UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

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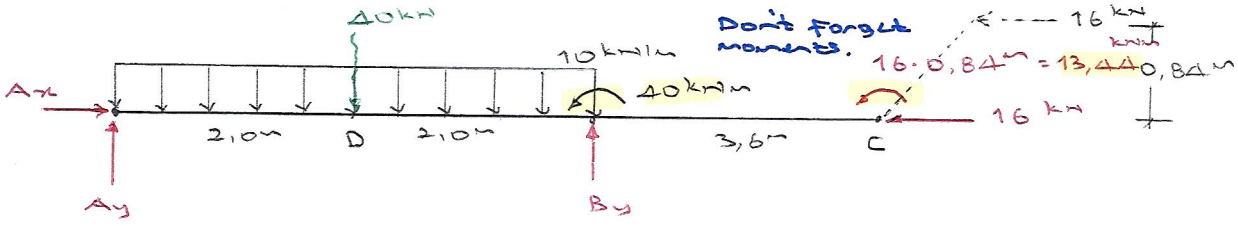
COURSE NO.	COURSE NAME	2
CIV 100F	Mechanics	student #

Problem Set 8 (PSB)

Solution

1. First, replace the inclined part with a point load and moment. Then find all support reactions.



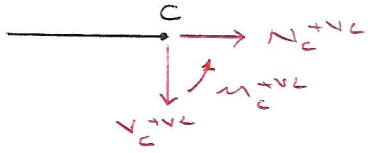
- $\Sigma M_A = 0 \Rightarrow -40 \cdot 2,0 + B_y \cdot 4,0 + 13,44 + 40 = 0 \Rightarrow B_y = 6,64\ kN$
- $\Sigma F_y = 0 \Rightarrow A_y = 40 - 6,64 = 33,36\ kN$
- $\Sigma F_x = 0 \Rightarrow A_x = 16\ kN$
- check: $\Sigma M_B \overset{?}{=} 0 \Rightarrow 40 \cdot 2,0 + 13,44 + 40 - 33,36 \cdot 4,0 = 0$ ok

- At point C: Answer

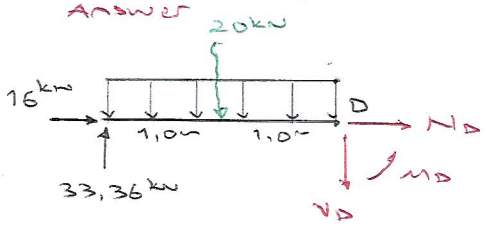
$N_c = -16\ kN$

$V_c = 0$

$M_c = +13,4\ kNm$



- At point D: Answer



$N_D = -16\ kN$

$V_D = +13,36\ kN$

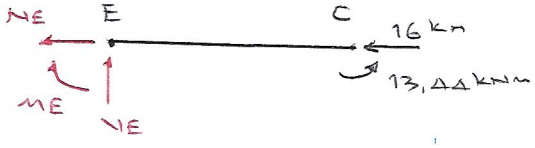
$M_D = 33,36 \cdot 2,0m - 20 \cdot 1,0m = +46,7\ kNm$

- At point E: Answer

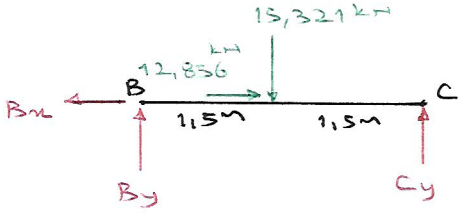
$N_E = -16\ kN$

$V_E = 0$

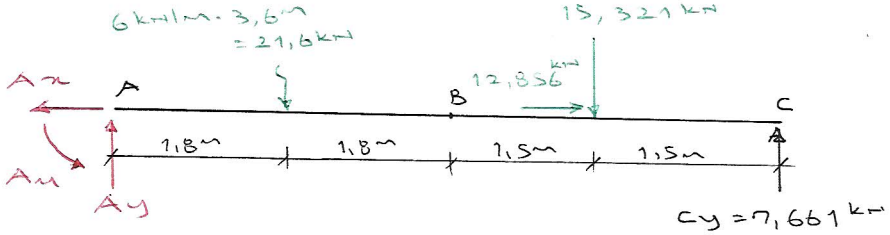
$M_E = +13,4\ kNm$



2-) First, need to find support r+ns. But 4 reactions! We can solve for up to 3 reactions. Need to isolate the system. Luckily, we have an internal pin at B. So dissemble the system at B. Look at the right side.

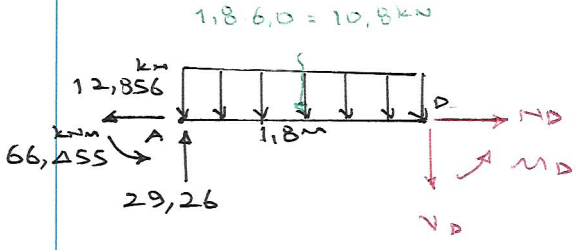


- $\Sigma M_B = 0 \Rightarrow 15,321 \cdot 1,5 = C_y \cdot 3,0$
  $\Rightarrow C_y = 7,661$ kN
- Since we found 1 unknown, we can solve the remaining 3 unknowns from the global system.



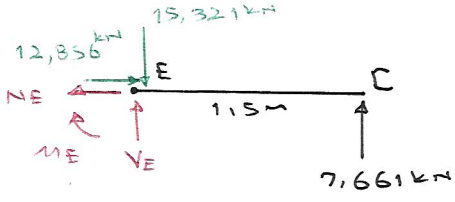
- $\Sigma M_A = 0 \Rightarrow 21,6 \cdot 1,8 + 15,321 \cdot 5,1 - 7,661 \cdot 6,6 - A_m = 0$
  $\Rightarrow A_m = 66,455$ kNm
- $\Sigma F_y = 0 \Rightarrow A_y + 7,661 - 21,6 - 15,321 = 0 \Rightarrow A_y = 29,26$ kN
- $\Sigma F_x = 0 \Rightarrow A_x = 12,856$ kN
- Support reactions are all found. Now, we can find required internal forces.

i-) For D, examine the left portion of the beam.



- $\Sigma M_D = 0 \Rightarrow M_D + 10,8 \cdot 0,9 + 66,455 - 29,26 \cdot 1,8 = 0$
  $\Rightarrow M_D = -23,507$ kNm
- $\Sigma F_y = 0 \Rightarrow V_D = 29,26 - 10,8 = 18,46$ kN
- $\Sigma F_x = 0 \Rightarrow N_D = 12,856$ kN

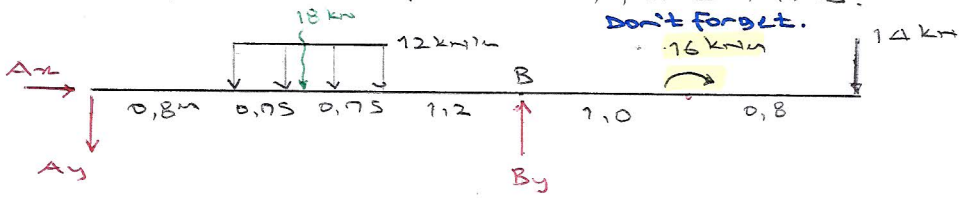
ii-) For E, examine the right portion. (note: point load is on the right of E; therefore, we need to include it.)



- $\Sigma M_E = 0 \Rightarrow M_E = 7,661 \cdot 1,5 = 11,492$ kN
- $\Sigma F_y = 0 \Rightarrow V_E = 15,321 - 7,661 = 7,660$ kN
- $\Sigma F_x = 0 \Rightarrow N_E = 12,856$ kN

3- First, need to find support rxns.

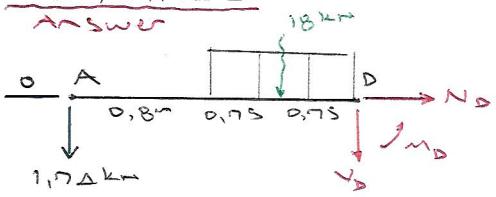
Don't forget.



- $\Sigma M_A = 0 \Rightarrow 18 \cdot (0,8 + 0,75) + 16 + 14 \cdot 5,3 = B_y \cdot 3,5 \Rightarrow B_y = 33,74 \text{ kN}$
- $\Sigma F_y = 0 \Rightarrow A_y = 33,74 - 18 - 14 = 1,74 \text{ kN}$
- $\Sigma F_x = 0 \Rightarrow A_x = 0$
- Check: $\Sigma M_B \overset{?}{=} 0 \Rightarrow 1,74 \cdot 3,5 + 18 \cdot 1,95 - 16 - 14 \cdot 1,8 = 0$ OK

- At point D:

Answer



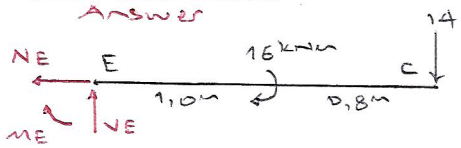
$N_D = 0$

$V_D = -18 - 1,74 = -19,7 \text{ kN}$

$M_D = -18 \cdot 0,75 - 1,74 \cdot 2,3 = -17,5 \text{ kNm}$

- At point E:

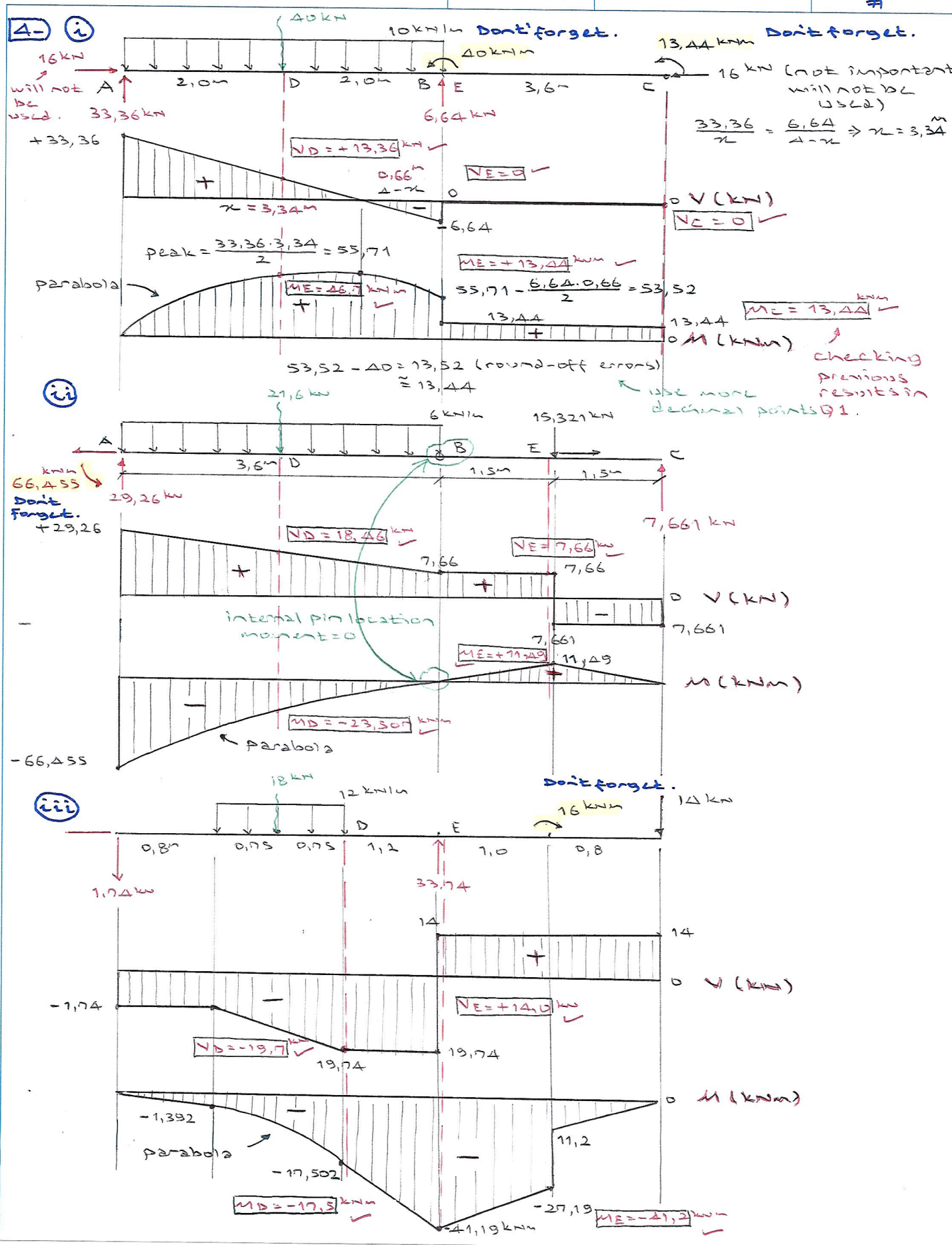
Answer



$N_E = 0$

$V_E = 14 \text{ kN}$

$M_E = -16 - 14 \cdot 1,8 = -41,2 \text{ kNm}$


4- (i)
40 kN
10 kN/m
Don't forget.
40 kNm
13,44 kNm
Don't forget.
16 kN
will not be used.
2,0 m
2,0 m
3,6 m
A
D
B
E
C
33,36 kN
6,64 kN
16 kN (not important will not be used)
33,36 / x = 6,64 / (4-x) ⇒ x = 3,34 m
+33,36
ND = +13,36 kN
0,66 m
4-x
VE = 0
x = 3,34 m
0
V (kN)
6,64
VC = 0
peak = 33,36 · 3,34 / 2 = 55,71
ME = +13,44 kNm
parabola
ME = 46,7 kNm
55,71 - 6,64 · 0,66 / 2 = 53,52
13,44
MC = 13,44 kNm
M (kNm)
checking previous results in
53,52 - 40 = 13,52 (round-off errors)
≈ 13,44
use more decimal points @ 1.
(ii)
27,6 kN
6 kN/m
15,321 kN
A
B
E
C
3,6 m
D
1,5 m
1,5 m
66,455 kNm
29,26 kN
Don't Forget.
7,661 kN
+29,26
ND = 18,46 kN
VE = 7,66 kN
7,66
7,66
V (kN)
internal pin location moment = 0
7,661
7,661
ME = +11,49
11,49
M (kNm)
MD = -23,507 kNm
parabola
-66,455
(iii)
18 kN
12 kN/m
Don't forget.
14 kN
16 kNm
D
E
0,8 m
0,75
0,75
1,2
1,0
0,8
1,74 kN
33,74
14
14
V (kN)
-1,74
VE = +14,0 kN
VD = -19,7 kN
19,74
19,74
M (kNm)
-1,392
parabola
-17,502
11,2
MD = -17,5 kNm
-27,19
ME = -41,3 kNm
-41,19 kNm