QUIZ 2

Fall 2012-13

(Wednesday December 19, 2012)

CIVE210 – STATICS

CLOSED BOOK, 2 HOURS

Name: ϕϕ7 **ID#:** ϕϕ7 **Section:** ϕ

NOTES

- 3 PROBLEMS– 12 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- **THREE 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)

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

YOUR GRADE

Problem I:	40 /40
Problem II:	35 /35
Problem III:	25 /25
Bonus/Extras – Organization, Neatness, Special, …:	–
TOTAL:	100 /100

Problem I: *(40 points)*

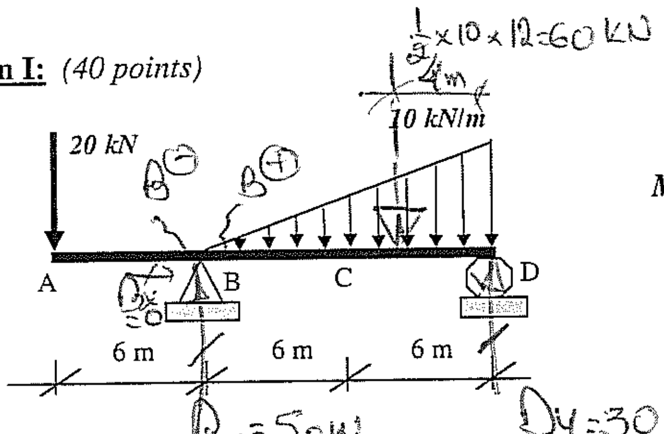
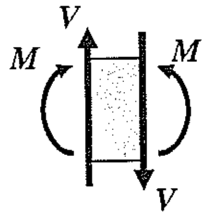


Figure I



(+) Convention

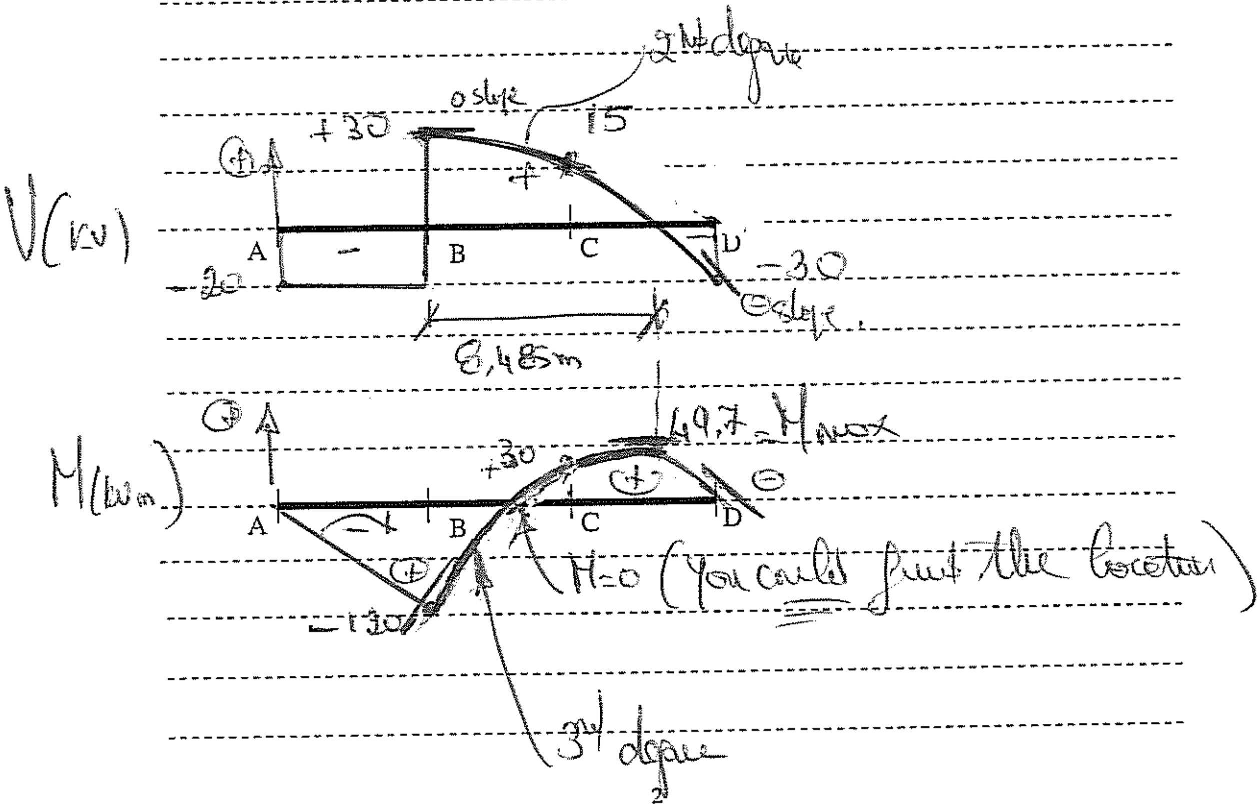
Tick Boxes to check that you solved all questions

For the beam shown in Figure I:

1- Compute the reactions at points B and D (advice: double/triple check them!). *(7 points)*
2- Using sections, compute the shears and moments at points A, B, C and D. *(8 points)*
3- In a "convenient" way, write the equations of shears and moments in the beam, and use them to compute the shears and moments computed in question 2 above. *(18 points)*
4- Using your equations, draw the shear and moment diagrams showing the necessary and important features and values. *(7 points)*

Calculations and/or Diagrams:

KEEP THIS PAGE FOR YOUR DIAGRAMS IN QUESTION 4



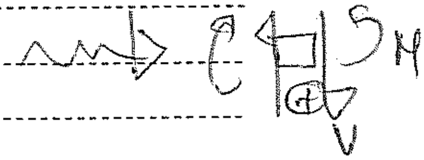
Calculations and/or Diagrams (cont'd):

① Reactions: $\Sigma M_B = 0 \Rightarrow D_y \times 10 = 60\times 8 - 20\times 6 = 30\text{ kN } (\uparrow)$

$\Sigma F_y = 0 \Rightarrow B_y = 20+60-30 = 50\text{ kN } (\uparrow)$

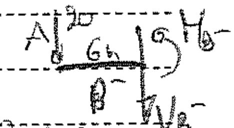
$B_x = 0$

② Shear V + Moment M D

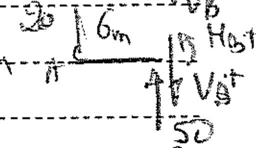


A: $V_A = -20\text{ kN}$ $M_A = 0$

B^-: $V_B^- = -20\text{ kN}$ $M_B^- = -20\times 6 = -120\text{ kNm}$

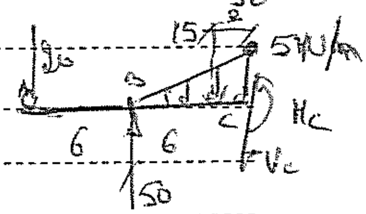


B^+: $V_B^+ = 50-20 = 30\text{ kN}$ $M_B^+ = M_B^- = -120\text{ kNm}$



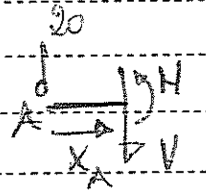
C: $V_C = 50-20-15 = 15\text{ kN}$

$M_C = 50\times 6 - 20\times 12 - 15\times 2 = 30\text{ kNm}$



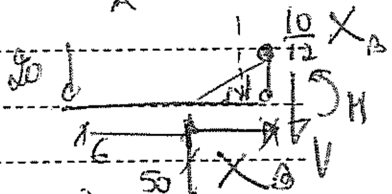
D: $V_D = -30\text{ kN}$ $M_D = 0$

③ Equations:



$A \to B$ $V = -20$ (I)

$M = -20X_A$



$B \to D$ $V = 50 - 20 - \left(\frac{1}{2}\right)\left(\frac{5}{6}X_B\right)(X_B)$

$= 30 - \frac{5}{12}X_B^2$

(II) $M = 50X_B - 20(6+X_B) - \left(\frac{1}{2}\right)\left(\frac{5}{6}X_B\right)(X_B)\frac{X_B}{3}$

$= -120 + 30X_B - \frac{5}{36}X_B^3$

@A (I) $\Rightarrow V_A = -20$ $M_A = 0$ ✓

@B^- (I) $\Rightarrow X_A = 6$ $V_B^- = -20$ $M_B^- = -120$ ✓

@B^+ (II) $\Rightarrow X_B = 0$ $V_B^+ = 30$ $M_B^- = -120$ ✓

@C (II) $\Rightarrow X_B = 6 \Rightarrow V_C = 15$ $M_C = 30$ ✓

@D (II) $\Rightarrow X_B = 12 \Rightarrow V_D = -30,$ $M_D = 0$ ✓

Equations Checked with previous 2

Calculations and/or Diagrams (cont'd):

4. Equations Diagrams

A → B ✓ (See Diagram)

B → D $V(x^2)$ $V' = -\frac{5}{6}x$ $= 0$ @ B, < 0 D

$V'' = -\frac{5}{6}$

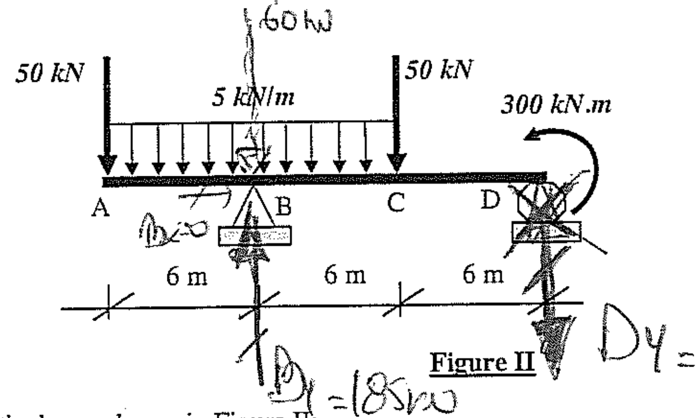
$M(x^3)$ $M' = -\frac{5}{12}x^2 + 30$ $= 30$ (+) @ B, $= -30$ (−) @ D

$M'' = -\frac{5}{6}x < 0$

$M' = 0$ $x = \sqrt{\frac{30 \times 12}{5}} = \sqrt{72} = 6\sqrt{2} = 8.485\text{ m}$

$M_{max}(=8.485) = \ldots = 49.7\text{ kN·m}$

Problem II: *(35 points)*



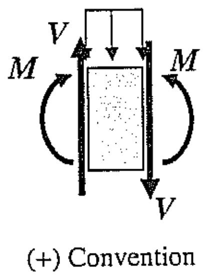


Figure II

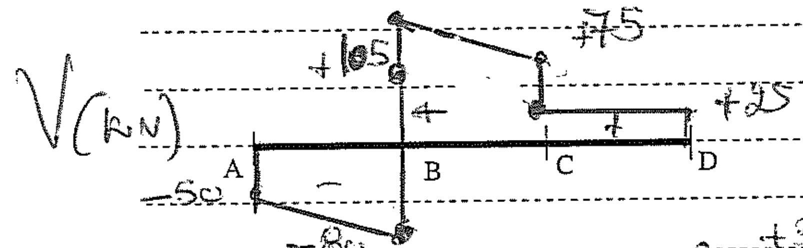
For the beam shown in Figure II:

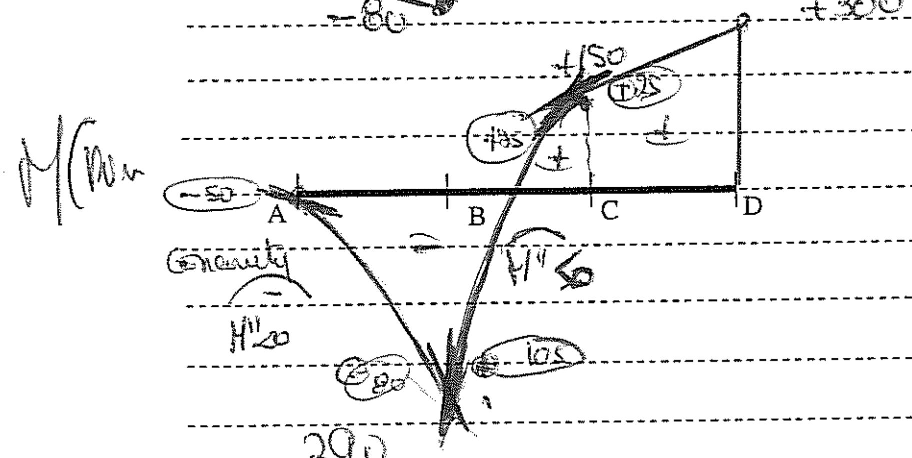
1- Compute the reactions at points B and D (advice: double/triple check them!). *(7 points)* ☐

2- Using the method of integration (or areas), draw the shear force and bending moment diagrams (use the space provided below for the diagrams and draw to scale as much as you can). Show the important and necessary features and values on the diagrams. *(28 points)* ☐

Calculations and/or Diagrams:

KEEP THIS PAGE FOR YOUR DIAGRAMS IN QUESTION 2





Reactions; $\Sigma M_B = 0$ (upward) $D_y \times 12 = -300 \Rightarrow D_y = -25$ kN $\Rightarrow \boxed{D_y = 25 \text{ kN}}$

ΣF_y $B_y = 100 + 60 + 25 = \boxed{185 \text{ kN} \uparrow}$

$B_x = 0$

Problem III: *(25 points)*

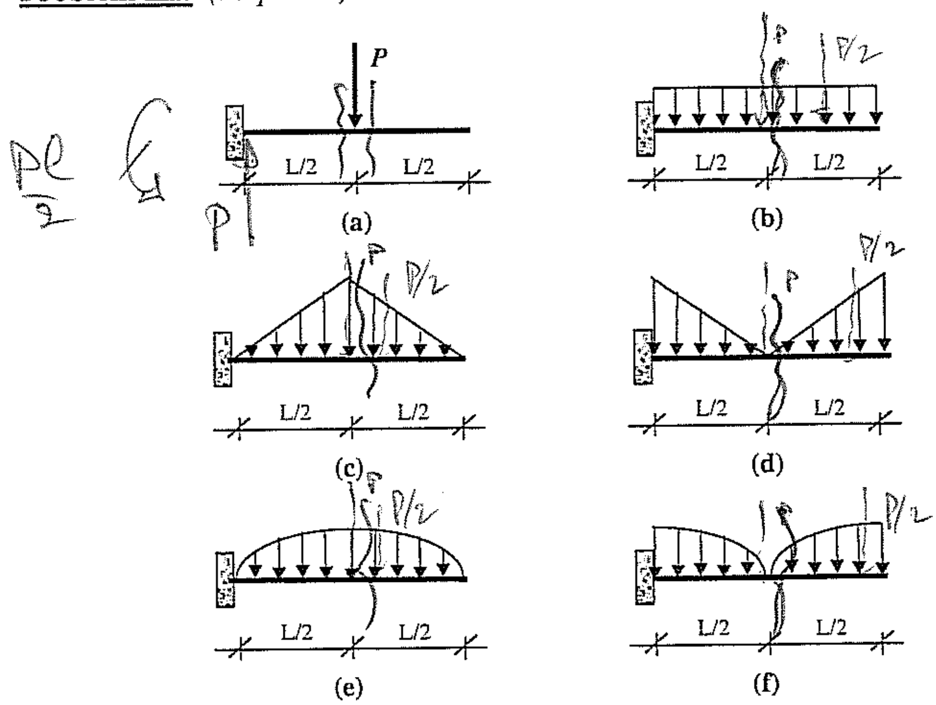


Figure III

The fixed-end cantilever beams shown in Figure III are loaded with different types of concentrated or distributed loads; however **the total equivalent vertical load in each of the cases (a) to (f) have the same total intensity P**. Also, all distributed loads are symmetrical about the midpoint.

NOTE: No "real" calculations are needed and the information above is sufficient to solve the problem, so please do not ask for any information or clarifications, otherwise you will be asking for the answers.

1- Compare the vertical and moment reactions (in absolute values) at the fixed ends for the six cases from largest to smallest. *(8 points)*

$R(a) = R(b) = R(c) = R(d) = R(e) = R(f)$ $(= P)$

$M(a) = M(b) = M(c) = M(d) = M(e) = M(f)$ $\left(= \frac{PL}{2}\right)$

No need

Briefly explain how you reached your solution: (2-3 lines maximum)

all equivalent forces are equal (P) @ at $\frac{L}{2}$ (symmetry)

⇒ Same R & M
$(= P)$ $\left(= \frac{PL}{2}\right)$

2- Compare the internal vertical shear and bending moment (in absolute value) at the midpoint of the beams for the six cases from largest to smallest. *(10 points)*

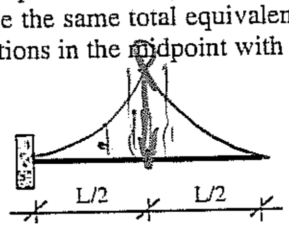
$\underset{=0}{\overset{+}{V(a)}} < V(b) = V(c) = V(d) = V(e) = V(f)$ $\left(< \underset{=P}{\bar{V}(a)} \right)$

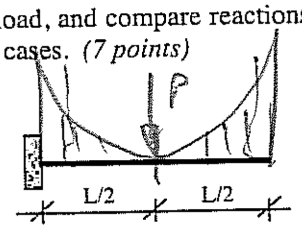
Leyeptamen $\underset{=0}{M(a)} < M(e) < M(c) < M(b) < M(d) < M(f)$

Briefly explain how you reached your solution: (2-3 lines maximum)

Consider ~~All~~ Right Side only for all cases @ (+)
Consider only for case (a–) @ (–)

3- You are the teacher now: Suggest two cases of loading below that follow the same pattern as above, and explain how they compare with questions 1 and 2 (i.e. choose and draw cases which will have the same total equivalent vertical load, and compare reactions at fixed end and internal actions in the midpoint with the earlier cases. *(7 points)*


(g)


(h)

Briefly explain your choices and how they compare with earlier cases: (few lines only)

Same equivalent P @ middle
(1)e Same answer for question (1) R(g) = R(h) = all
M(g) = M(h) = all

(2)e Same Shear M(g) < M(e) , M(h) > M(f)

Other options