Engineering Calculation Report: Problem 2-16

November 30, 2025

1 Known Variables

Vector	F_x (lbf)	F_y (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F_R}$	-378.7	-761.0	850.0	30.0	$\vec{F_{BA}}$

2 Unknown Variables

Vector	F_x (lbf)	F_y (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F_{BA}}$	?	?	650.0	?	-x
$\vec{F_{BC}}$	?	?	?	-45.0	+x

3 Equations Used

1. $|\vec{F_{BC}}|^2 = |\vec{F_R}|^2 + |\vec{F_{BA}}|^2 - 2 \cdot |\vec{F_R}| \cdot |\vec{F_{BA}}| \cdot \cos(\angle(\vec{F_{BA}}, \vec{F_R}))$
2. $\dfrac{\sin(\angle(\vec{F_{BA}}, \vec{F_{BC}}))}{|\vec{F_R}|} = \dfrac{\sin(\angle(\vec{F_{BA}}, \vec{F_R}))}{|\vec{F_{BC}}|}$

4 Step-by-Step Solution

Step 1: Solve for $\angle(\vec{F_{BA}}, \vec{F_R})$

$$\begin{aligned}\angle(\vec{F_{BA}}, \vec{F_R}) &= 30^\circ (given) \\ &= 30^\circ\end{aligned}$$

Step 2: Solve for $|\vec{F_{BC}}|$ using Eq 1

$$\begin{aligned}|\vec{F_{BC}}| &= \sqrt{850^2 + 650^2 - 2 \cdot 850 \cdot 650 \cdot \cos(30^\circ)} \\ &= 434 \text{ lbf}\end{aligned}$$

Step 3: Solve for $\angle(\vec{F_{BA}}, \vec{F_{BC}})$ using Eq 2

$$\angle(\vec{F_{BA}}, \vec{F_{BC}}) = \sin^{-1}(850 \cdot \frac{\sin(30^\circ)}{434})$$
$$= 78.5^\circ$$

Step 4: Solve for $\angle(-\vec{x}, \vec{F_{BA}})$

$$\angle(-\vec{x}, \vec{F_{BA}}) = \angle(\vec{F_{BA}}, \vec{F_{BC}}) - |\angle(+\vec{x}, \vec{F_{BC}})|$$
$$= 78.5^\circ - 45^\circ$$
$$= 33.5^\circ$$

5 Summary of Results

Vector	F_x (lbf)	F_y (lbf)	$\lvert\vec{F}\rvert$ (lbf)	θ (deg)	Reference
$\vec{F_{BA}}$	-541.7	-359.2	650.0	33.5	-x
$\vec{F_{BC}}$	306.6	-306.6	433.6	-45.0	+x

Disclaimer

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