QUIZ 1

Spring 2005-2006

(Wednesday March 22, 2006)

CIVE311 – STRUCTURES I

CLOSED BOOK, 1 & 1/2 HOURS

Name: Solution **ID#:** 000-00000

NOTES

- 2 PROBLEMS – 16 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- ONE EXTRA SHEET IS PROVIDED AT THE END.
- ASK FOR ADDITIONAL SHEETS IF YOU NEED MORE SPACE.
- SOME ANSWERS MAY REQUIRE MUCH LESS THAN THE SPACE PROVIDED.
- *DO NOT* USE THE BACK OF THE SHEETS FOR ANSWERS.
- DRAFT BOOKLET WILL BE PROVIDED; BUT DO NOT USE FOR ANSWERS.
- BOTH QUESTION SHEETS AND DRAFT BOOKLET SHOULD BE RETURNED.
- CHECK BOXES ARE TO CONFIRM THAT YOU HAVE SOLVED A QUESTION. ☑

YOUR COMMENT(S)

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

YOUR GRADE

Problem I: 30 /30
Problem II: ~~70~~ 78 /50 70
Problem III: ___ /20
Other: ___

TOTAL: 100/100

Problem I: *(30 points)*

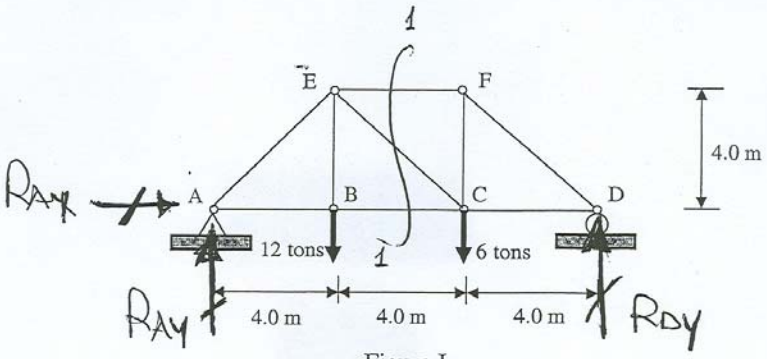


Figure I

1. Referring to the weightless plane truss shown in Figure I, compute the reactions and the forces in members EB, BC, EC, and EF. *(10 points)*

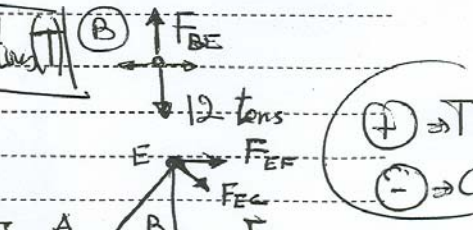
Calculations and/or Diagrams:

React. $\Sigma F_x = 0 \Rightarrow \boxed{R_{Ax} = 0}$

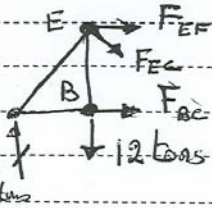
$\Sigma M_D = 0 \Rightarrow R_{Ay} \times 12 = 12 \times 8 + 6 \times 4 \Rightarrow \boxed{R_{Ay} = 10 \text{ tons} \uparrow}$

$\Sigma F_y = 0 \Rightarrow R_{Ay} + R_{Dy} = 12 + 6 \Rightarrow \boxed{R_{Dy} = 8 \text{ tons} \uparrow}$

Forces. (B) $\Sigma F_y = 0 \Rightarrow \boxed{F_{BE} = 12 \text{ tons (T)}}$



(1-1) cut



$\Sigma F_y = 0 \Rightarrow F_{EC} \frac{\sqrt{2}}{2} = -12 + 10$

$\Rightarrow \boxed{F_{EC} = -2.83 \text{ tons (C)}}$

$\Sigma M_{E=0}\ F_{BC} \times 4 = 10 \times 4$

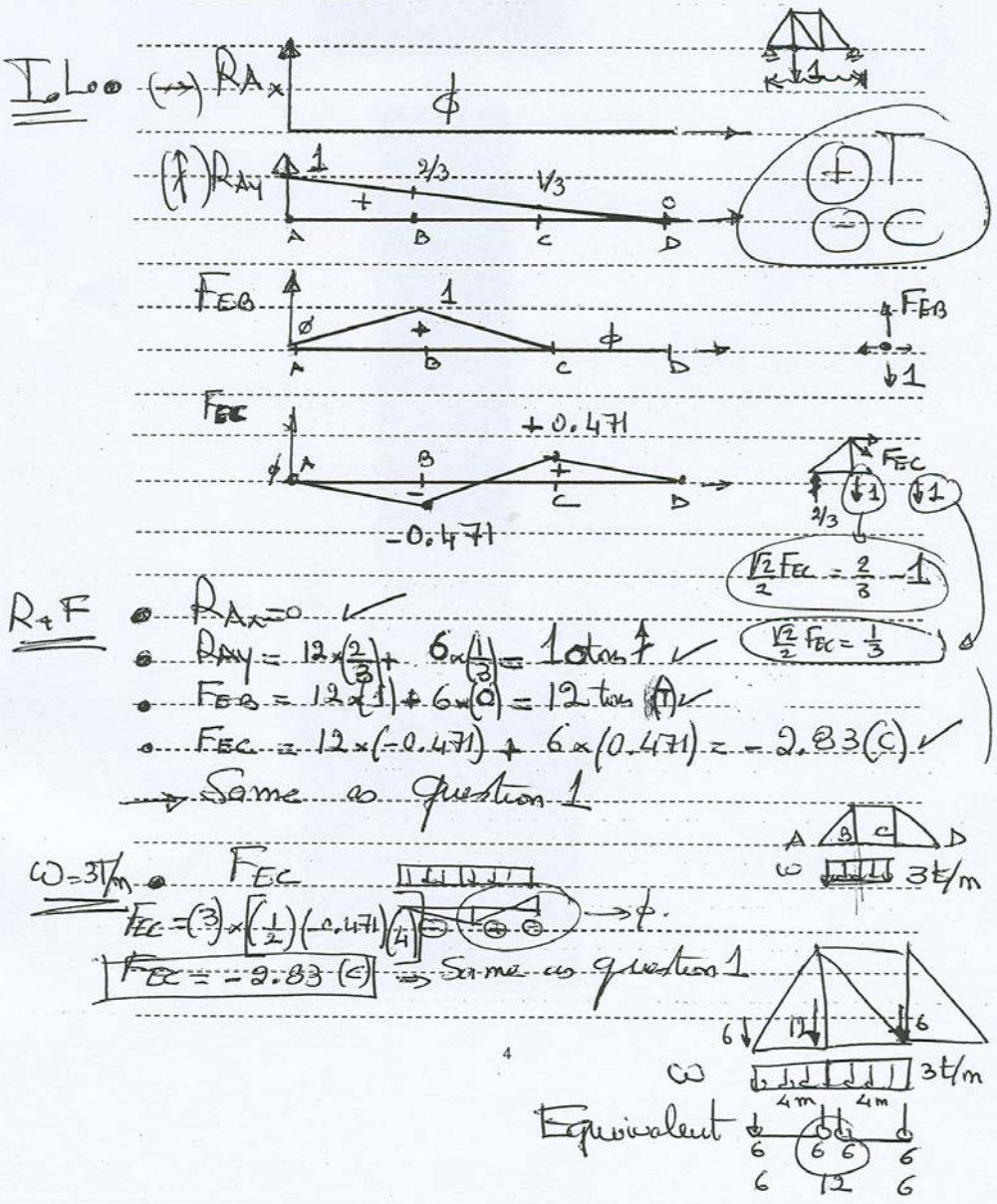
$\Rightarrow \boxed{F_{BC} = 10 \text{ tons (T)}}$

$\Sigma F_x = 0 \Rightarrow F_{EF} + F_{EC} \frac{\sqrt{2}}{2} + F_{BC} = 0 \Rightarrow \boxed{F_{EF} = -8 \text{ tons (C)}}$

OR (better) $\Sigma M_C = 0 \quad F_{EF} \times 4 = 12 \times 4 - 10 \times 8 \Rightarrow F_{EF} = -8 \text{ tons (C)}$

2. Draw the influence lines of: Reactions at A, and member forces EB and EC, for a load moving vertically downward along ABCD. *(10 points)*
   From influence lines, compute the reactions and forces above for the loads shown in Figure I and compare with question 1. *(5 points)*
   If a uniform vertical load (down) of 3 tons/m is applied on AB and BC, calculate from influence line the force in member EC. Deduce an equivalent system of concentrated loads placed at nodes A, B, C, which will replace the uniform load on AB and BC (your system should lead to the same results for member force EC and this should be verified). *(5 points)*

Calculations and Diagrams:



Problem II: *(70 points)*

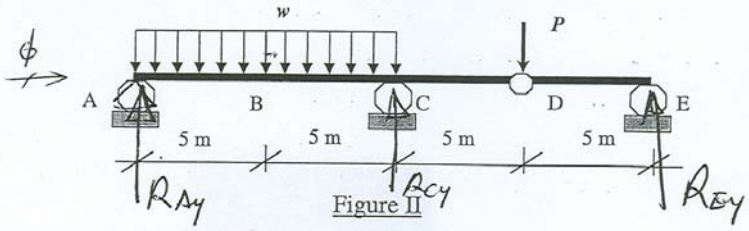
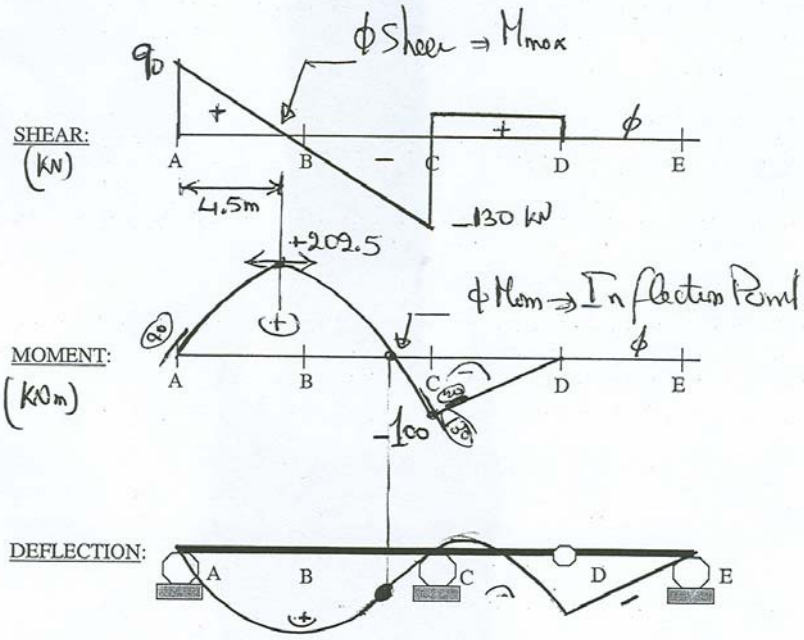


Figure II

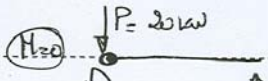
For the beam shown in Figure II, the own weight is neglected.
Your diagrams/sketches should include any feature/value you think is relevant or important.

1. Let w=**20 kN/m** and **P=20 kN**
   Compute the ***reactions*** in the beam, and draw the ***shear*** and bending ***moment*** diagrams; sketch the ***deflected shape***. *(20 points)*



Calculations and/or Diagrams (cont'd):

- Condition DE



$\sum M_D = 0 \Rightarrow \boxed{R_{E_y} = 0}$

- (AE) $\Rightarrow \sum M_A = 0 \Rightarrow R_{Ay} \times 10 = 20 \times 10^2 + 20 \times 15$

$\Rightarrow \boxed{R_{Ay} = 130\ kN \uparrow}$

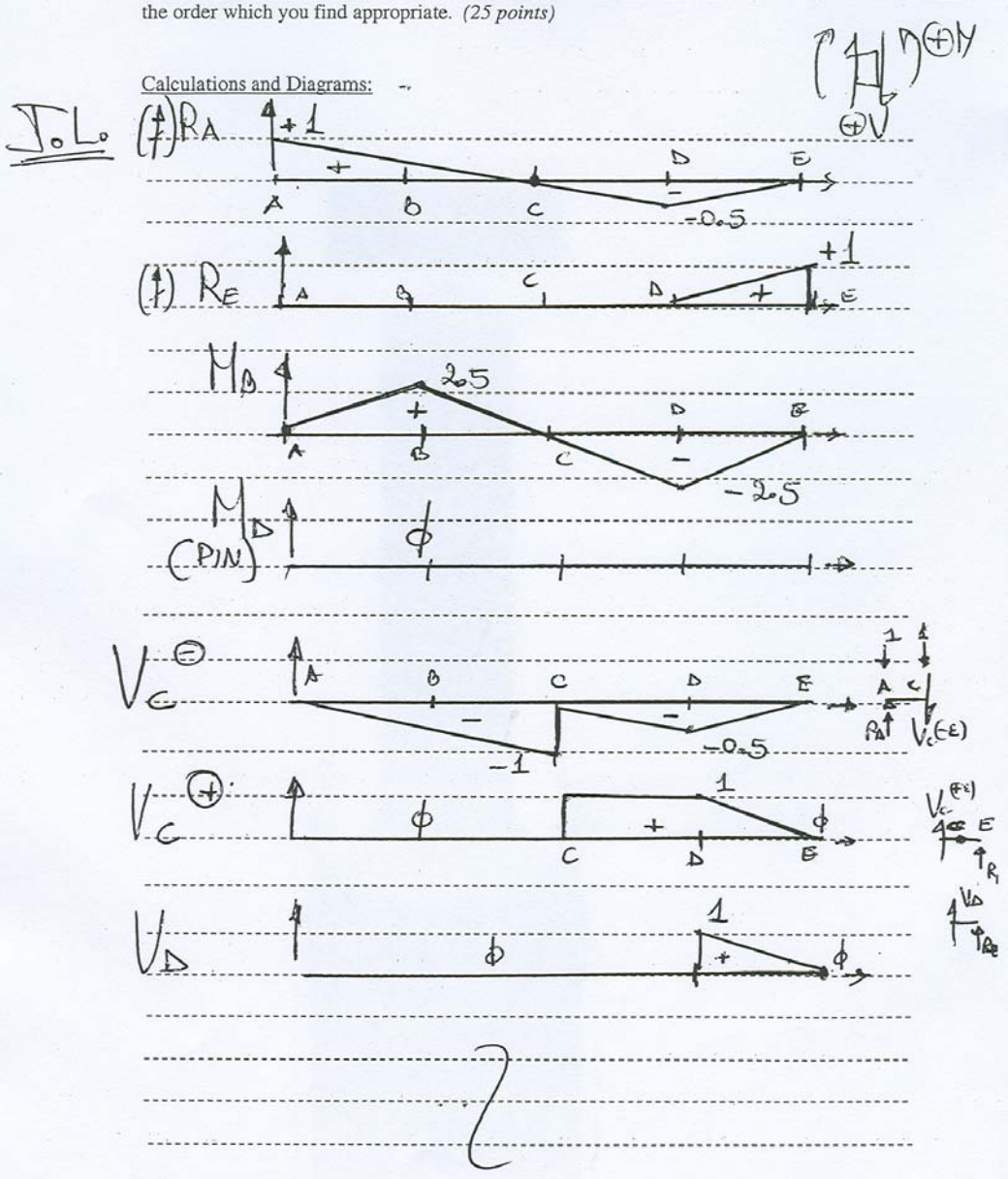
$\sum F_y = 0 \Rightarrow R_{Ay} = 20 \times 10 + 20 - 130$

$\Rightarrow \boxed{R_{Ay} = 90\ kN \uparrow}$

$\boxed{R_{Ax} = 0}$

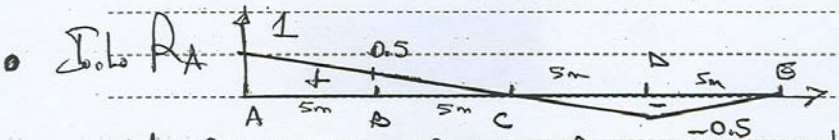
2. Referring to Figure II, draw the influence lines for R_A, R_E, M_B, M_D, V_C, and V_D. Draw in the order which you find appropriate. *(25 points)*

Calculations and Diagrams:



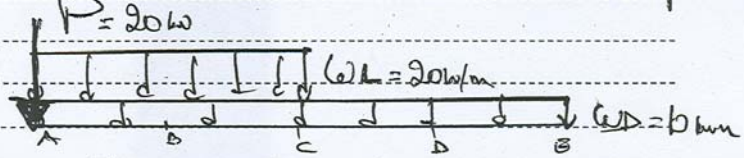
3. Let w_D=**10 kN/m** (dead load); w_L=**20 kN/m** and P=**20 kN** (live loads)
   - Compute the maximum absolute value for R_A, and show the corresponding loading position. *(9 points)* ☐
   - Compute R_A for w_L on AC only and P on D and compare with question 1 (do not include w_D). *(6 points)* → ☐

Calculations and Diagrams:



→ Max R_A (absolute) ← R_A max ⊕ / R_A max ⊖ ← Larger by Inspection

(↑) Max R_A ⊕



$$R_A = (30)\times\left[\left(\tfrac{1}{2}\right)(1)(10)\right] + (10)\left[\left(\tfrac{1}{2}\right)(-0.5)(10)\right] + 20\times 1$$

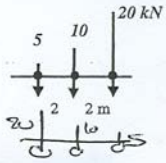
(↑) Max R_A = 145 kN (↑)

→ (Same load as in question 1)

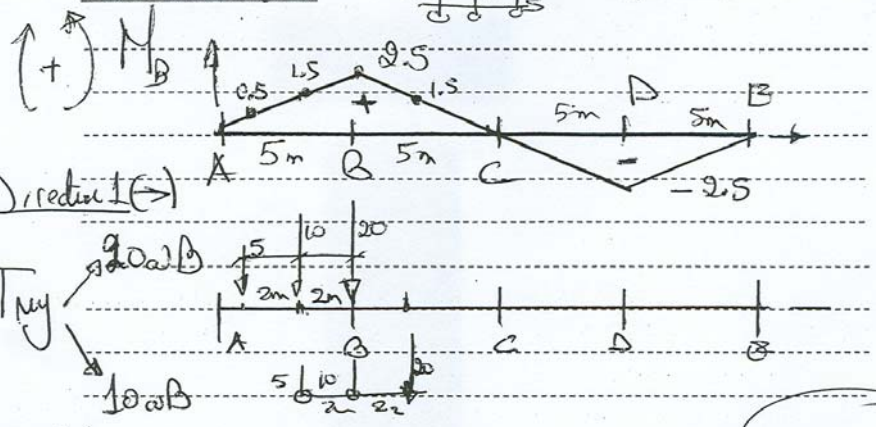
$$R_A = (20)\times\left[\left(\tfrac{1}{2}\right)(1)(10)\right] + 20\times(-0.5) = 90\text{ kN}\uparrow$$

Same as in question 1.

4. Compute the maximum absolute value of M_B for the truck load shown, assuming that the truck can travel in either directions, and show the corresponding position(s) of the truck. *(10 points)*



Calculations and Diagrams:



Direction 1 (→)

(+) $M_{B(20\,kN)} = 20 \times 2.5 + 10 \times 1.5 + 5 \times 0.5 = 67.5\ kN\cdot m$

(+) $M_{B(10\,kN)} = 20 \times 1.5 + 10 \times 2.5 + 5 \times 1.5 = 62.5\ kN\cdot m$

Note: $+ = -$ $\Rightarrow (+)M_{B_{max}} = (-)M_{B_{max}}$

Same

Direct 1 = Direct 2

$\Rightarrow$ Same

$\Rightarrow M_{B\,max} = 67.5\ kN\cdot m$