CE 461 – Structural Analysis Name: [illegible]
EXAM No. 1

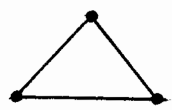
1. [5] Explain what an influence line describes.

An influence line is a graph of a response function of a structure as a function of a unit load (downward acting) moving across the structure.

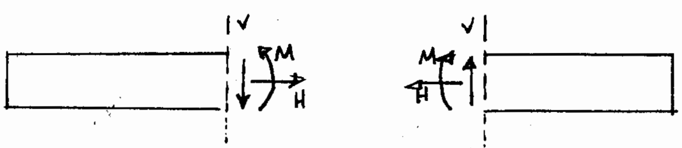
2. [5] What does the principle of superposition state? (A picture or diagram may be helpful in your explanation)

On a linear-elastic structure, the combined effect of several loads acting simultaneously is equal to the algebraic sum of the effects of each load acting separately.

3. [4] Draw the basic truss element.

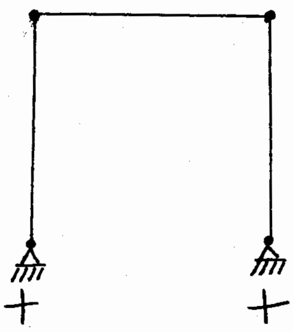


4. [6] Draw the arrowheads on internal forces M, V, and H on both sides of the cut according to positive internal force sign convention.



2. [20] Label the following structures as determinate, indeterminate, or unstable. If the structure is indeterminate, indicate the degree of indeterminacy.

(a)

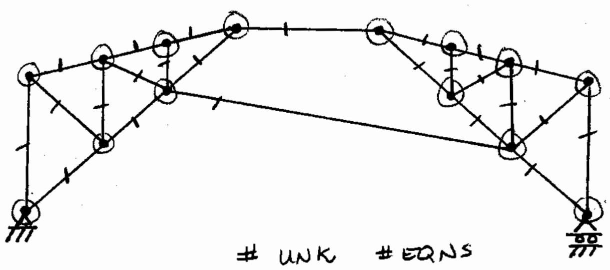


UNK # EQNS

4 < 3+2

UNSTABLE!

(b)



b = 24 # UNK # EQNS

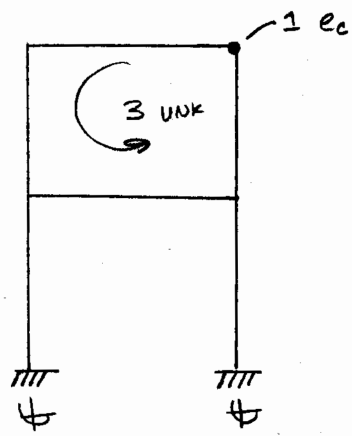
j = 14 b+r 2j

24 + 3 2(14)

27 < 28

UNSTABLE!

(c)



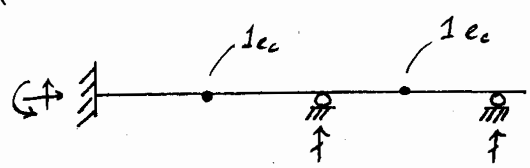
UNK # EQNS

6 + 3 3 + 1

9 > 4 ∴ 5° Ind. iff stable.

Stable ∴ 5° ind.

(d)



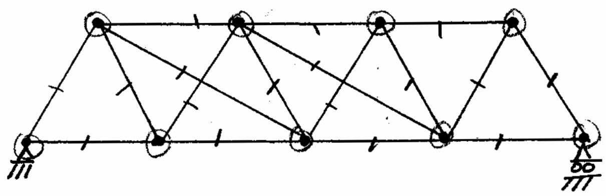
UNK # EQN

5 = 3 + 2

∴ Det. iff STABLE

Stable ∴ Determinate

(e)



b = 17 # UNK # EQNS

j = 9 b+r 2j

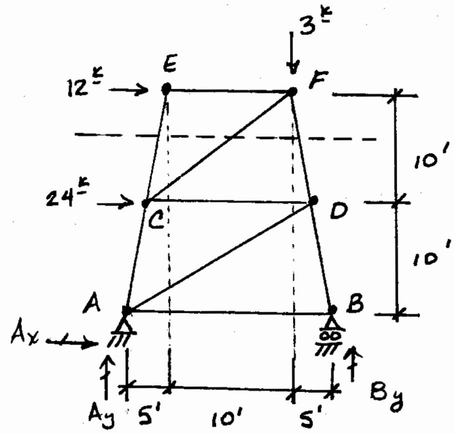
17 + 3 2(9)

20 > 18

2° indeterminate iff stable

Stable ∴ 2° indeterminate

3. [20] Solve for the force in member CF of the following truss. Indicate whether the force is compressive or tensile.



Rxns. $\circlearrowleft + \Sigma M_A = 0 = B_y(20') - 3^k(15') - 12^k(20') - 24^k(10')$

$\underline{B_y = 26.25^k,\ pos \therefore \uparrow}$

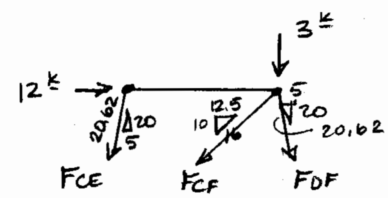
$+\uparrow \Sigma F_y = 0 = A_y - 3 + B_y$

$A_y = 3 - 26.25^k = \underline{(-)23.25^k,\ neg \therefore \downarrow}$

$\xrightarrow{+} \Sigma F_x = 0 = A_x + 24^k + 12^k$

$\underline{A_x = (-)36,\ neg \therefore \leftarrow}$

Method of Sections



$+\uparrow \Sigma F_y = 0 = -\frac{20}{20.62} F_{CE} - \frac{10}{16} F_{CF} - \frac{20}{20.62} F_{DF} - 3^k$

$\xrightarrow{+} \Sigma F_x = 0 = 12^k - \frac{5}{20.62} F_{CE} - \frac{12.5}{16} F_{CF} + \frac{5}{20.62} F_{DF}$

$\circlearrowleft + \Sigma M_E = 0 = -3^k(10') - \frac{10}{16}(F_{CF})(10') - \frac{20}{20.62} F_{DF}(10')$

$\underline{F_{CE} = 0^k}$

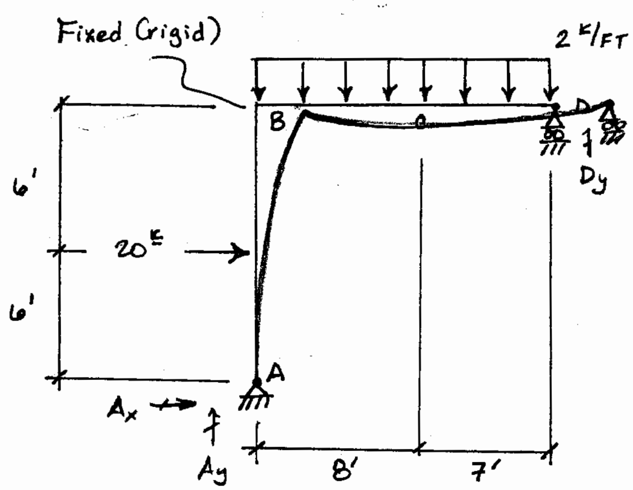
$\underline{F_{CF} = 12^k,\ pos \therefore (T)}$

$\underline{F_{DF} = -10.83^k,\ neg \therefore (C).}$

4. Given the following frame,

(a) [10] Solve for internal shear, moment, and axial thrust at point C on the frame shown below.

10 (b) ~~[15]~~ Draw the shear and moment diagrams for Member AB. Remember, the moment diagram should be drawn with positive moments shown on the compression side of the member.



Rxns

$\circlearrowleft^{+} \Sigma M_A = 0 = D_y(15') - 2^{k}/_{'}(15')(7.5') - 20^k(6')$

$D_y = 23^k$, pos ∴ ↑

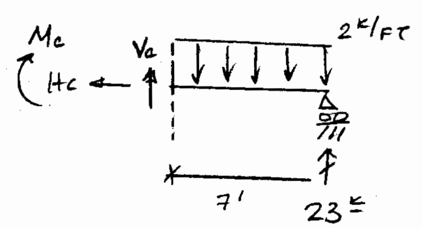
$+\uparrow \Sigma F_y = 0 = A_y - 2^{k}/_{'}(15') + 23^k$

$A_y = 7^k$ pos ∴ ↑

$\xrightarrow{+} \Sigma F_x = 0 = A_x + 20^k$

$A_x = -20^k$, neg ∴ ←

PART A



$+\uparrow \Sigma F_y = 0 = V_c - 2\frac{k}{FT}(7') + 23^k$

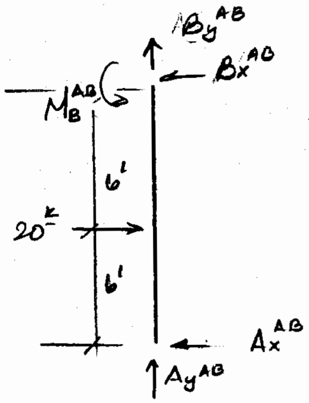
$V_c = -9^k$, neg ∴ ↓

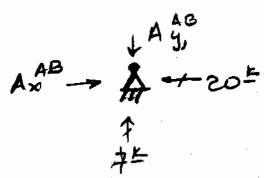
$\circlearrowleft^{+} \Sigma M_c = 0 = -M_c - 2^{k}/_{FT}(7')(3.5') + 23^k(7')$

$0 = -M_c + 112$

$M_c = 112$, pos ∴ ↺

$\xrightarrow{+} \Sigma F_x = 0$





jt A

$+\uparrow \Sigma F_y = 0 = 7^k - A_y^{AB}$, $\underline{A_y^{AB} = 7^k}$,

$\overset{+}{\rightarrow} \Sigma F_x = 0 = A_x^{AB} - 20^k$, $\underline{A_x^{AB} = 20^k}$

MEMBER AB

$+\uparrow \Sigma F_y = 0 = A_y^{AB} + B_y^{AB}$

$0 = 7^k + B_y^{AB}$

$\underline{B_y^{AB} = -7^k}$

$\overset{+}{\rightarrow} \Sigma F_x = 0 = -A_x^{AB} + 20^k - B_x^{AB}$

$0 = -20 + 20 - B_x^{AB}$

$\underline{B_x^{AB} = 0}$

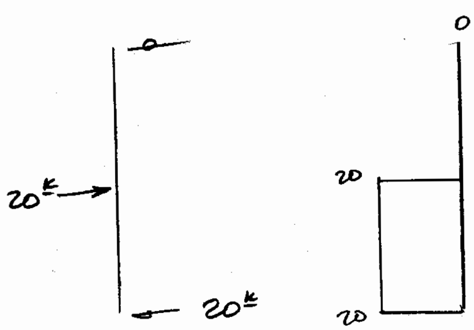
$\overset{+}{\circlearrowright} \Sigma M_B^{AB} = 0 = M_B^{AB} + 20^k(6') - A_x^{AB}(12')$

$0 = M_B^{AB} + 20(6') - 20(12')$

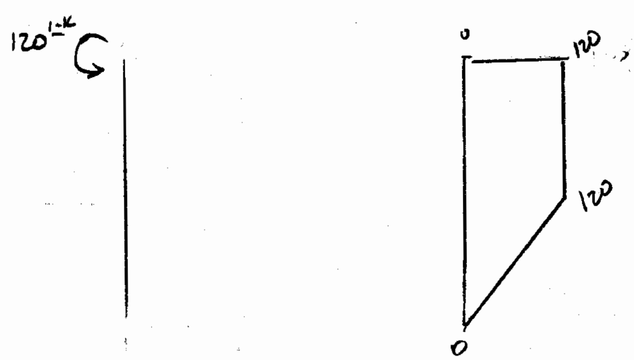
$0 = M_B^{AB} - 120$

$\underline{M_B^{AB} = 120^{1\text{-}k}, \text{ pos } \therefore \circlearrowright}$

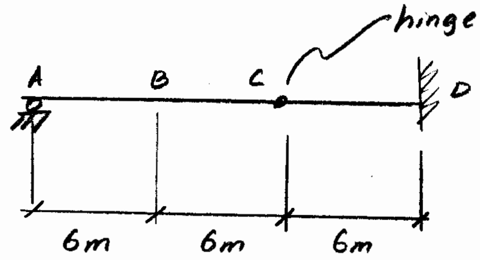
SHEAR DIAGRAM



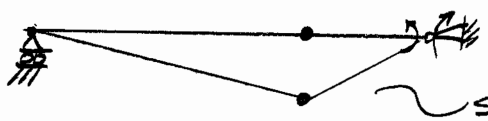
MOMENT DIAGRAM



5. [20] Given the following beam, draw the influence line for the moment reaction at D. You may choose to use either the equilibrium method or Muller Breslau's Principle, but be sure to indicate which you use. Label the influence line ordinates at A, B, C, and D.

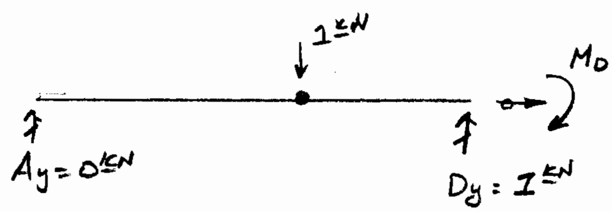


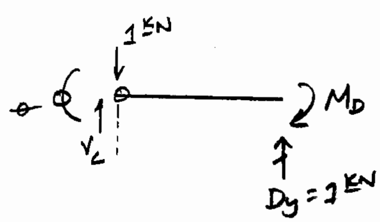
Using Mueller-Breslau's principle, release moment @ D and apply a small rotation.



Shape of I.L. for M_D.

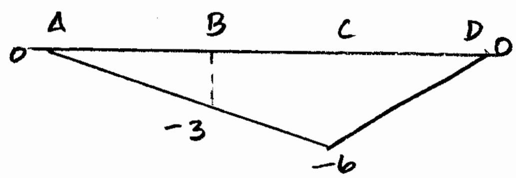
Since the I.L. ordinate at D will obviously be zero (looking at the qualitative I.L.), evaluate the ordinate at C.





$\circlearrowleft^{+} \sum M_c = -M_D + 1^{kN}(6m)$

$M_D = 6 \text{ kn·m}$, pos ∴



I.L. for M_D