
        $L_3 - L_4$

b)   Calculate the forces in:
        $M_1 - M_2$
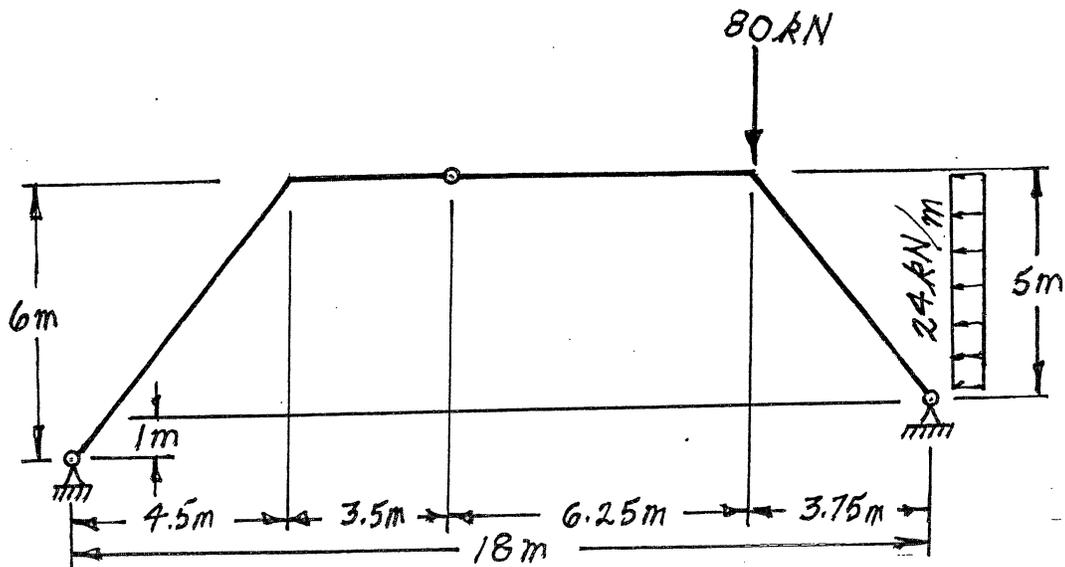 $L_2 - M_2$ and
        $L_2 - L_3$

Select and answer TWO QUESTIONS ONLY from Questions #5, #6, #7 or #8.

(20)   5.   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. Take advantage of symmetry.
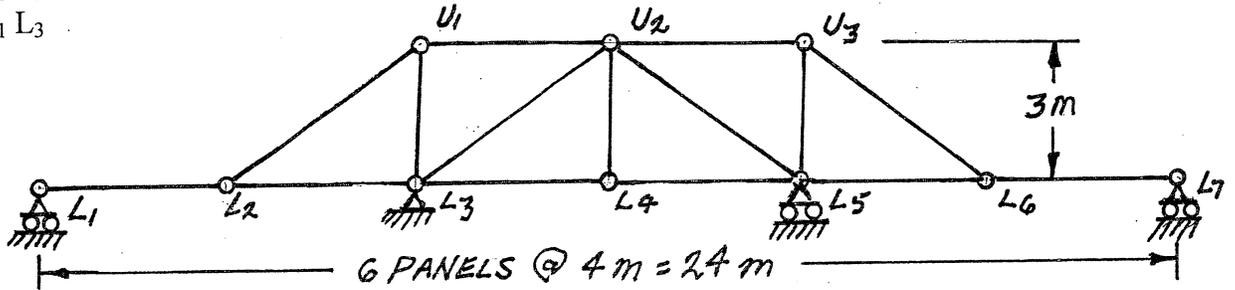

(20)   6.   For the structure shown below, compute the reactions and draw shear and bending moment diagrams. On both diagrams for each member, calculate and label the maximum and minimum ordinates (Minimum ordinates are frequently negative values).
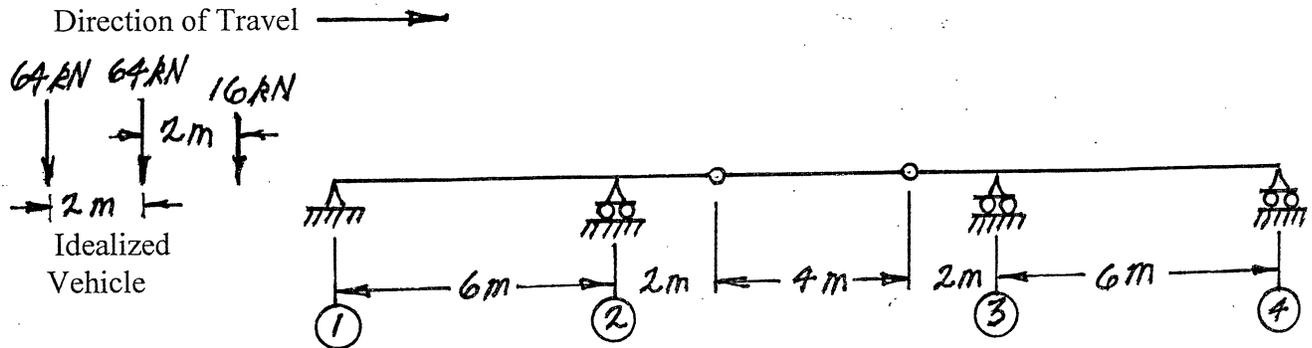
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Select and answer TWO QUESTIONS ONLY from Questions #5, #6, #7 or #8.

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

$U_1 U_2$
$U_2 L_5$
$U_1 L_3$

6 PANELS @ 4 m = 24 m

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 negative bending moment over support ③. Also calculate the negative bending moment over support ③ with the maximum absolute value that would occur while the idealized vehicle crosses the structure.

Direction of Travel ————▶

64 kN 64 kN 16 kN

Idealized
Vehicle

Select and answer TWO QUESTIONS ONLY from Questions #5, #6, #7 or #8.

(20)   8.   Use the principle of virtual work to calculate the horizontal deflection at joint L_3 of the truss shown below. All members have the same EA value which is 9.45×10^4 kN.