Alkım DOĞAN
2521482
CENG

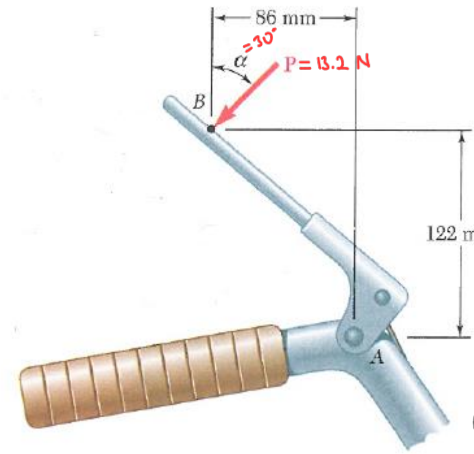
HOMEWORK 3

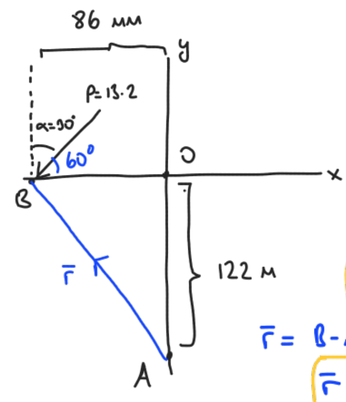
Q1)

$180 \quad \pi$

$x \quad ?$

$? = \frac{x \cdot \pi}{180}$

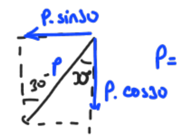




x y

$B = (-86, 0)$

$A = (0, -122)$



$P = \{-P.\sin 30\,\hat{i} - P.\cos 30\,\hat{j}\}$

$\bar{P} = 13.2\,\{-\sin 30\,\hat{i} - \cos 30\,\hat{j}\}$

$\boxed{\bar{P} = \{-6.6\,\hat{i} - 11.43\,\hat{j}\}}$ ①

$\bar{r} = B - A = (-86, 0) - (0, -122)$

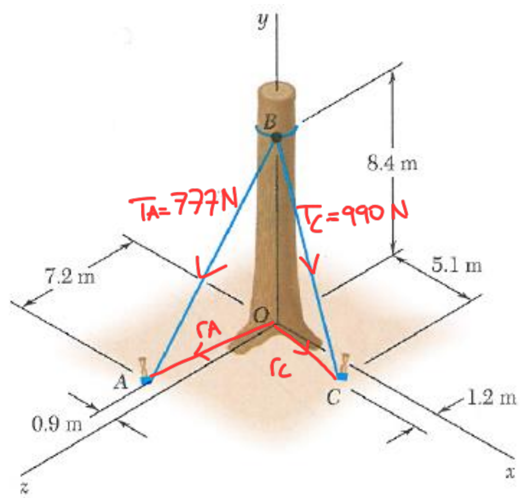
$\boxed{\bar{r} = \{-86\,\hat{i} + 122\,\hat{j}\}}$ ②

$$\bar{M} = \bar{r} \times \bar{P} = \begin{vmatrix} i & j & k \\ -86 & 122 & 0 \\ -6.6 & -11.43 & 0 \end{vmatrix} = (86 \times 11.43 + 6.6 \times 122)\,\hat{k} \text{ N mm}$$

$$\boxed{\bar{M} = \{1788.18\,\hat{k}\} \text{ NMM}}$$

A 13.2-N force **P** is applied to the lever which controls the auger of a snowblower. Determine the moment of **P** about A when α is equal to 30^0.

Q2)



$\bar{M} = \bar{M}_A + \bar{M}_B$

$\bar{M}_A = \bar{r}_A \times \bar{T}_A$

$\bar{M}_C = \bar{r}_C \times \bar{T}_C$

$A = (-0.9, 0, 7.2)$

$B = (0, 8.4, 0)$

$C = (5.1, 0, 1.2)$

$\bar{r}_A = \{-0.9\,\hat{i} + 7.2\,\hat{k}\}$

$\bar{r}_C = \{5.1\,\hat{i} + 1.2\,\hat{k}\}$

I first found the needed vectors.

Before the trunk of a large tree is felled, cables AB and BC are attached as shown. Knowing that the tension in cables AB and BC are 777 N and 990 N, respectively, determine the moment about O of the resultant force exerted on the tree by the cables at B.

$\overline{T_A} = \underbrace{T_A}_{777} \cdot \overline{u_A}$ $\quad \overline{u_A} = \dfrac{\overline{r_{AB}}}{|r_{AB}|} = \dfrac{\{-0.9\hat{i} - 8.4\hat{j} + 7.2\hat{k}\}}{\sqrt{(0.9)^2 + (8.4)^2 + (7.2)^2}} = \dfrac{\{-0.9\hat{i} - 8.4\hat{j} + 7.2\hat{k}\}}{11.1}$

$\overline{T_A} = 777 \cdot \dfrac{\{-0.9\hat{i} - 8.4\hat{j} + 7.2\hat{k}\}}{11.1} = \boxed{\{-63\hat{i} - 588\hat{j} + 504\hat{k}\} = T_A}$

$\overline{T_C} = \underbrace{T_C}_{990} \overline{u_C}$ $\quad \overline{u_C} = \dfrac{\overline{r_{CB}}}{|r_{CB}|} = \dfrac{\{5.1\hat{i} - 8.4\hat{j} + 1.2\hat{k}\}}{\sqrt{(5.1)^2 + (8.4)^2 + (1.2)^2}} = \dfrac{\{5.1\hat{i} - 8.4\hat{j} + 1.2\hat{k}\}}{9.9}$

$\overline{T_C} = \cancel{990}^{100} \cdot \dfrac{\{5.1\hat{i} - 8.4\hat{j} + 1.2\hat{k}\}}{\cancel{9.9}} = \boxed{\{510\hat{i} - 840\hat{j} + 120\hat{k}\} = T_C}$

I have found the needed vectors. Now, I will apply $\overline{M} = \overline{r} \times F$ for each point.

$\overline{M_A} = \overline{r_A} \times \overline{T_A}$ $\quad \overline{M_A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -0.9 & 0 & 7.2 \\ -63 & -588 & 504 \end{vmatrix} = \hat{i}(588 \times 7.2) - \hat{j}(-0.9 \times 504 + 7.2 \times 63) + \hat{k}(588 \times 0.9)$

$$\boxed{\overline{M_A} = \{4233.6\hat{i} + 0\hat{j} + 529.2\hat{k}\}}$$

$\overline{M_C} = \overline{r_C} \times \overline{T_C}$

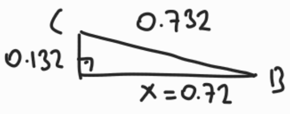
$\overline{M_C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 5.1 & 0 & 1.2 \\ 510 & -840 & 120 \end{vmatrix} = \hat{i}(+840 \times 1.2) - \hat{j}(120 \times 5.1 - 1.2 \times 510) + \hat{k}(-840 \times 5.1)$

$$\boxed{\overline{M_C} = \{1008\hat{i} - 4284\hat{k}\}}$$

$\overline{M} = \overline{M_A} + M_C$

$\overline{M} = \{(4233.6 + 1008)\hat{i} + 0\hat{j} + (529.2 - 4284)\hat{k}\} = \boxed{\{5241.6\hat{i} + \cancel{0\hat{j}} - 3754.8\hat{k}\}}$

SOLUTION OF Q3

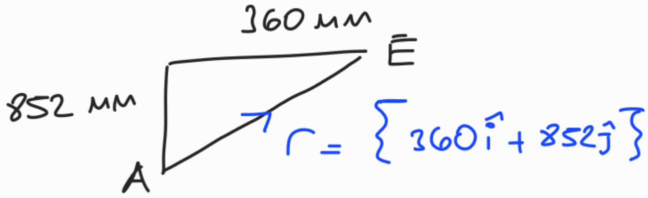


$x = \sqrt{(0.732)^2 - (0.132)^2} = 0.72$

$E = (0.360, 0.852, 0$

$B = (1.2, 0, 0)$

$C = (1.2, 0.132, 0.72)$



$\overline{r} = \overline{E} - \overline{A} = \boxed{\{360\hat{i} + 852\hat{j}\} = \overline{r}}$ MM

$\overline{T} = T \cdot \overline{u_T}$

$\overline{u_T} = \dfrac{\overline{r_{EC}}}{|r_{EC}|} = \dfrac{\{-0.84\hat{i} + 0.72\hat{j} - 0.720\hat{k}\}}{\sqrt{(0.84)^2 + (0.72)^2 + (0.72)^2}} = \dfrac{\{-0.84\hat{i} + 0.72\hat{j} - 0.72\hat{k}\}}{1.32}$

$\overline{T} = 54 \dfrac{\{-0.84\hat{i} + 0.72\hat{j} - 0.72\hat{k}\}}{1.32} = \boxed{\{-34.36\hat{i} + 29.45\hat{j} - 29.45\hat{j}\} = \overline{T}}$

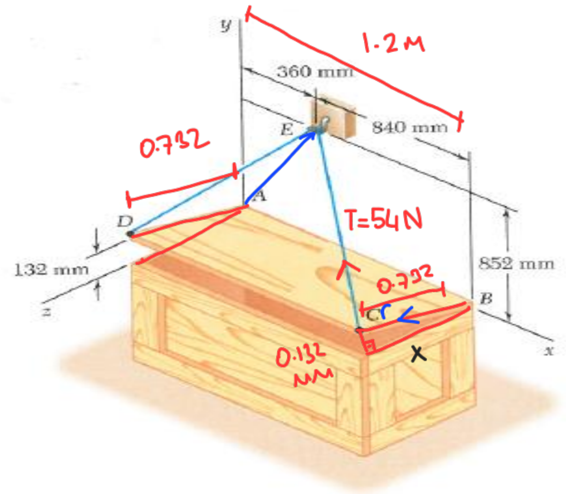
$\overline{M} = \overline{r} \times \overline{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0.36 & 0.852 & 0 \\ -34.36 & 29.45 & -29.45 \end{vmatrix} = \hat{i}(0.852 \times (-29.45)) - \hat{j}(0.36 \times -29.45) + \hat{k}(29.45 \times 0.36 + 0.852 \times 34.36)$

$$\boxed{\overline{M} = \{-25.09\hat{i} + 10.6\hat{j} + 39.88\hat{k}\}}$$

$\overline{M} = \overline{M_x} + \overline{M_y} + \overline{M_z}$

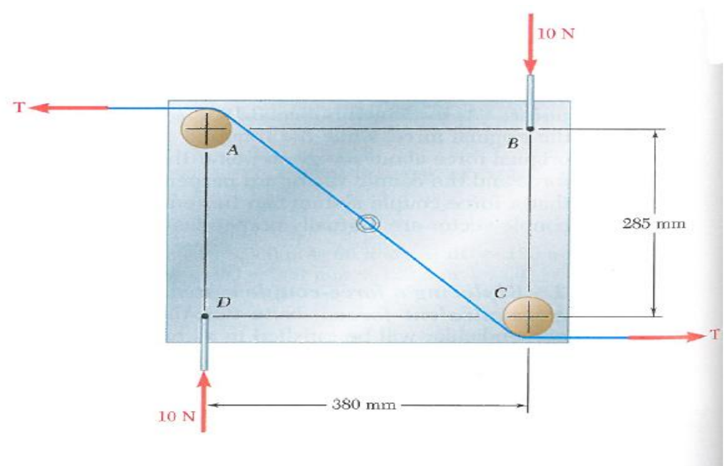
$$\bar{M}_x = (\bar{M}\cdot\bar{U}_x)\bar{U}_x = -25.09 \text{ N·M}$$
$$\bar{M}_y = (\bar{M}\cdot\bar{U}_y)\bar{U}_y = 10.6 \text{ N·M}$$
$$\bar{M}_z = (\bar{M}\cdot\bar{U}_z)\bar{U}_z = 39.88 \text{ N·M}$$

Q3)



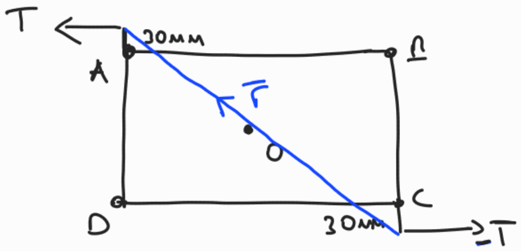
The 0.732×1.2-m lid ABCD of a storage bin is hinged alongside AB and is held open by looping cord DEC over a frictionless hook at E. If the tension in the cord is 54 N, determine the moment about each of the coordinate axes of the force exerted by the cord at C.

Q4)



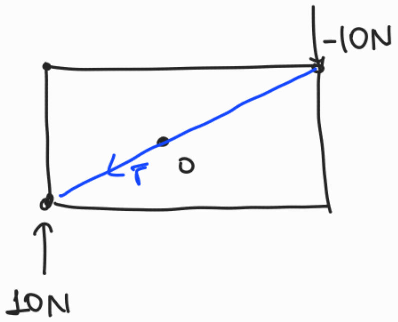
Two 60-mm-diameter pegs are mounted on a steel plate at A and C, and two rods are attached to the plate at B and D. A cord is passed around the pegs and pulled as shown, while the rods exert on the plate 10-N forces as indicated. (a) Determine the resulting couple acting on the plate when T=36 N. (b) If only the cord is used, in what direction should it be pulled to create the same couple with the minimum tension in the cord? (c) Determine the value of that minimum tension.

$285 + 60 = 345$ mm



$$\overrightarrow{M_{cord}} = \vec{r} \times \vec{T}$$

$$\vec{r} = \left\{ -380\,\hat{i} + 345\,\hat{j} \right\}$$



$$\bar{M}_{rods} = \bar{r} \times \left\{ 10\,\hat{j} \right\}$$

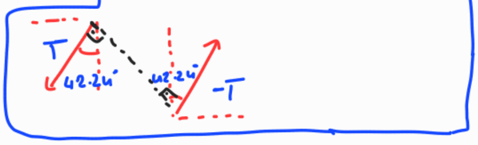
$$\vec{r} = \left\{ -380\,\hat{i} - 285\,\hat{j} \right\}$$

A) $\bar{M}_{cord} + \bar{M}_{rod} = \begin{vmatrix} i & j & k \\ -380 & 345 & 0 \\ -36 & 0 & 0 \end{vmatrix} + \begin{vmatrix} i & j & k \\ -380 & -285 & 0 \\ 0 & 10 & 0 \end{vmatrix} = \left\{ -36 \times -345\,\hat{k} \right\} + \left\{ -10 \times 380\,\hat{k} \right\}$

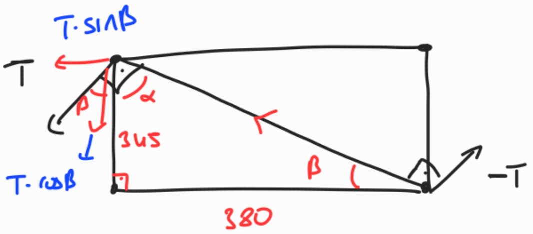
$T = 36\ N$

$$= \left\{ -36 \times -345\,\hat{k} - 10 \times 380\,\hat{k} \right\} = \boxed{\left\{ 8620\,\hat{k} \right\}} \quad N\,mm$$

B) If only cord was used, It should be pulled in COUNTERCLOCKWISE direction. Also, it should be perpendicular to $\vec{r}$.



C)



$$\beta = \arctan\left(\frac{345}{380}\right) = 42.24°$$

$$T \cdot \sin(42.24) \cdot 345 + T \cdot \cos(42.24) \cdot 380 = 8620$$

$$T = \frac{8620}{345 \sin(42.24) + 380 \cdot \cos(42.24°)} = \boxed{16.8\ N}$$