Task 4 Single-cylinder engine

Task

In a single-cylinder engine inertia forces and moment of inertia occur and act on the environment of the mechanism. The effect of the inertia forces will be examined based on the non-offset planar slider-crank mechanism shown in figure 1.

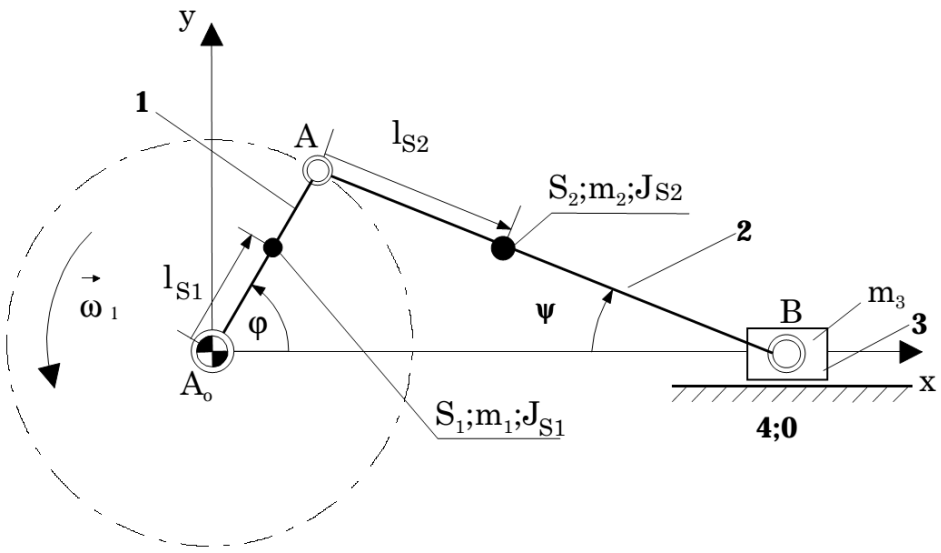

Figure 1

Given: crank length $l_1=\overline{A_0A}$, distance from the centre of gravity l_{S1}

connecting rod length $l_2=\overline{AB}$, distance from the centre of gravity l_{S2}

mass m_1 , mass m_2 , mass m_3;

mass moment of inertia J_{S2} ;

angular velocity of the crankshaft: $\omega_1=\text{const.}$;

angular acceleration of the connecting rod 2: $\ddot{\psi}=\psi(\varphi)$;

acceleration components: $\ddot{x}_A=\ddot{x}_A(\varphi)$, $\ddot{y}_A=\ddot{y}_A(\varphi)$, $\ddot{x}_B=\ddot{x}_B(\varphi)$, $\ddot{y}_B=\ddot{y}_B(\varphi)$;

a) Determine the equivalent dynamic system´s variables of the connecting rod 2 and specify the equivalent masses Q_1 and Q_3 .

Asked for: Variables of the dynamically equivalent system m_{21}, m_{23}, J_2 and Q_1, Q_3.

b) With the given acceleration components determine the scalar components of the global acting inertia forces of crank 1 (F_1) and piston 3 (F_3) and the frame torque M_{2z} , which is acting on the connecting rod 2. In figure 2 sketch the acting force vectors $\vec{F}_1$ and $\vec{F}_3$ as well as the frame torque $\overrightarrow{M}_{2z}$ (assuming that $F_{3x}>0$ and $M_{2z}>0$).

Asked for: F_{1x}, F_{1y}, F_{3x} and F_{3y}, M_{2z} as well as $\vec{F}_1$, $\vec{F}_3$, $\overrightarrow{M}_{2z}$ in figure 2.

c) Following the internal forces and moments, the components of the bearing forces of the frame joints A_0und B are to be determined as an equation form. Here, the variables occurring according to figure 2 must be split or moved in an appropriate manner in figure 3. All components are to be determined as an equation form.

Asked for: F_{A_0x}, F_{A_0y}, F_{Bx}, F_{By} and all other components as an equation form.

d) By vector addition, the resultant bearing forces $\vec{F}_{A_0}$ und $\vec{F}_B$ are to be determined in figure 4.

Asked for: Force vector $\vec{F}_{A_0}$ and $\vec{F}_{Bx}$ in figure 4.

e) Determine the occurring moments in z-direction as they act on the crankshaft and on the frame. Specify the resultant moment on the crankshaft M_1 and on the frame M_G as well as the frame torque M_z .

Asked for: moments in z-direction, M_1, M_G and M_z

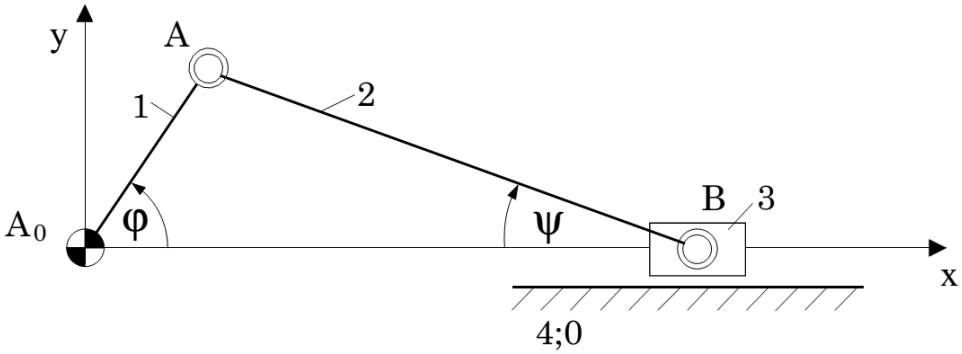

Figure 2

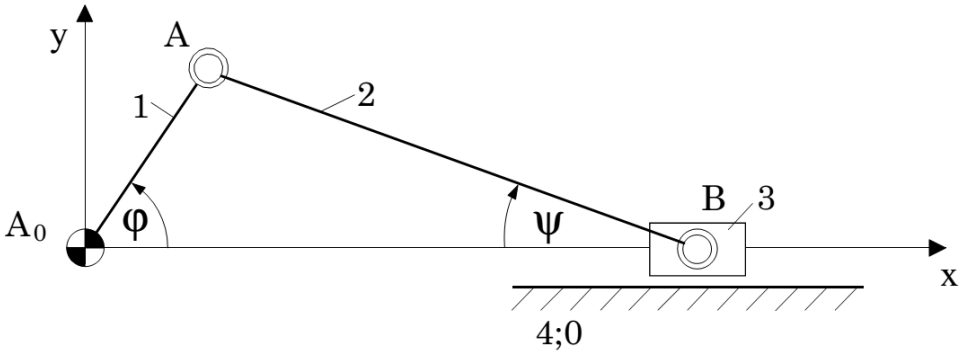

Figure 3

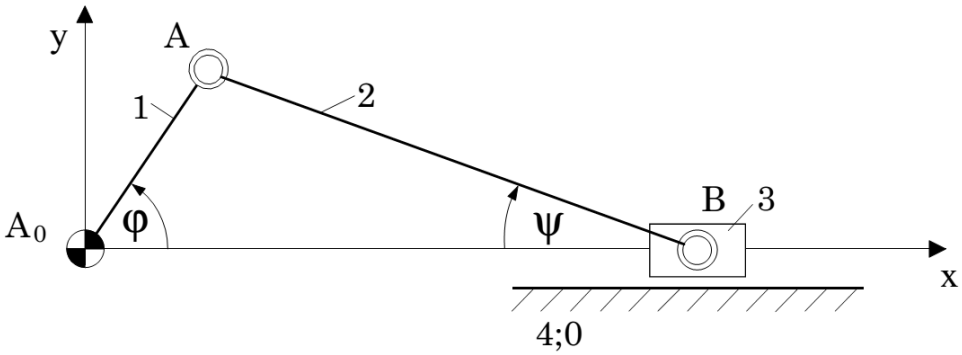

Figure 4