QUIZ 1

Spring 2007-2008

(March 19, 2008)

CIVE311 – STRUCTURES I

CLOSED BOOK, 1 & 1/2 HOURS

Name: Key Key **ID#:** 007

NOTES

- 2 PROBLEMS– 14 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- **TWO EXTRA SHEETS 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)

Fair & Interesting

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

Ok

YOUR GRADE

Problem I:	60 /60	+5
Problem II:	40 /40	+1
Other:	+5 bonus	
TOTAL:	100+5 /100	

bonus

Problem I (*for a student engineer*): *(60 points)*

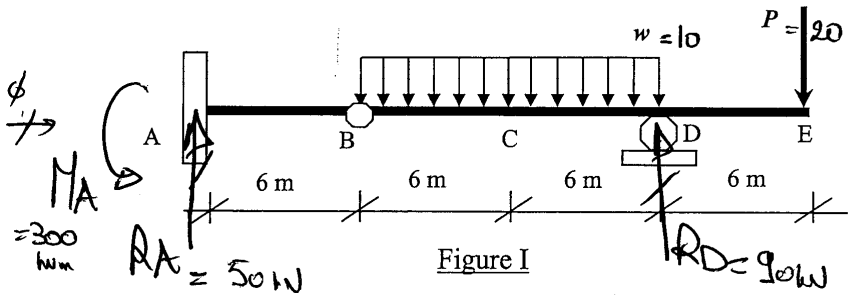
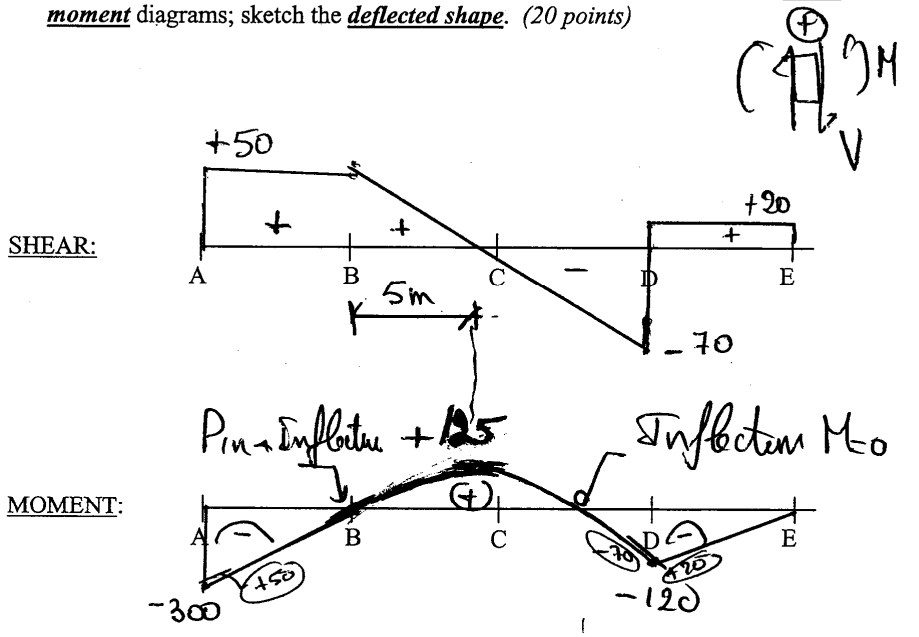
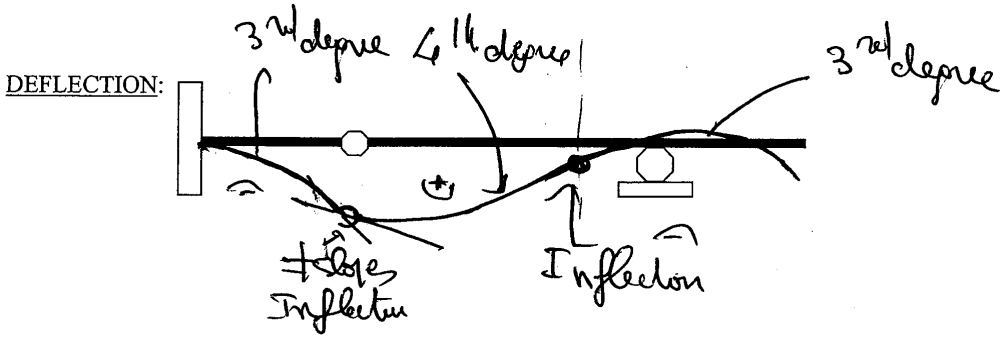


Figure I

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

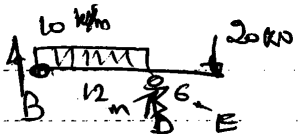
1. Let w=**10 kN/m** and **P=20 kN**
   Compute the ***reactions*** (forces and moments) in the beam, and draw the ***shear*** and bending ***moment*** diagrams; sketch the ***deflected shape***. *(20 points)*





Calculations and/or Diagrams (cont'd):

Considering BE part:



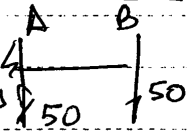
$\Sigma M_B = 0 \Rightarrow R_D \times 12 = \frac{10 \times 12^2}{2} + 20 \times 18$

$\Rightarrow R_D = 90\ kN (\uparrow)$

Considering AE:

$\Sigma F_y = 0 \Rightarrow R_A = -R_D + 10 \times 12 + 20 = 50\ kN (\uparrow)$

(AB) $\Sigma M_A = 0 \Rightarrow M_A = 50 \times 6$



$= 300\ kN.m \quad M_A = 300$

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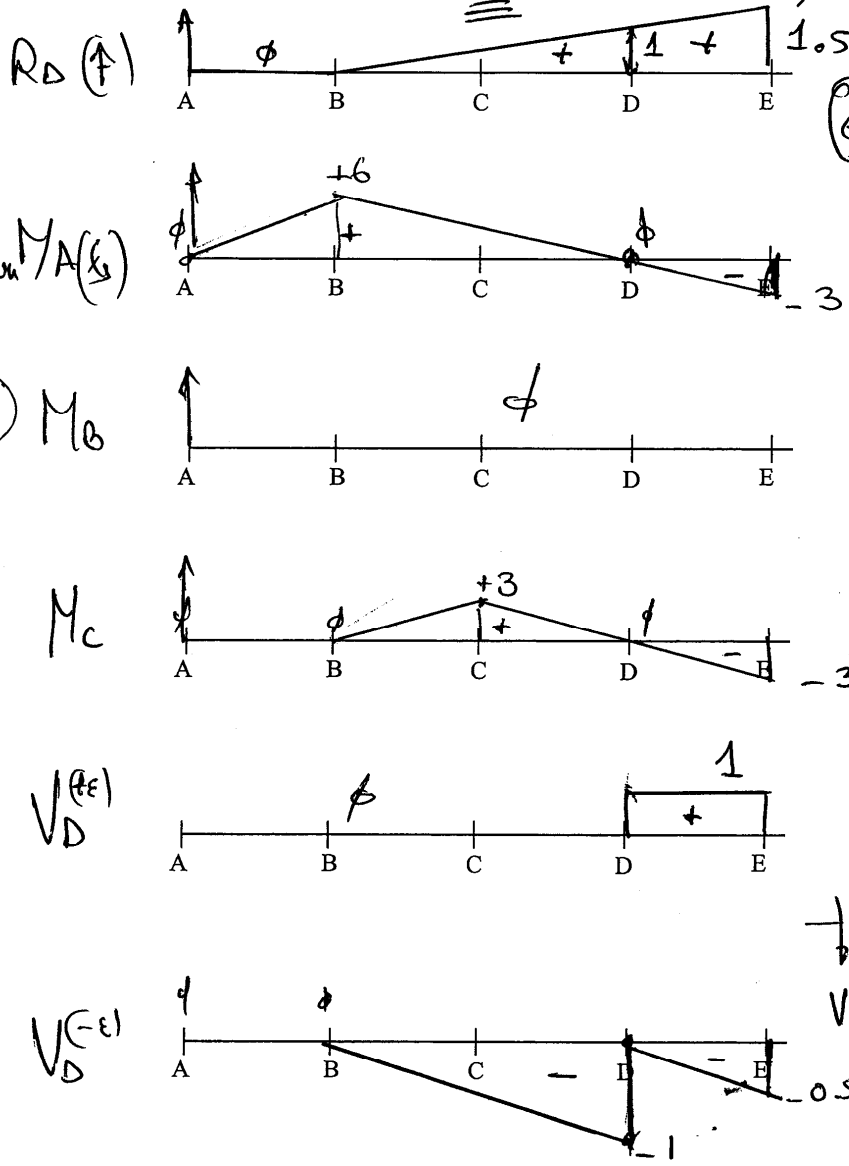
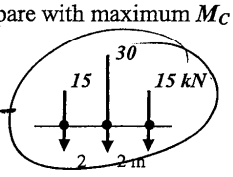
2. Referring to Figure I, draw the influence lines for R_B, R_D, M_A, M_B, M_C, and V_D. Draw in the order which you find appropriate. *(30 points)*

Calculations and Diagrams: There is no reaction at B



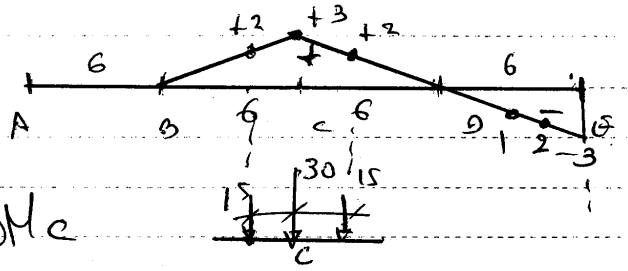
3. Compute the maximum value(s) of M_C for the truck load shown below, and show the corresponding position(s) of the truck. *(5 points)*
Compute the maximum absolute positive moment that can ever occur between B and D for the truck load shown below. Compare with maximum M_C and briefly comment *(5 points)*



Same in both directions (⇆)

M_C (+) (⟳)

Calculations and Diagrams:



Max Mc

• Max (+) Mc

$= 30\times3 + 15\times2\times2 = 150$ kN.m $\quad \boxed{M_{C(+)max} = 150 \text{ kN.m}}$

• Max (−) Mc (1) $= 30(-2) + 15(-3) + 15(-1)$

$= -120$ kN.m

(2) $= 30(-3) + 15(-2)$

$= -120$ kN

(1) + (2) are the same $\quad \boxed{M_{C(-)max} = -120 \text{ kN.m}}$

Max M_{BD} Positive

By inspection $\boxed{M_{(abs)pos} = M_{C(+)max}}$

$= +150$ kN.m

(Centroid of forces is at 30 kN ← largest value)

Problem II (*for a professional engineer*): *(40 points)*

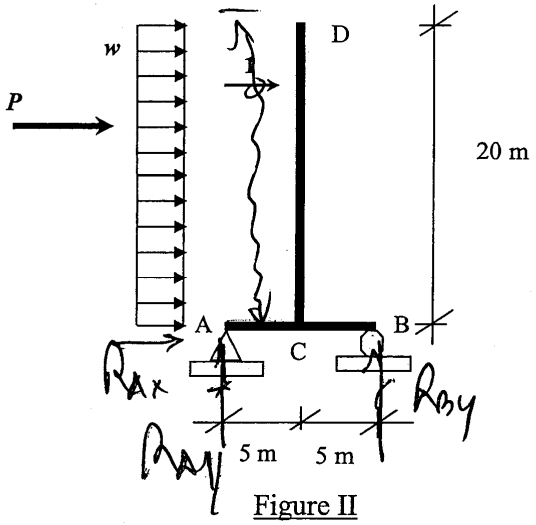


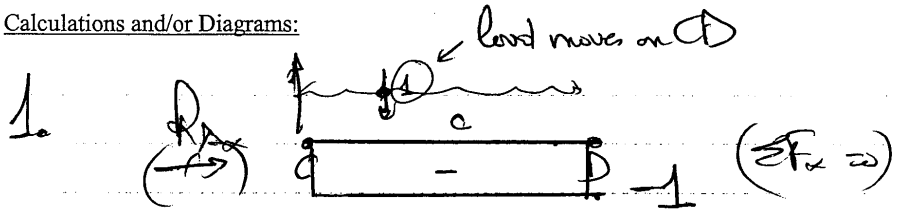
Figure II

The reinforced concrete beam AB supports a reinforced concrete column monument CD as shown in Figure II.

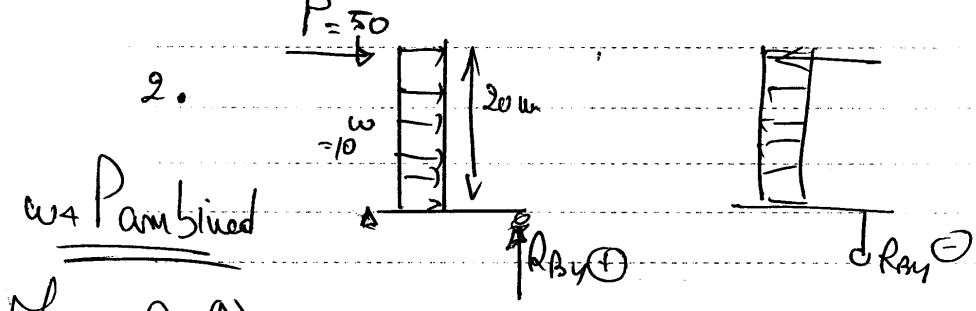
1. Assuming that a horizontal unit load moves on the vertical column CD as shown in the figure, draw the influence lines for the reactions at A and B, and for the moment in the beam at C. *(15 points)*
2. For a combination of wind load w=**10 kN/m,** and an impact force from a flying object P=**50 kN** that can hit the column at any location between C and D, and not considering the own weight of the system, calculate the maximum vertical reaction at B (Assume that w and P can hit in either directions – i.e. left to right, or right to left-, and that they can occur either individually or simultaneously). *(15 points)*
3. What should be the total weight of the system (beam and column) so that an uplift at B does not occur. In this case, choose a suitable square cross-section for the beam and column that will prevent the uplift (same cross-section for beam and column) given that the density of concrete is 25 kN/m^3. *(10 points)*

Calculations and/or Diagrams:

1.



2.



w4 Pamblued

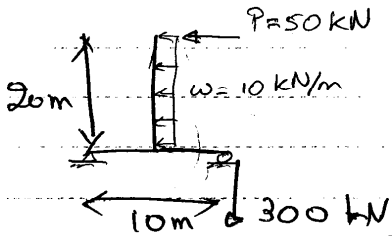
$Max\ (+) R_{By}(\uparrow) = 50 \times 2 + 10 \times \left(\frac{1}{2}\right)(2)(20) = 300\ kN$ (↑1)

$Max\ (-) R_{By}(\downarrow) = -(\quad \sim 10 \quad) = 300\ kN$ (↓1)

Calculations and/or Diagrams (cont'd):

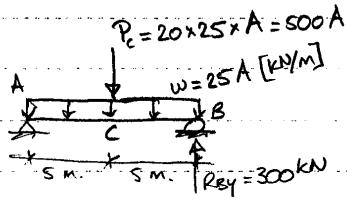
No Uplift:

$\gamma = 25\ kN/m^3$



In general

To prevent uplift $R_{By} \geq 300\ kN\ (\uparrow)$ due to system weight



$\Sigma M_A = 0 \Rightarrow$

$500A \times 5 + 25A \times 10 \times 5 = 300 \times 10$

$3750A = 3000$

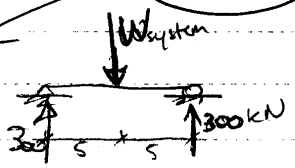
$A = 0.8\ m^2$

$b = h = \sqrt{0.8} \approx 0.89\ m. \rightarrow 0.9$

$W_{system} = 500A + 250A = 750A = 600\ kN$

OR:

due to symmetry:



$(\Sigma M_A = 0 \Rightarrow W_s \times 5 = 300 \times 10 \Rightarrow W_s = 600\ kN)$

OR $W_{system} = 2 \times 300\ kN = 600\ kN$

$W_{system} = 750\ A = 600\ kN$

$\hookrightarrow (30\ m \times 0)$

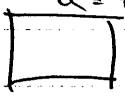
$\Rightarrow A = 0.8\ m^2$

$a = \sqrt{0.8} = 0.895\ m$

Use 90×90 cm (practical)

Square

a = 90cm



Solution

Courtesy of Carla Huijer — Thanks