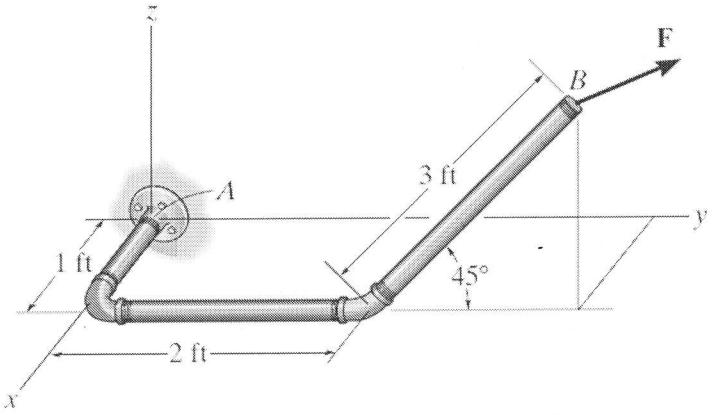
CME 250 – Statics
Exam #4 (10/11/2023)

StarID or TechID (no names) Grading

Show your work (you will not receive any credit if all you have is a final answer, right or wrong).
Do one of the two problems shown below (the second problem is on the back).

1. Determine the magnitude and coordinate direction angles of the moment of the force **F** about point A. The magnitude of F = 80 lb and its coordinate direction angles are alpha = 50 deg, beta = 40 deg, and gamma = 70 deg.



$\vec{F} = F\vec{\mu}_F = 80\,lb\,(\cos 50°\,i + \cos 40°\,j + \cos 70°\,k)$

$= 51.42\,i + 61.28\,j + 27.36\,k$ (lb) (2 pts)

$\vec{r}_{AB} = 1\,i + (2 + 3\cos 45°)\,j + 3\sin 45°\,k$ (ft)

$= 1\,i + 4.121\,j + 2.121\,k$ (ft) (2 pts)

$\vec{M}_A = \vec{r}_{AB} \times \vec{F}$

$$= \begin{vmatrix} + & - & + \\ i & j & k \\ 1 & 4.121 & 2.121 \\ 51.42 & 61.28 & 27.36 \end{vmatrix} \begin{matrix} \\ (ft) \\ (lb) \end{matrix}$$

$= +i\,((4.121)(27.36) - (2.121)(61.28))$
$\quad -j\,((1)(27.36) - (2.121)(51.42))$ (lb-ft)
$\quad +k\,((1)(61.28) - (4.121)(51.42))$

$= -17.22\,i + 81.70\,j - 150.62\,k$ (lb-ft) (2 pts)

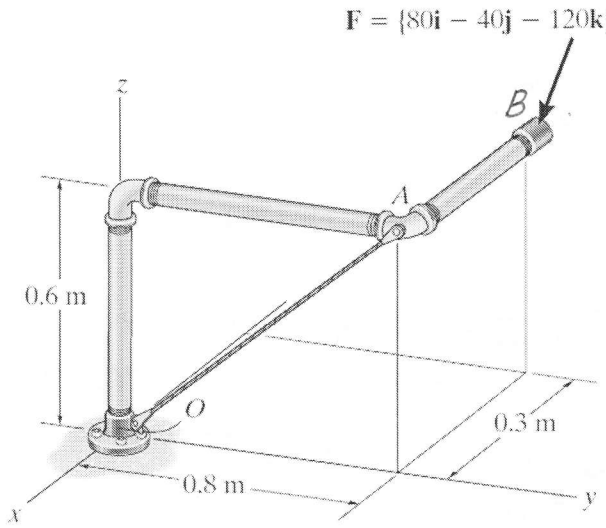
$M_A = \sqrt{(-17.22)^2 + (81.70)^2 + (-150.62)^2}$ (lb-ft)

172.2 lb-ft $\rightarrow$ **172 lb-ft** (1 pt)

$\cos\alpha = \frac{-17.22\ lb\text{-}ft}{172.2\ lb\text{-}ft}$, $\cos\beta = \frac{81.70\ lb\text{-}ft}{172.2\ lb\text{-}ft}$, $\cos\gamma = \frac{-150.62\ lb\text{-}ft}{172.2\ lb\text{-}ft}$

$\alpha = 95.7°$ (1 pt) **$\beta = 61.7°$** (1 pt) **$\gamma = 151°$** (1 pt)

2. Determine the moment of the force **F** about an axis extending between O and A. Express the result as a Cartesian vector.



$$\vec{M}_{OA} = \left[\vec{\mu}_{OA} \cdot (\vec{r}_{AB} \times \vec{F}) \right] \vec{\mu}_{OA}$$

$\vec{r}_{OA} = 0.8\,j + 0.6\,k$ (m) (2 pts)

$r_{OA} = 1$ m

$\vec{\mu}_{OA} = 0.8\,j + 0.6\,k$ (1 pt)

$\vec{r}_{AB} = -0.3\,i$ (m) (2 pts)

$$M_{OA} = \begin{vmatrix} + & - & + \\ 0 & 0.8 & 0.6 \\ -0.3 & 0 & 0 \\ 80 & -40 & -120 \end{vmatrix} \begin{matrix} \\ (m) \\ (N) \end{matrix}$$

$$= \begin{matrix} +(0)(\quad) \\ -0.8\left((-0.3)(-120) - (0)\right) \\ +0.6\left((-0.3)(-40) - (0)\right) \end{matrix} \quad (N\text{-}m)$$

$= -28.8 + 7.2 = -21.6$ (N-m) (3 pts)

$\vec{M}_{OA} = (-21.6\ (N\text{-}m))(0.8\,j + 0.6\,k)$

$= -17.28\,j - 12.96\,k$ (N-m)

$\boxed{-17.3\,j - 13.0\,k\ (N\text{-}m)}$ (2 pts)