FACULTY OF APPLIED SCIENCE AND ENGINEERING

Problem Set 3 (PS3)

Solution

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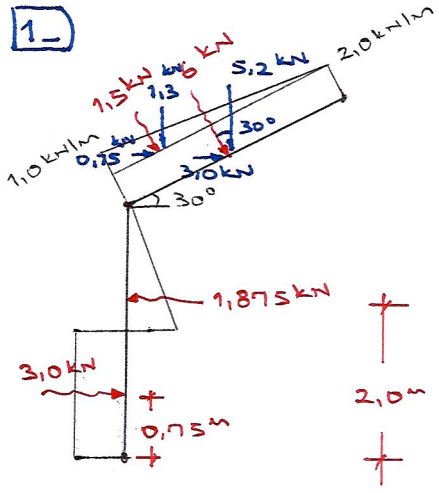
COURSE NO.	COURSE NAME	2
CIV100F	MECHANICS	Student No. # # #

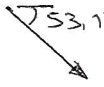
1.-



- First, draw a FBD.
- Indicate all forces and components.
- Work with x, y axes. (y ↑, x → +ve)
- Find the resultant force.

$F_{Rx} = \Sigma F_x = 0,75 + 3,0 + 3,0 - 1,875$
$= 4,875\ kN\ (\rightarrow)$

$F_{Ry} = \Sigma F_y = -5,2 - 1,3 = -6,5\ kN\ (\downarrow)$

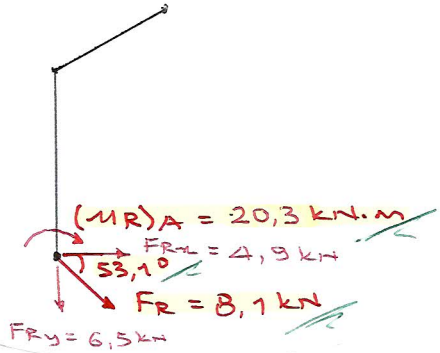


$F_R = \sqrt{4,875^2 + 6,5^2} = 8,125\ kN$
$\cong 8,1\ kN$

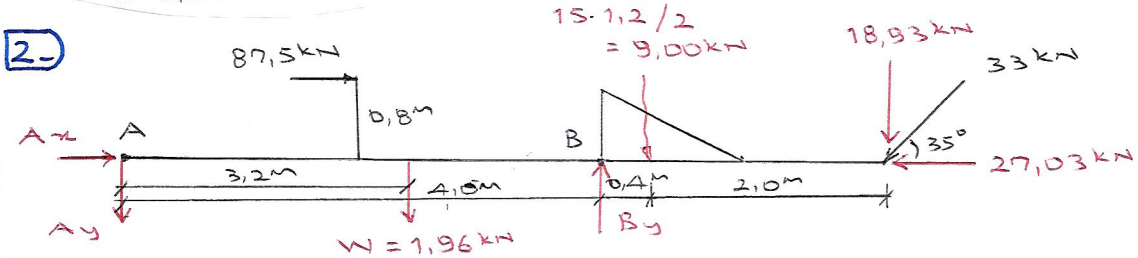
- Then, find the resultant couple moment

$(\Sigma M_R)_A = +3,0^{kN} \cdot 0,75^{m} + 1,3 \cdot (1 \cdot \cos 30°) + 5,2 \cdot (1,5 \cdot \cos 30°)$
$+ 3,0 \cdot (1,5 \cdot \sin 30° + 3,0) - 1,875 \cdot 2,0$
$+ 0,75 \cdot (1,0 \cdot \sin 30° + 3,0)$
$= 20,25\ kNm$

- Answer

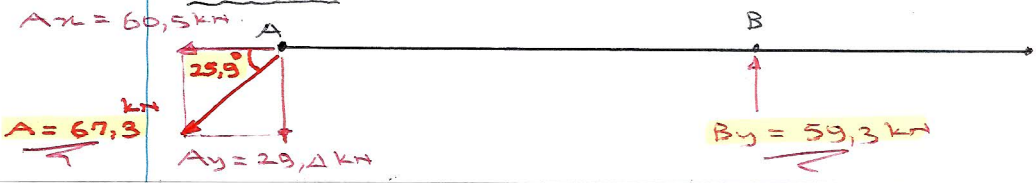


2.-

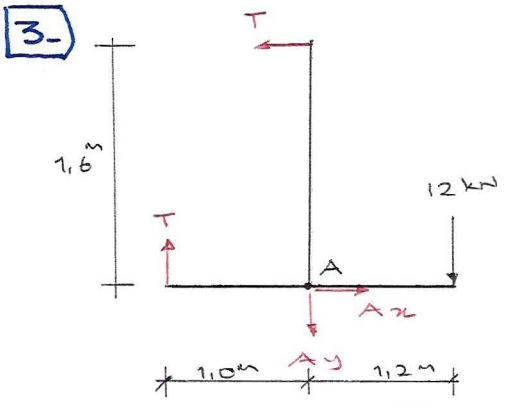


- $\Sigma F_x = 0 \Rightarrow A_x + 87,5 - 27,03 = 0 \Rightarrow A_x = -60,47\ kN$
- $\Sigma M_A = 0 \Rightarrow B_y^{kN} \cdot 4,0^{m} - 87,5^{kN} \cdot 0,8^{m} - 9,00^{kN} \cdot 4,4^{m} - 18,93^{kN} \cdot 6,4^{m} - 1,96 \cdot 3,2^{m} = 0$
$\Rightarrow B_y = 59,26\ kN$
- $\Sigma F_y = 0 \Rightarrow B_y - A_y - 1,96 - 9,00 - 18,93 = 0 \Rightarrow A_y = 29,37\ kN$

Answer:



3-



- First, draw a FBD. Identify all forces and unknowns. (Assume directions for unknowns.)
- Then, apply equilibrium eqs.

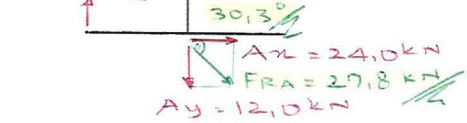
- $\Sigma F_x = 0 \Rightarrow T = A_x$
- $\Sigma F_y = 0 \Rightarrow T = A_y + 12\,kN$
- $\Sigma M_A = 0 \Rightarrow T \cdot 1,6\,m - T \cdot 1,0\,m - 12 \cdot 1,2\,m = 0$

$\Rightarrow T = 24,0\,kN$

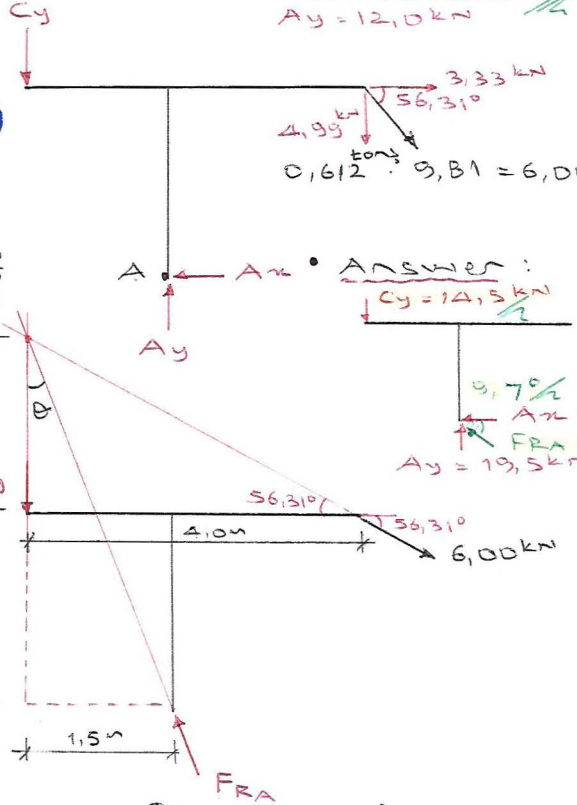
$A_x = 24,0\,kN\ (\rightarrow)$

$A_y = 12,0\,kN\ (\downarrow)$

- Answer:



4- (i)



- First, draw a FBD. Find force components. Apply eq'il. eqs.

- $\Sigma F_x = 0 \Rightarrow A_x = 3,33\,kN\ (\leftarrow)$
- $\Sigma F_y = 0 \Rightarrow A_y = 4,99 + C_y$
- $\Sigma M_A = 0 \Rightarrow C_y \cdot 1,5 - 3,33 \cdot 2,8 - 4,99 \cdot 2,5 = 0$

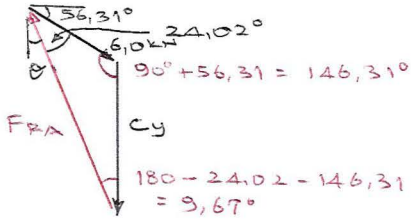
$\Rightarrow C_y = 14,53\,kN\ (\downarrow)$

$\Rightarrow A_y = 19,52\,kN\ (\uparrow)$

- Answer:

(i) **Three-Force member solution (optional)**

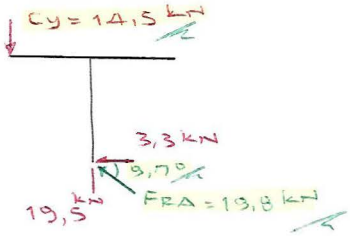
- $\tan^{-1}\left(\frac{1,5}{8,8}\right) = 9,67° = \theta$



- $\frac{F_{RA}}{\sin 146,31} = \frac{C_y}{\sin 24,02} = \frac{6,0}{\sin 9,67}$

$\Rightarrow F_{RA} = 19,81\,kN$; $C_y = 14,54\,kN$

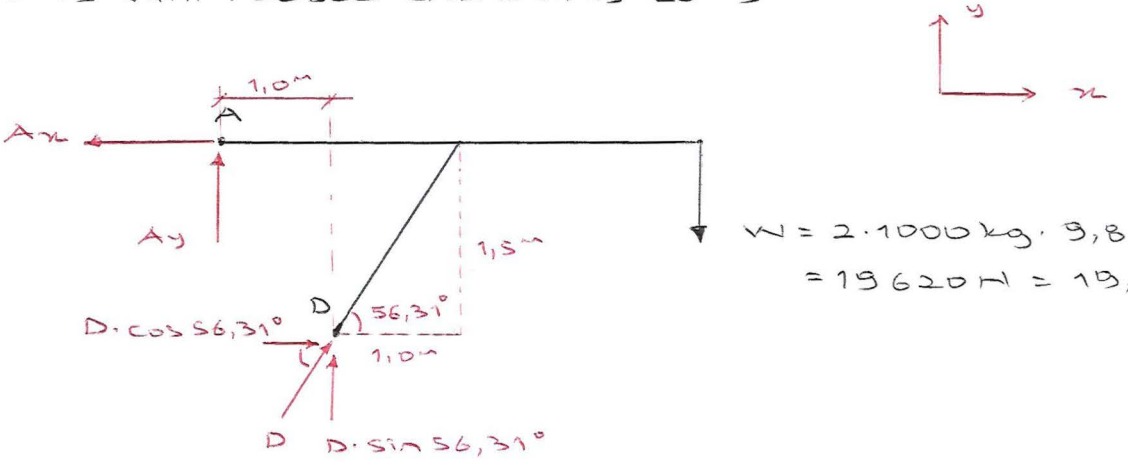
- Answer:



4-cont'd, ii.

- 2 pins = 4 reactions
  3 equilibrium equations } cannot solve!

- Realize member BD is a <u>two-force member</u>
  (only two end forces are present)
  → this will reduce unknowns to 3 ⌐

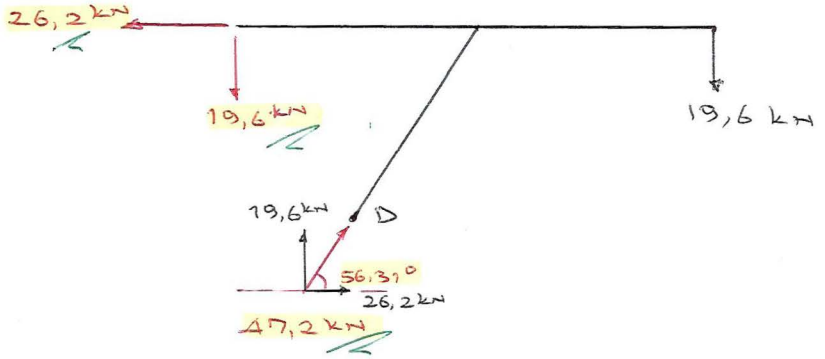


- $\Sigma M_A = 0 \Rightarrow D \cdot \cos 56,31^\circ \cdot 1,5\,m + D \cdot \sin 56,31^\circ \cdot 1,0\,m - 19,62\,kN \cdot 4,0\,m = 0$
  $\Rightarrow D = 47,16\,kN$ ∠56,31°

- $\Sigma F_x = 0 \Rightarrow D \cdot \cos 56,31 - A_x = 0 \Rightarrow A_x = 26,16\,kN$ ←

- $\Sigma F_y = 0 \Rightarrow D \cdot \sin 56,31 + A_y - 19,62 = 0 \Rightarrow A_y = -19,62\,kN$ ↓

- Answer:



check: $\Sigma F_y \overset{?}{=} 0$ OK ⌐
$\Sigma F_x \overset{?}{=} 0$ OK ⌐
$\Sigma M_D = 19,6\,kN \cdot 1,0 + 26,2 \cdot 1,5 - 19,6 \cdot 3,0 = 0,1 \cong 0$ OK ⌐