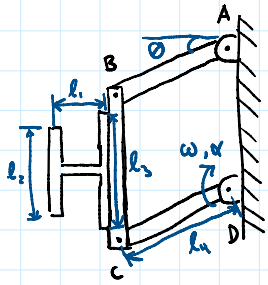
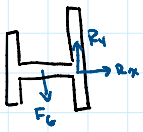
20-R-KIN-DK-35

July 22, 2020 9:39 AM

20-R-KIN-DK-35 Intermediate Multibody (RBK)

Inspiration: Hibbeler R17-2





Students are working on a prototype of a switch for their design team. The switch consists of 3 slender rods, each with a mass of ***5 kg***, welded to a linkage system. The rods are assembled in such a shape to resemble that of the letter H, with the shortest rod with length ***l_1 = 0.1 m*** acting as the bridge. The rod on the left has a length ***l_2 = 0.3 m*** and the rod on the right has a length ***l_3 = 0.4 m***. The linkage arms each have a length ***l_4 = 0.6 m***. Determine the internal forces and the moment that the linkage system exerts on the rods at the instant ***theta = 30 degrees***. The two pinned linkage arms have an angular velocity of ***omega = 5 rad/s*** and an angular acceleration of ***alpha = 3 rad/s^2*** at this instant.

$$\bar{x} = \frac{\sum \tilde{x} m}{\sum m} = \frac{0(5) + 0.05(5) + 0.1(5)}{5+5+5} = 0.05$$

$\hat{k}$ ↑ $\hat{j}$

$$\vec{a}_B = \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A} - \omega^2 \vec{r}_{B/A}$$

$$= 0 + (-3\hat{k}) \times (0.6\cos 30\,\hat{i} - 0.6\sin 30\,\hat{j}) - (5)^2(-0.6\cos 30\,\hat{i} - 0.6\sin 30\,\hat{j})$$

$$= 1.8\cos 30\,\hat{j} - 1.8\sin 30\,\hat{i} + 15\cos 30\,\hat{i} + 15\sin 30\,\hat{j}$$

$$= (15\cos 30 - 1.8\sin 30)\hat{i} + (15\sin 30 + 1.8\cos 30)\hat{j}$$

$\sum F_x$: $ma_{Gx} = R_x$ $\quad 15(15\cos 30 - 1.8\sin 30) = R_x$ $\quad$ **$R_x = 181.3557$ N**

$\sum F_y$: $ma_{Gy} = R_y - F_g$ $\quad 15(15\sin 30 + 1.8\cos 30) = R_y - 15(9.81)$ $\quad$ **$R_y = 283.0327$ N**

$\sum M_G$: $I_G \alpha = 0 = M_R + R_y \bar{x}$ $\quad -(283.0327)(0.05) = M_R$ $\quad$ **$M_R = -14.1516$ N·m**