20-R-KM-DK-16

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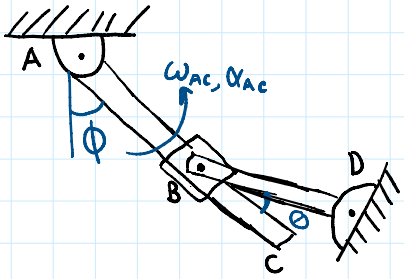
20-R-KM-DK-16 Intermediate Rotating Frame Analysis

Inspiration: 16-140 Hibbeler



Bar AC rotates at ***omega_AC = 2 rad/s*** with an angular acceleration of ***alpha_AC = 1 rad/s^2***. At that instant, it forms a ***phi = 55 degree*** angle with the vertical. If link BD makes a ***theta = 20 degrees*** angle with bar AC and has a length ***r_BD = 0.8 m***, determine the magnitude of the angular velocity and the magnitude of the angular acceleration of link BD, as well as the magnitude of the relative acceleration of collar B. The link is connected to a collar which slides along bar AC. The distance to B from A is ***r_AB = 1.1 m***.

$$\vec{v}_B = \vec{v}_A + \vec{\Omega}_{AC} \times \vec{r}_{B/A} + (v_{B/A})_{xyz}$$
$$= 2\hat{k} \times (1.1\hat{i}) + (v_{B/A})_{xyz}\hat{i}$$

$$v_B = -\omega_{BD}\hat{k} \times (-0.8\cos 20\,\hat{i} - 0.8\sin 20\,\hat{j})$$
$$= 0.8\cos 20\,\omega_{BD}\hat{j} - 0.8\sin 20\,\omega_{BD}\hat{i}$$

$\hat{i}$: $-0.8\sin 20\,\omega_{BD} = (v_{B/A})_{xyz}$

$\omega_{BD} = 2.926488\ldots$ rad/s

$\hat{j}$: $2.2 = 0.8\cos 20\,\omega_{BD}$

$(\vec{v}_{B/A})_{xyz} = -0.8007345151\ \text{m/s}\ \hat{i}$

$$\vec{a}_B = \vec{a}_A + \dot{\vec{\Omega}}_{AC} \times \vec{r}_{B/A} + \vec{\Omega}_{AC} \times (\vec{\Omega}_{AC} \times \vec{r}_{B/A}) + 2\vec{\Omega}_{AC} \times (v_{B/A})_{xyz} + (\vec{a}_{B/A})_{xyz}$$
$$= \vec{0} + 1\hat{k} \times 1.1\hat{i} + 2\hat{k} \times (2\hat{k} \times 1.1\hat{i}) + 2(2\hat{k}) \times (-0.8007345151\hat{i}) + (a_{B/A})_{xyz}\hat{i}$$
$$= 1.1\hat{j} + (-4.4\hat{i}) - 3.202939466\hat{j} + (a_{B/A})_{xyz}\hat{i}$$

$$\vec{a}_B = \vec{\alpha}_{BD} \times \vec{r}_{B/D} - \omega_{BD}^2 r_{B/D}$$
$$= \alpha_{BD}\hat{k} \times (-0.8\cos 20\,\hat{i} - 0.8\sin 20\,\hat{j}) - (2.926488)^2(-\cos 20\,\hat{i} - 0.8\sin 20\,\hat{j})$$
$$= -0.8\cos 20\,\alpha_{BD}\hat{j} + 0.8\sin 20\,\alpha_{BD}\hat{i} + 6.438275\hat{i} - 2.343334\hat{j}$$

$\hat{i}$: $6.438275 + 0.8\sin 20\,\alpha_{BD} = -4.4 + (a_{B/A})_{xyz}$

$\hat{j}$: $-0.8\cos 20\,\alpha_{BD} + 2.343334065 = 1.1 - 3.202939466$

$\alpha_{BD} = 5.914540846\ \text{rad/s}^2$

$(a_{B/A})_{xyz} = 12.45658\ \text{m/s}^2$