

# Machine Dynamics - Assignment 3

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## Q1

Determine L and R according to the required stroke.

$$\begin{cases} l + r - (l - r) &= 76\text{mm} \\ \frac{l}{r} &= 3.5 \end{cases}$$

Obtains:

$$\begin{cases} r &= 38\text{mm} \\ l &= 133\text{mm} \end{cases}$$

## Q2

Consider the gas force only, determine the corresponding shaking force, the shaking moment based on the point  $O$ , and the output torque  $T_2$ .

$$\begin{cases} \omega_2 &= 120\pi\text{rad/s} \\ \alpha_2 &= 0 \end{cases}$$

$$\begin{cases} F &= F_g + F_i \\ T &= T_g + T_i \end{cases}$$

$$F_{34} + F_g + F_{14} = 0$$

$$F_{23} = F_{34}$$

$$T_{21} = -x \times F_{41} = 0$$

$$x = r \cos \omega_2 t + l \sqrt{1 - \left(\frac{r}{l} \sin \omega_2 t\right)^2}$$

Torque on pin 2:

$$T_{21} = F_g \frac{r}{l} \sin \omega_2 t (1 + \frac{r^2}{2l^2} \sin^2 \omega_2 t) r \cos \omega_2 t + F_g r \sin \omega_2 t$$

Shaking force  $F_S$ :

$$F_S = F_{12} + F_{14}$$

### Q3

Consider the inertial force only, determine the corresponding shaking force, the shaking moment based on the point  $O$ , and the output torque  $T_2$ .

Link3 masses:

- Assuming that  $m_3$  is composed by two masses,  $m_a + m_b = m_3$ .
- $m_a$  and  $m_b$  is distance  $l_a$  and  $l_b$  correspondly.

$$\begin{cases} m_a + m_b & = m_3 \\ m_a l_a & = m_b l_b \\ m_a l_a^2 + m_b l_b^2 & = I_{G3} \\ l_b & = l - r_{G3} = 0.64l \\ l_a & = r_{G3} = 0.36l \end{cases}$$

Obtains:

$$\begin{cases} l_b & = 0.08512 \\ l_a & = 0.04788 \\ m_a & = 0.3140683789674688 \\ m_b & = 0.1859316210325312 \end{cases}$$

Shaking force:

$$F_S = F_i = \begin{cases} F_x &= m_a r \omega_2^2 \cos \omega_2 t + m_b r \omega_2^2 (\cos \omega_2 t + \frac{r}{l} \cos 2\omega_2 t) \\ F_y &= -m_a (-r \omega_2^2 \sin \omega_2 t) \end{cases}$$

Torque on pin 2:

$$T_{21} = \frac{1}{2} m_b r^2 \omega_2^2 \left( \frac{r}{2l} \sin \omega_2 t - \sin 2\omega_2 t - \frac{3r}{2l} \sin 3\omega_2 t \right)$$