PROBLEM 3.4

A 300-N force is applied at A as shown. Determine (a) the moment of the 300-N force about D, (b) the magnitude and sense of the horizontal force applied at C that creates the same moment about D, (c) the smallest force applied at C that creates the same moment about D.

SOLUTION

(a) See Problem 3.3 for the figure and analysis leading to the determination of $M_D$

$$M_D = 41.7 \text{ N} \cdot \text{m}$$

(b) Since C is horizontal $C = C \hat{i}$

$$r = DC = (0.2 \text{ m}) \hat{i} - (0.125 \text{ m}) \hat{j}$$

$$M_D = r \times C \hat{i} = C(0.125 \text{ m}) \hat{k}$$

$$41.7 \text{ N} \cdot \text{m} = (0.125 \text{ m})(C)$$

$$C = 333.60 \text{ N}$$

(c) The smallest force C must be perpendicular to DC; thus, it forms $\alpha$ with the vertical

$$\tan \alpha = \frac{0.125 \text{ m}}{0.2 \text{ m}}$$

$$\alpha = 32.0^\circ$$

$$M_D = C(DC); \quad DC = \sqrt{(0.2 \text{ m})^2 + (0.125 \text{ m})^2} = 0.23585 \text{ m}$$

$$41.70 \text{ N} \cdot \text{m} = C(0.23585 \text{ m})$$

$$C = 176.8 \text{ N} \longleftarrow 58.0^\circ$$
PROBLEM 3.21
A 200-N force is applied as shown to the bracket $ABC$. Determine the moment of the force about $A$.

SOLUTION
We have
$$M_A = r_{CA} \times F_C$$
where
$$r_{CA} = (0.06 \text{ m})\mathbf{i} + (0.075 \text{ m})\mathbf{j}$$
$$F_C = -(200 \text{ N})\cos 30^\circ \mathbf{j} + (200 \text{ N})\sin 30^\circ \mathbf{k}$$
Then
$$M_A = 200 \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0.06 & 0.075 & 0 \\ 0 & -\cos 30^\circ & \sin 30^\circ \end{vmatrix} = 200[(0.075\sin 30^\circ)\mathbf{i} - (0.06\sin 30^\circ)\mathbf{j} - (0.06\cos 30^\circ)\mathbf{k}]$$
or
$$M_A = (7.50 \text{ N} \cdot \text{m})\mathbf{i} - (6.00 \text{ N} \cdot \text{m})\mathbf{j} - (10.39 \text{ N} \cdot \text{m})\mathbf{k}$$
PROBLEM 3.26

A small boat hangs from two davits, one of which is shown in the figure. The tension in line $ABAD$ is 82 lb. Determine the moment about $C$ of the resultant force $\mathbf{R}_A$ exerted on the davit at $A$.

SOLUTION

We have

$\mathbf{R}_A = 2\mathbf{F}_{AB} + \mathbf{F}_{AD}$

where

$\mathbf{F}_{AB} = -(82 \text{ lb})\mathbf{j}$

and

$\mathbf{F}_{AD} = \frac{\mathbf{A}D}{AD} = \frac{(82 \text{ lb}) \mathbf{i} - 7.75 \mathbf{j} - 3 \mathbf{k}}{10.25}$

$\mathbf{F}_{AD} = (48 \text{ lb})\mathbf{i} - (62 \text{ lb})\mathbf{j} - (24 \text{ lb})\mathbf{k}$

Thus

$\mathbf{R}_A = 2\mathbf{F}_{AB} + \mathbf{F}_{AD} = (48 \text{ lb})\mathbf{i} - (226 \text{ lb})\mathbf{j} - (24 \text{ lb})\mathbf{k}$

Also

$\mathbf{r}_{AC} = (7.75 \text{ ft})\mathbf{j} + (3 \text{ ft})\mathbf{k}$

Using Eq. (3.21):

$\mathbf{M}_C = \begin{bmatrix} 0 & 7.75 & 3 \\ 48 & -226 & -24 \end{bmatrix}$

$\mathbf{M}_C = (492 \text{ lb} \cdot \text{ft})\mathbf{i} + (144 \text{ lb} \cdot \text{ft})\mathbf{j} - (372 \text{ lb} \cdot \text{ft})\mathbf{k}$

$\mathbf{M}_C = (492 \text{ lb} \cdot \text{ft})\mathbf{i} + (144.0 \text{ lb} \cdot \text{ft})\mathbf{j} - (372 \text{ lb} \cdot \text{ft})\mathbf{k}$