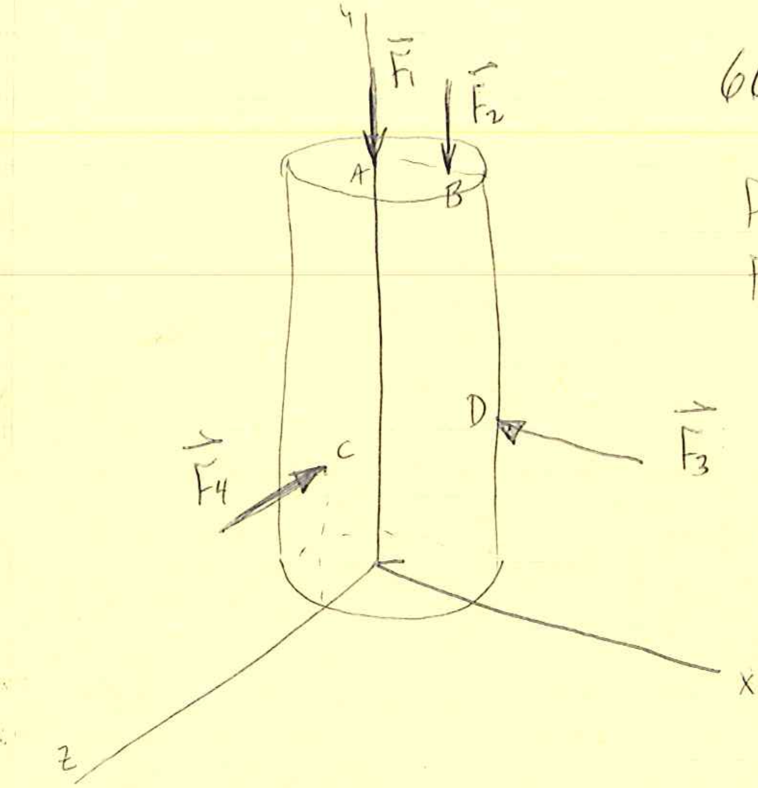
EXAMPLE PROB. 3.119



60-mm-dia cylinder

Find EQUIVALENT FORCE-COUPLE SYSTEM AT C

A(0, 140, 0)

~~[illegible]~~

B(20, 140, 0)

C(0, 30, 30)

D(30, 60, 0)

$$\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4$$

$$\vec{M}_C = \vec{r}_{CA} \times \vec{F}_1 + \vec{r}_{CB} \times \vec{F}_2 + \vec{r}_{CD} \times \vec{F}_3$$

FORCES: ~~[illegible]~~ $\vec{F}_1 = (-17)\hat{j}$ N

$\vec{F}_2 = (-12)\hat{j}$ N

$\vec{F}_3 = (-21)\hat{i}$ N

$\vec{F}_4 = (-16)\hat{k}$ N

$$\boxed{\vec{R} = (-21)\hat{i} + (-29)\hat{j} + (-16)\hat{k} \text{ N}}$$

PROB. 3.119 CONT.

FIND POSITION VECTORS.

FOR $\vec{r}_{CA}$:

~~COORDINATES OF POINT C: $X_C = 0$, $Y_C = 30$ mm, $Z_C = 30$ mm~~

~~POINT A: $X_A = 0$, $Y_A = 140$ mm, $Z_A = 0$~~

$d_x = X_A - X_C = 0 - 0 = 0$

$d_y = Y_A - Y_C = 140 - 30 = 110$ mm

$d_z = Z_A - Z_C = 0 - 30 = -30$ mm

$\cancel{d = \sqrt{110^2 + 30^2} = 114.0 \text{ mm}}$

$\vec{r}_{CA} = (0)\hat{i} + (110)\hat{j} + (-30)\hat{k}$ mm

FOR $\vec{r}_{CB}$:

~~POINT B: $X_B = 20$ mm, $Y_B = 140$ mm, $Z_B = 0$~~

$d_x = X_B - X_C = 20 - 0 = 20$ mm

$d_y = Y_B - Y_C = 140 - 30 = 110$ mm

$d_z = Z_B - Z_C = 0 - 30 = -30$ mm

$\vec{r}_{CB} = (20)\hat{i} + (110)\hat{j} + (-30)\hat{k}$ mm

FOR $\vec{r}_{CD}$:

PROB. 3.119 CONT.

~~POINT D: $x_D = 0$, $y_D = 60$ mm, $z_D = 0$~~ 30mm

$d_x = x_D - x_C = 30 - 0 = 30$ mm

$d_y = y_D - y_C = 60 - 30 = 30$ mm

$d_z = z_D - z_C = 0 - 30$ mm $= -30$ mm

$$\vec{r}_{CD} = (30)\hat{i} + (30)\hat{j} + (-30)\hat{k} \text{ mm}$$

$$\vec{M}_C = \vec{r}_{CA} \times \vec{F}_1 + \vec{r}_{CB} \times \vec{F}_2 + \vec{r}_{CD} \times \vec{F}_3 = \vec{M}_1 + \vec{M}_2 + \vec{M}_3$$

$$M_1 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 110 & -30 \\ 0 & -17 & 0 \end{vmatrix}$$

$$\vec{M}_1 = [(110)(0) - (-30)(-17)]\hat{i}$$
$$- [(0)(0) - (-30)(0)]\hat{j}$$
$$+ [(0)(-17) - (110)(0)]\hat{k}$$

$$\vec{M}_1 = (-510)\hat{i} \text{ N-mm}$$

$$\vec{M}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 20 & 110 & -30 \\ 0 & -12 & 0 \end{vmatrix}$$

PROB. 3.119 CONT.

$$\vec{M}_2 = [(110)(0)-(-30)(-12)]\hat{i}$$
$$-[(20)(0)-(-30)(0)]\hat{j}$$
$$+[(20)(-12)-(110)(0)]\hat{k}$$

$$\vec{M}_2 = (-360)\hat{i} + (0)\hat{j} + (-240)\hat{k} \ \text{N-mm}$$

$$\vec{M}_3 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & 30 & -30 \\ -21 & 0 & 0 \end{vmatrix}$$

$$\vec{M}_3 = [(30)(0)-(-30)(0)]\hat{i}$$
$$-[(30)(0)-(-30)(-21)]\hat{j}$$
$$+[(30)(0)-(30)(-21)]\hat{k}$$

$$\vec{M}_3 = (0)\hat{i} + (630)\hat{j} + (630)\hat{k} \ \text{N-mm}$$

$$\vec{M}_c = (-510)\hat{i} + (-360)\hat{i} + (-240)\hat{k}$$
$$+ (630)\hat{j} + (630)\hat{k} \ \text{N-mm}$$

$$\vec{M}_c = (-870)\hat{i} + (630)\hat{j} + (390)\hat{k} \ \text{N-mm}$$

$$\boxed{\vec{M}_c = (-0.87)\hat{i} + (0.63)\hat{j} + (0.39)\hat{k} \ \text{N-m}}$$