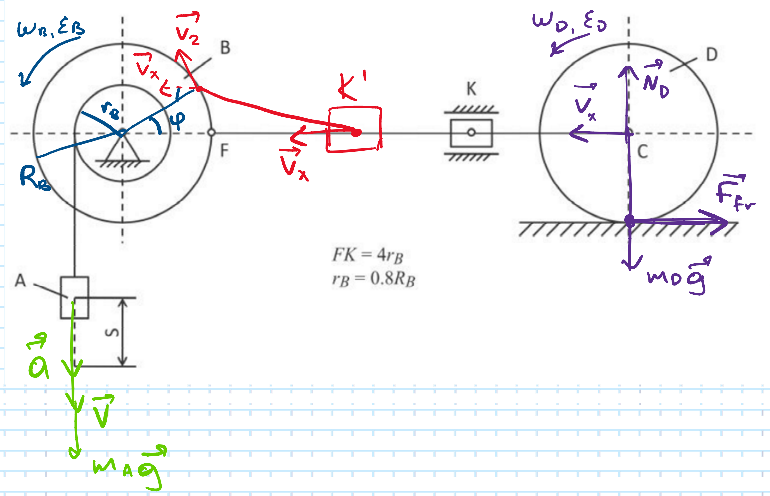
TM Homework 6 Anton Buguev B19-RO-01

Task 1



R.O.: system of 4 bodies:

block A - transl. motion

disk B - rot. motion

slider K - transl. motion

disk D - planar motion

Force analysis:

$$G_A = m_A g,\quad G_D = m_D g,\quad F_{fr} = \varphi N_D = \varphi G_D$$

Solution:

1) Let us use method $T_2 - T_1 = \sum A$

Since A moves from rest $T_1 = 0$, so $T_2 = \sum A$

2) Let us define velocities of all bodies:

$$\begin{cases} \omega_B = \dfrac{V_A}{r_B}, \\ \varphi_B = \dfrac{s}{r_B}. \end{cases} \Rightarrow V_2 = \omega_B R_B = \frac{V_A R_B}{r_B} \Rightarrow V_x = V_2 \cos\left(\frac{\pi}{2} - \varphi_B\right) \Rightarrow$$

$$\Rightarrow V_x = \frac{V_A R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right) = V_k = V_D \Rightarrow \omega_D = \frac{V_D}{R_D} = \frac{V_A R_B}{r_B R_D} \cdot \sin\left(\frac{s}{r_B}\right)$$

$$\Rightarrow s_D = \frac{s R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)$$

3) $T = T_A + T_B + T_D$

$$T_A = \frac{1}{2} m_A V_A^2,\quad T_B = \frac{1}{2} J_B \omega_B^2 = \frac{1}{2} m_B \cdot i_{Bx}^2 \cdot \left(\frac{V_A}{r_B}\right)^2,$$

$$T_D = \frac{1}{2} m_D V_D^2 + \frac{1}{2} J_D \omega_D^2 = \frac{1}{2} m_D \left(\frac{V_A R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2 + \frac{1}{2} m_D \cdot i_{Bx}^2 \cdot \left(\frac{V_A R_B}{r_B R_D} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2$$

$$T = \frac{1}{2} m_A V_A^2 + \frac{1}{2} J_B \omega_B^2 + \frac{1}{2} m_D V_D^2 + \frac{1}{2} J_D \omega_D^2 =$$

$$= \frac{1}{2} m_A V_A^2 + \frac{1}{2} J_B \left(\frac{V_A}{r_B}\right)^2 + \frac{1}{2} m_D \cdot \left(\frac{V_A R_B}{r_B} \cdot \sin\left(\frac{S}{r_B}\right)\right)^2 + \frac{1}{2} J_B \cdot \left(\frac{V_A R_B}{r_B \cdot R_D} \cdot \sin\left(\frac{S}{r_B}\right)\right)^2$$

4) $\sum A = A_{G_A} + \cancel{A_{G_D}}^{0} + A_{F_{fr}}$

$$\sum A = m_A g s - \psi m_D g \cdot S_D = m_A g s - \psi m_D g \cdot \frac{s \cdot R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)$$

5) So we have:

$$m_A V_A^2 + V_A^2 \cdot J_B \frac{1}{r_B^2} + V_A^2 \cdot m_D \left(\frac{R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2 + V_A^2 \cdot J_B \left(\frac{R_B}{r_B R_D} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2 =$$

$$= 2 m_A g s - 2 \psi m_D g \cdot \frac{s \cdot R_B}{r_B} \sin\left(\frac{s}{r_B}\right) \Rightarrow$$

$$\Rightarrow \quad \boxed{V_A = \sqrt{\frac{2 m_A g s - 2 \psi m_D g \cdot \frac{s R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)}{m_A + J_B \cdot \frac{1}{r_B} + m_D \left(\frac{R_B}{r_B} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2 + J_D \left(\frac{R_B}{r_B R_D} \cdot \sin\left(\frac{s}{r_B}\right)\right)^2}}}$$