NATIONAL UNIVERSITY OF SCIENES & TECHNOLOGY

Engineering Mechanics (ME-100)

Assignment # 1

Submitted to: Dr. Hina Gohar Ali

Submitted by: Muhammad Umer

Class: BEE-12C

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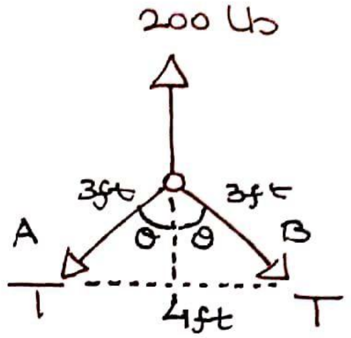
3.36

$\xrightarrow{+} \Sigma F_x = 0;$

$+\uparrow \Sigma F_y = 0;$



For A and B,

$$\Sigma F_x = T\sin\theta - T\sin\theta = 0$$

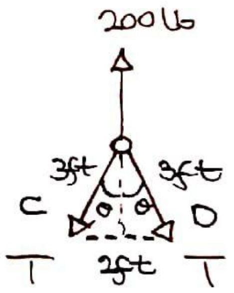
$$\Sigma F_y = 200 - 2T\cos\theta = 0$$

$$T = \frac{100}{\cos\theta} = \underline{134.163\ lb}$$

$\theta = \sin^{-1}(2/3)$

$\theta = 41.81°$

For C and D,



$$\Sigma F_x = T\sin\theta - T\sin\theta = 0$$

$$\Sigma F_y = 200 - 2T\cos\theta = 0$$

$$T = \frac{100}{\cos\theta} = \underline{106.06\ lb}$$

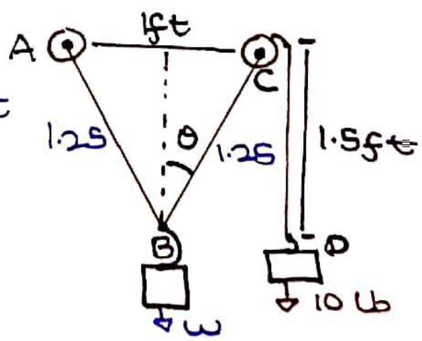
Hence, C and D attachment produces the least amount of tension; of 106.06 lb.

$\theta = \sin^{-1}(1/3)$

$\theta = 19.47°$

3.39

Tension remains same throughout the cord.



At D,

$$+\uparrow \Sigma F_y = T - 10 = 0$$

$$\boxed{T = 10\ lb}$$

$\theta = \sin^{-1}(0.5/1.25)$

$\theta = 23.57°$

At B,

$$\Sigma F_x = T\sin\theta - T\sin\theta = 0$$

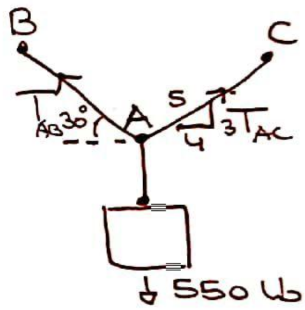
$$\Sigma F_y = 2T\cos\theta - W = 0$$

$$W = 2(10)\cos(23.57)$$

$$\boxed{W = 18.33\ lb}$$

Which is the weight of the block at B.

F.3-1



$+\uparrow \Sigma F_y = 0;$

$\xrightarrow{+} \Sigma F_x = 0;$

$$\Sigma F_x = T_{AC}(4/5) - T_{AB}\cos(30) = 0$$

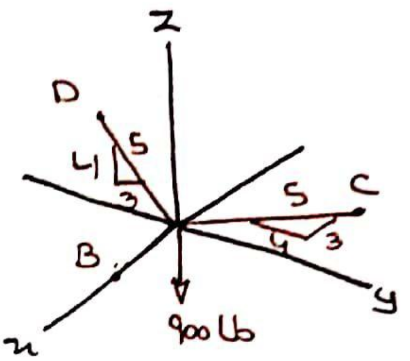
$$\Sigma F_y = T_{AB}\sin(30) + T_{AC}(3/5) - 550 = 0$$

$$\left(\frac{3}{5}\right)T_{AC} + T_{AB}\sin(30) = 550$$

Solving this linear system,

$$\boxed{\begin{aligned} T_{AC} &= 517.94\ lb \\ T_{AB} &= 478.46\ lb \end{aligned}}$$

F.3-8



$\sum F_x = 0;$

$\sum F_y = 0;$

$\sum F_z = 0;$

$$\sum F_x = \underline{F_B - (3/5) F_C = 0}$$

$$\sum F_y = \underline{-\left(\frac{3}{5}\right) F_D + \left(\frac{4}{5}\right) F_C = 0}$$

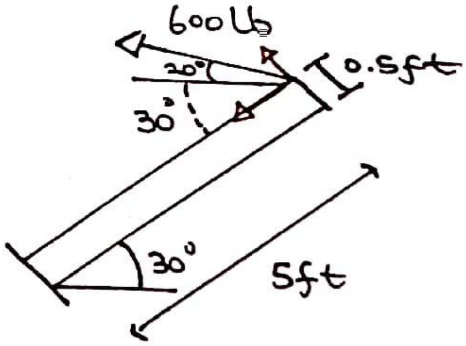
$$\sum F_z = \left(\frac{4}{5}\right) F_D - 900 = 0$$

$$\underline{\frac{4}{5} F_D = 900}$$

Solving this linear system gives;

$$\boxed{\begin{aligned} F_B &= 506.25 \text{ lb} \\ F_C &= 843.75 \text{ lb} \\ F_D &= 1125 \text{ lb} \end{aligned}}$$

F.4-1



$\circlearrowleft + M_o$;

The force along the length is;

$\underline{600 \cos(50)}$ along 5 ft

And along width is;

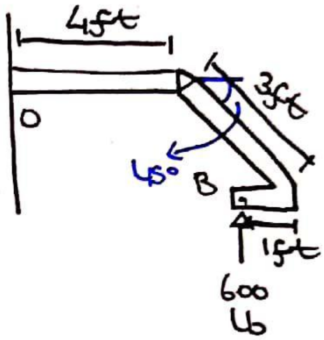
$\underline{600 \sin(50)}$ along 0.5 ft

$\circlearrowleft + M_o = 600\cos(50)(0.5) + 600\sin(50)(5)$
$= 2490.96 \text{ lb.m}$

$M_o = 2490.96 \text{ lb.m}$

F.4-4

The perpendicular distance between O and B is;



$r = 4 + 3\cos(45) - 1$
$= 5.121 \text{ ft}$

$\circlearrowleft + M_o = 600(5.121)$
$= 3072.79 \text{ lbm}$

$M_o = 3072.79 \text{ lb.m}$

4-1

Prove $A \times (B+D) = (A \times B) + (A \times D)$

$\vec{A} = A_x i + A_y j + A_z k$
$\vec{B} = B_x i + B_y j + B_z k$
$\vec{D} = D_x i + D_y j + D_z k$

$$A \times (B+D) = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x+D_x & B_y+D_y & B_z+D_z \end{vmatrix}$$

$$// \quad = [A_y(B_z+D_z) - A_z(B_y+D_y)]i - [A_x(B_z+D_z) - A_z(B_x+D_x)]j + [A_x(B_y+D_y) - A_y(B_x+D_x)]k$$

" $= \left[(A_yB_z - A_zB_y)i - (A_xB_z - A_zB_x)j + (A_xB_y - A_yB_x)k\right]$

$+ \left[(A_yD_z - A_zD_y)i - (A_xD_z - A_zD_x)j + (A_xD_y - A_yD_x)k\right]$

" $= \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} + \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ D_x & D_y & D_z \end{vmatrix}$

$\underline{A \times (B+D) = (A \times B) + (A \times D)}$

4-2 $A \cdot B \times C = A \times B \cdot C$ (Prove)

L.H.S

$= (A_x i + A_y j + A_z k) \cdot \begin{vmatrix} i & j & k \\ B_x & B_y & B_z \\ C_x & C_y & C_z \end{vmatrix}$

$= (A_x i + A_y j + A_z k) \cdot \left[i(B_yC_z - B_zC_y) - j(B_xC_z - B_zC_x) + k(B_xC_y - B_yC_x)\right]$

$= A_x(B_yC_z - B_zC_y) - A_y(B_xC_z - B_zC_x) + A_z(B_xC_y - B_yC_x)$

$= A_xB_yC_z - A_xB_zC_y - A_yB_xC_z + A_yB_zC_x + A_zB_xC_y - A_zB_yC_x$

R.H.S

$= \begin{vmatrix} i & j & k \\ A_x & y & A_z \\ B_x & B_y & B_z \end{vmatrix} \cdot (C_x i + C_y j + C_z k)$

$= \left[i(A_yB_z - A_zB_y) - j(A_xB_z - A_zB_x) + k(A_xB_y - A_yB_x)\right](C_x i + C_y j + C_z k)$

$= C_x(A_yB_z - A_zB_y) - C_y(A_xB_z - A_zB_x) + C_z(A_xB_y - A_yB_x)$

$= A_xB_yC_z - A_xB_zC_y - A_yB_xC_z + A_yB_zC_x + A_zB_xC_y - A_zB_yC_x$

Hence, $\underline{LHS = RHS}$

$$\underline{A \cdot B \times C = A \times B \cdot C}$$

4.3 If $A \cdot (B \times C) = 0$, A, B, C are coplanar

Let $\vec{X} = \vec{B} \times \vec{C}$

Then, $A \cdot X = 0$

$$|A||X| \cos\theta = 0$$

Since all vectors are non-zero,

$\theta = 90^\circ$ $\therefore$ A is $\perp$ to X

And, $X = B \times C$ $\therefore$ X is $\perp$ to both B & C

Thus, X is $\perp$ to all A, B and C

i.e They lie in the same plane