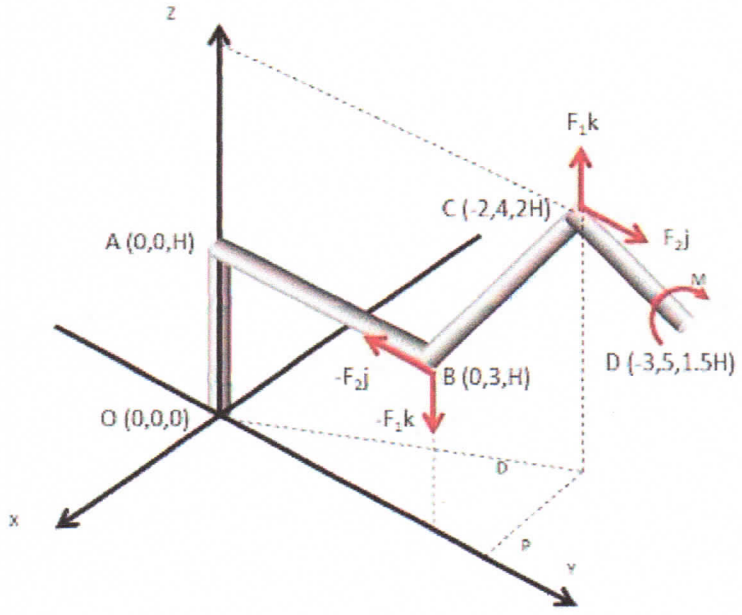
SOLUTION

ip4STATICS Worksheet for U04_3d_P05

The pipe assembly shown below is loaded with two force couples and a moment M. Note that M acts along pipe segment CD in the direction shown.

Instance variables: forces F1 and F2 in N; moment magnitude Mmag in N-m; length H in m.



(1) What is the resultant force FR(i,j,k) acting on the pipe assembly?

(2) What is the resultant moment MO(i,j,k) acting at the origin O?

(1) Forces F1 and F2 form couple moments.

$$FR(i,j,k) = (0)\bar{i} + (0)\bar{j} + (0)\bar{k}$$

direction of moment M: $\dfrac{(-2-(-3))\bar{i} + (4-5)\bar{j} + (0.5H)\bar{k}}{d}$

or $M = Mmag\left(\left(\frac{1}{d}\right)\bar{i} + \left(\frac{-1}{d}\right)\bar{j} + \left(\frac{0.5H}{d}\right)\bar{k}\right)$

where $d = SQRT(1^2 + (-1)^2 + (0.5H)^2)$

or $d = SQRT(2 + 0.25 \cdot H^2)$

For pipe segment BC: $-2\bar{i} + 1\bar{j} + H\bar{k}$

Components of couple moment F1: *

$M_{1x} = 1 \cdot F1$

$M_{1Y} = 2 \cdot F1$

$M_{1Z} = 0$

Components due to F2: *

$M_{2X} = -H \cdot F2$

$M_{2Y} = 0$

$M_{2Z} = -2 \cdot F2$

Assembling M, M1 and M2:

$$M_O = \left(\frac{M_{mag}}{d} + 1 \cdot F1 - H \cdot F2\right)\bar{i} + \left(-\frac{M_{mag}}{d} + 2 \cdot F1\right)\bar{j} + \left(\frac{0.5H}{d} - 2 \cdot F2\right)\bar{k}$$

* See next page for details.

(repeat) $\overline{BC} = -2\bar{\imath} + 1\bar{\jmath} + H\bar{k}$

$$M1 = \overline{BC} \times F1 \cdot \bar{k} = \begin{vmatrix} i & j & k \\ -2 & 1 & H \\ 0 & 0 & F1 \end{vmatrix} = F1 \cdot \bar{\imath} + 2 \cdot F1 \cdot \bar{\jmath}$$

$$M2 = \overline{BC} \times F2 \cdot \bar{\jmath} = \begin{vmatrix} i & j & k \\ -2 & 1 & H \\ 0 & F2 & 0 \end{vmatrix} = -2 \cdot F2\,\bar{k} - H \cdot F2\,\bar{\imath}$$