QUIZ 2
Spring 2013-14
(Wednesday April 23, 2014)
CIVE210 – STATICS
CLOSED BOOK, 1.5 HOURS + 15 MN

Name: Spring 2014 **ID#:** 2014 **** **Section:** 1,2,3&4

NOTES

- 1 "QUICK" TEST (15 MN) + 2 PROBLEMS (90 MN) – 11 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- **TWO EXTRA SHEETS ARE 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

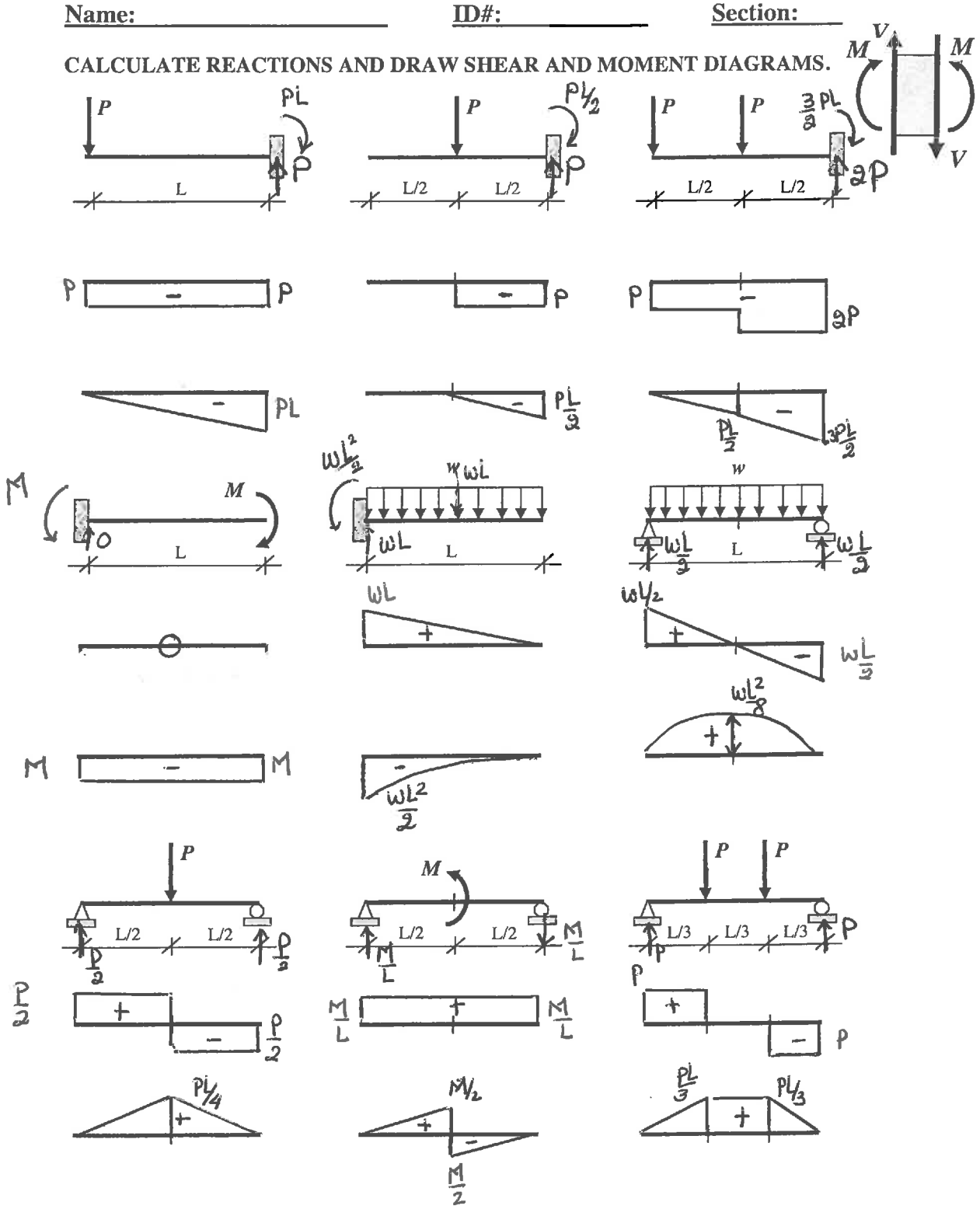
Quick Test:	___/15
Problem I:	___/40
Problem II:	___/45
Bonus/Extras – Organization, Neatness, Special, ….:	___
TOTAL:	/100

Quick Test *(15 points)*

(Paper will be collected in 15 mn)

Name: _____ **ID#:** _____ **Section:** _____

CALCULATE REACTIONS AND DRAW SHEAR AND MOMENT DIAGRAMS.



Problem I: (40 points)

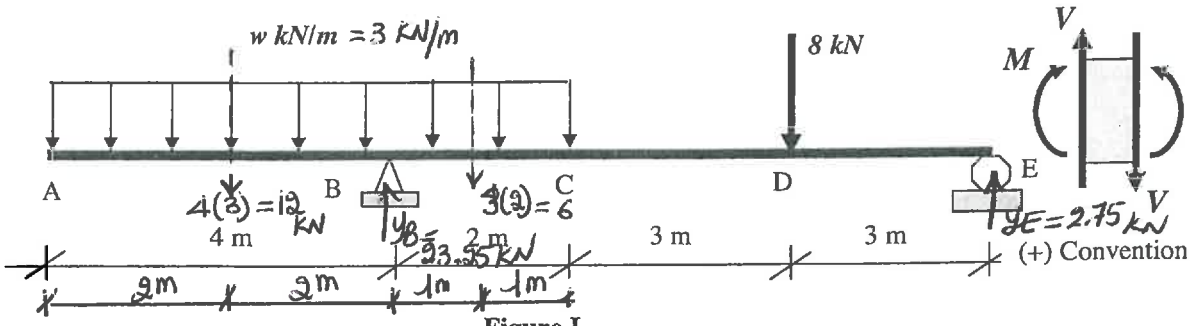


Figure I

Tick Boxes to check that you solved all questions

For the beam shown in Figure I:

For $w = 3$ kN/m

1- Compute the reactions at points B and E. ☐
(CHECK THEM MORE THAN ONE TIME BEFORE YOU CONTINUE) *(5 points)*

2- Compute the shear and moments at A, B, C, D, and E. *(15 points)* ☐

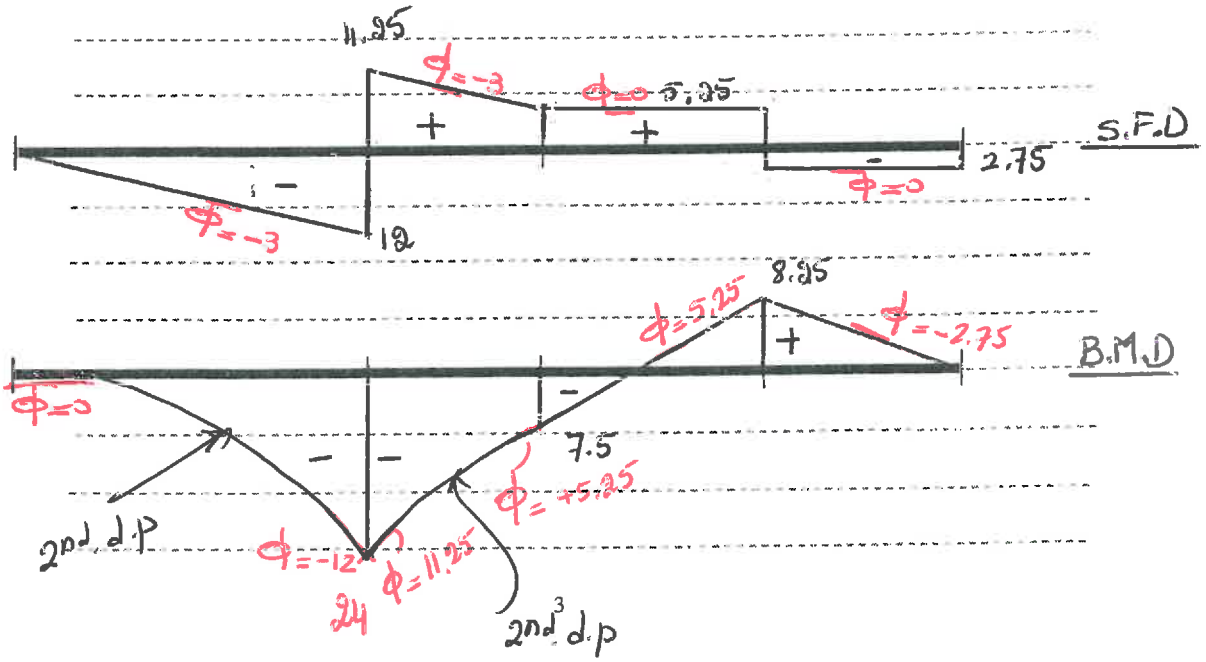
3- Draw the shear and bending moment diagrams using whichever approach you like (HINT: you can use the results of question 2 and "join" the points appropriately – recommended for fastest results). *(10 points)* ☐

For w = unknown

4- Find w which will make the reaction at E theoretically "useless"; then deduce the reaction at B. *(5 points)* ☐

5- What will happen to these reactions at E and B when w exceeds the value calculated in question 4; give an example on this situation (assume w, calculate reactions at E and B and explain, **very** briefly (2-3 lines max). *(5 points)* ☐

Calculations and/or Diagrams: (LEAVE THIS PAGE CLEAN FOR YOUR DIAGRAMS)



Calculations and/or Diagrams (cont'd):

1- External reactions at B and E

$\pm \rightarrow \Sigma F_x = 0 \Rightarrow \boxed{x_B = 0}$

$+ \circlearrowleft \Sigma M_B = 0 \Rightarrow 12(2) - 6(1) - 8(5) + y_E(8) = 0 \Rightarrow \boxed{y_E = 2.75\ KN \uparrow}$

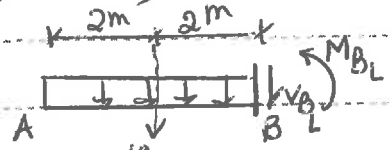
$+\uparrow \Sigma F_y = 0 \Rightarrow -12 + y_B - 6 - 8 + 2.75 = 0 \Rightarrow \boxed{y_B = 23.25\ KN \uparrow}$

2- Using sections:

(A)

$V_A = 0$, $M_A = 0$ (free end)

(B)

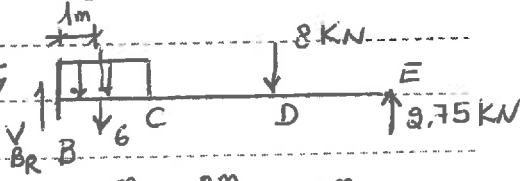


* Left

$+\uparrow \Sigma F_y = 0 \Rightarrow -12 + V_{B_L} = 0$

$\Rightarrow V_{B_L} = 12\ KN$

$+\circlearrowleft \Sigma M = 0 \Rightarrow M_B + 12(2) = 0 \Rightarrow M_B = -24\ KN.m$

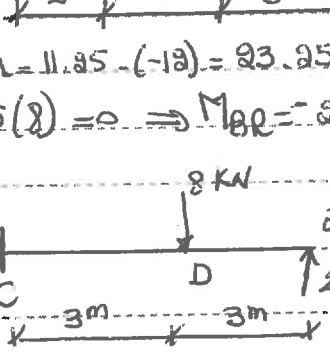


* Right

$+\uparrow \Sigma F_y = 0 \Rightarrow V_{BR} - 6 - 8 + 2.75 = 0$

$\Rightarrow V_{BR} = 11.25\ KN$ ($V_{BR} - V_{BL} = 11.25 - (-12) = 23.25\ KN$, reaction at B ∴ ok)

$+\circlearrowleft \Sigma M = 0 \Rightarrow -M_{BR} - 6(1) - 8(5) + 2.75(8) = 0 \Rightarrow M_{BR} = -24\ KN.m$ (same as left ∴ ok)



(C) $+\uparrow \Sigma F_y = 0 \Rightarrow V_C - 8 + 2.75 = 0$

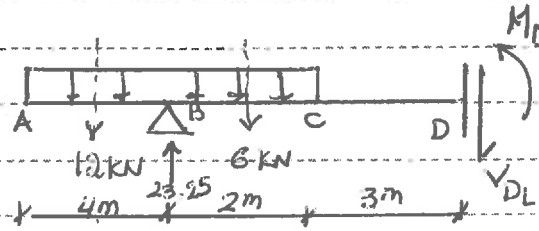
$\Rightarrow V_C = 5.25\ KN$

$\circlearrowleft \Sigma M_C = 0 \Rightarrow -M_C - 8(3) + 2.75(6) = 0 \Rightarrow M_C = -7.5\ KN.m$

Calculations and/or Diagrams (cont'd):

(D)

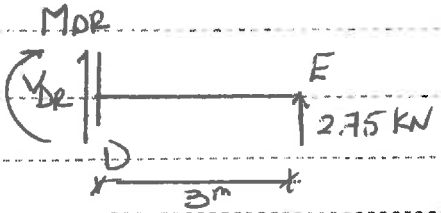
* Left



$+\uparrow \Sigma F_y = 0 \Rightarrow -12 - 6 + 23.25 - V_{DL} = 0 \Rightarrow V_{DL} = 5.25\ KN$

$+\circlearrowleft \Sigma M_D = 0 \Rightarrow M_{DL} + 12(7) + 6(4) - 23.25(5) = 0 \Rightarrow M_{DL} = 8.25\ KN.m$

* Right



$+\uparrow \Sigma F_y = 0 \Rightarrow V_{DR} + 2.75 = 0$

$\Rightarrow V_{DR} = -2.75\ KN$

$\Delta V = V_{DR} - V_{DL} = (-2.75 - 5.25) = -8\ KN$ (o.k. load at D)

$+\circlearrowleft \Sigma M_D = 0 \Rightarrow 2.75(3) - M_{DR} = 0 \Rightarrow M_{DR} = 8.25\ KN.m$ (Same as left. o.k)

(E) $V_E = -2.75\ KN$ & $M_E = 0$ (Roller support)
= (Reaction at E)

4-

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow 4w(2) - 2w(1) - 8(5) + 0(8) = 0$ ($y_E \approx 0$)

$\Rightarrow 6w - 40 = 0 \Rightarrow w = \frac{40}{6} = 6.67\ KN/m$

$\Rightarrow y_B = ?$ ∴ $\boxed{w = 6.67\ KN/m}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -6w + y_B - 8 + 0 = 0$

$\Rightarrow -6(6.67) + y_B - 8 = 0 \Rightarrow \boxed{y_B \simeq 48\ KN}$

Calculations and/or Diagrams (cont'd):

5- Assume $w = 10\ KN/m'$

Reactions at B and E are:

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow 40(2) - 20(1) - 8(5) + y_E(8) = 0$

$\Rightarrow y_E = -2.5\ KN = 2.5\ KN \downarrow$

$+\uparrow \Sigma F_y = 0 \Rightarrow -40 - 20 + y_B - 8 - 2.5 = 0 \Rightarrow$

$y_B = 70.5\ KN \uparrow$

When w exceeds 6.67 KN/m, the reaction at B changes in direction and value, and the reaction at E retains its direction (upward) and increases in value

Problem II: (45 points)

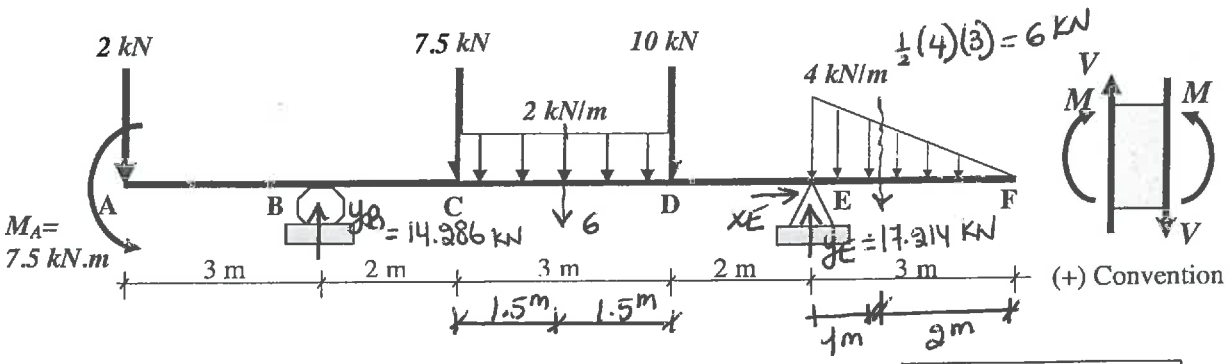


Figure II

Tick Boxes to check that you solved all questions

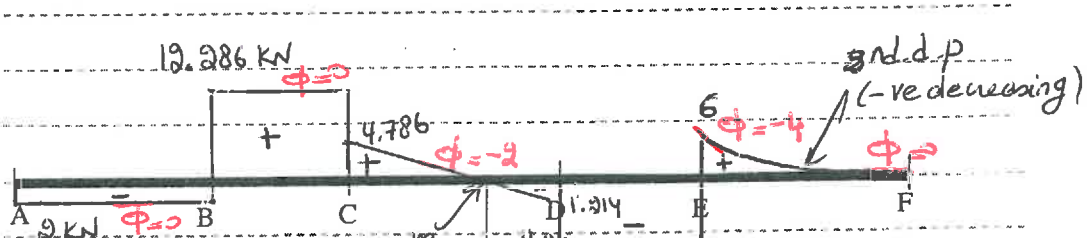
For the beam shown in Figure II:

1- Compute the reactions at points B, , and E. ☐
(CHECK THEM MORE THAN ONE TIME BEFORE YOU CONTINUE) (10 points)

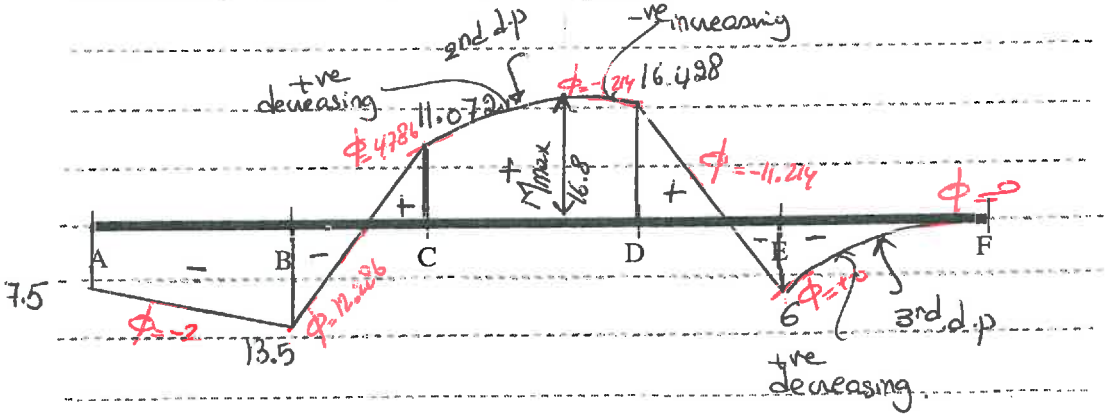
2- Using the method of integration (or areas), draw the shear force and bending moment diagrams (use the space provided below for the diagrams and draw to scale as much as you can). Show the important and necessary features and values on the diagrams and indicate the maximum positive and negative shears and moments in the beam. *(35 points)* ☐

Calculations and/or Diagrams: (LEAVE THIS PAGE CLEAN FOR YOUR DIAGRAMS)

S.F.D



B.M.D



Calculations and/or Diagrams (cont'd):

External Reactions:

$\pm \Sigma F_x = 0 \Rightarrow \boxed{x_E = 0}$

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow 7.5 + 2(3) - 7.5(2) - 6(3.5) - 10(5) + y_E(7) - 6(8) = 0$

$\Rightarrow \boxed{y_E = 17.214\ KN \uparrow}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -2 + 17.214 - 7.5 - 6 - 10 - 6 + y_B = 0$

$\Rightarrow \boxed{y_B = 14.286\ KN \uparrow}$

2- Shear

$V_A = -2\ KN$

$V_{BL} - V_A =$ area of dist. load bet A & B $= 0$

$\Rightarrow V_{BL} = V_A = 0 \Rightarrow V_{BL} = -2\ KN$

$V_{BR} = V_{BL} + y_B = -2 + 14.286 = 12.286\ KN$

$V_{CL} - V_{BR} =$ area of dist load bet B and C $= 0$

$\Rightarrow V_{CL} = V_{BR} = 12.286\ KN$

$V_{CR} = V_{CL} - 7.5 = 12.286 - 7.5 = 4.786\ KN$

$V_{D_L} - V_{CR} =$ area of dist. load bet C and D $= -2(3) = -6$

$\Rightarrow V_{D_L} = 4.786 - 6 = -1.214\ KN$

$V_{DR} = V_{DL} - 10 = -1.214 - 10 = -11.214\ KN$

$V_{EL} - V_{DR} =$ area of dist. load bet D and E $= 0$

$V_{EL} = V_{DR} = -11.214\ KN$

$V_{ER} = V_{EL} + 17.214 = -11.214 + 17.214 = 6\ KN$

$V_F - V_{ER} =$ area of dist. load bet E and F $= -\frac{1}{2} * 4 * 3 = -6\ KN$

$V_F = 6 - 6 = 0$ (ok free end)

Calculations and/or Diagrams (cont'd):

Moments

$M_A = -7.5$ KN.m (Concentrated moment at A)

$M_B - M_A$ = area of S.F diagram bet. A and B. $= -2 \times 3 = -6$

$M_B = -7.5 - 6 = -13.5$ KN.m

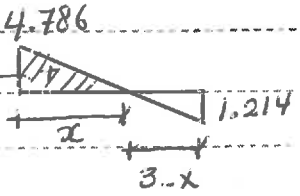
$M_C - M_B$ = area of S.F.D bet. C and B $= 12.286 \times 2 = 24.572$

$M_C = -13.5 + 24.572 = 11.072$ KN.m

$M_D - M_C$ = area of S.F.D bet. C and D

"location for Zero shear using similar triangles)

$$\frac{4.786}{x} = \frac{1.214}{3-x} \Rightarrow x = 2.393\ m$$



$M_{max} = M_C$ + area of triangle

$= 11.072 + \frac{1}{2} \times 4.786 \times 2.393 \simeq 16.8$ KN.m

$M_D = M_C$ + area of S.F.D bet. C and D $\Rightarrow$

$M_D = 11.072 + \left(\frac{1}{2} \times 4.786 \times 2.393 - \frac{1}{2} \times 1.214 (3 - 2.393)\right)$

$M_D = 16.43$ KN.m

$M_E - M_D$ = area of S.F.D bet. D and E

$\Rightarrow M_E = 16.43 - 11.214 \times 2 \simeq -6$ KN.m

$M_F - M_E$ = area of S.F.D bet. E and F

$M_F = -6 + \frac{1}{3} \times 6 \times 3 = -6 + 6 = 0$ (∴ ok. free end)

* $V_{max}^{+ve} = 12.286$ KN ; $M_{max}^{+ve} = 16.8$ KN.m

$V_{max}^{-ve} = 11.214$ KN ; $M_{max}^{-ve} = 13.5$ KN.m