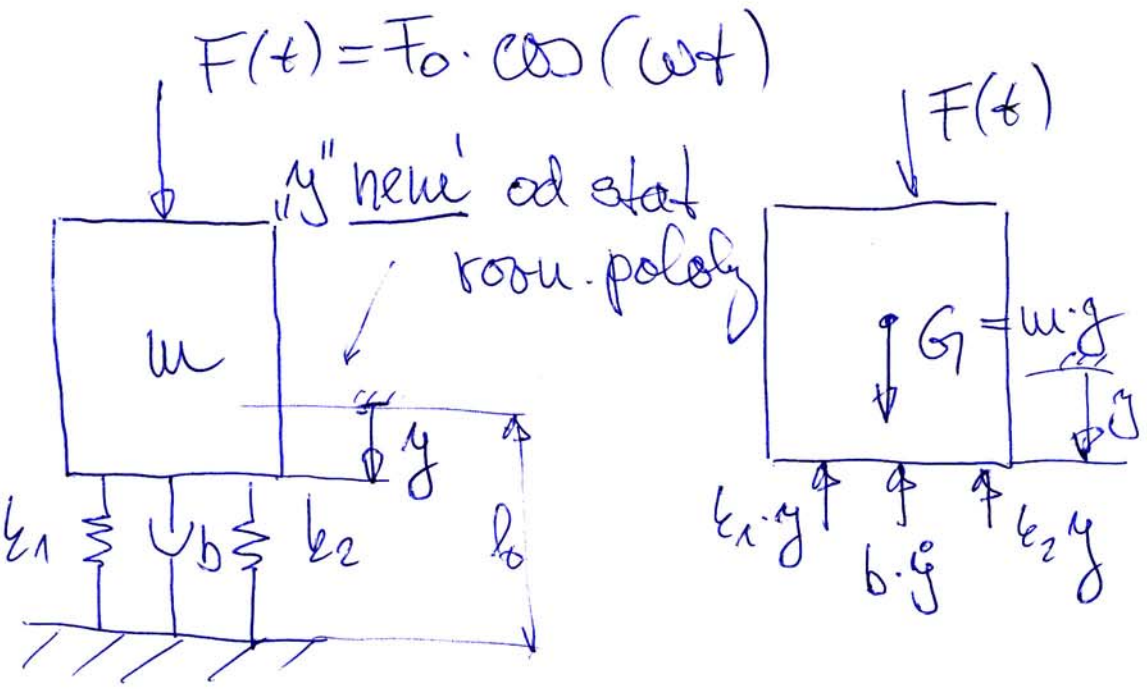

$$m \cdot \ddot{y} = +F(t) - y(k_1+k_2) - b \cdot \dot{y} + m \cdot g$$

$$m \cdot \ddot{y} + b \cdot \dot{y} + (k_1+k_2) \cdot y = F(t) + m g$$

$$\boxed{\ddot{y} + \frac{b}{m}\dot{y} + \frac{k_1+k_2}{m} y = \frac{F_0}{m}\cos\omega t + g}$$

$2 b_r \Omega$ $\quad$ Ω^2

→ rel. fr. netlumených km.

$$2 b_r \Omega = \frac{b}{m}$$

$$\Rightarrow b_r = \frac{b}{2 m \Omega}$$

$$\Omega_b = \Omega \sqrt{1 - b_r^2}$$

rel. fr. tlumených kmitů

↕ poměrný útlum

Stat. rovnovážná poloha ($\dot{y}, \ddot{y} = 0$)

$$\frac{k_1+k_2}{m} y_{st} = g$$

$$y_{st} = \frac{m \cdot g}{k_1+k_2}$$

Celkové řešení tlumené

$$y_c = y_h + \sum_{i=1}^{4} y_{pi}$$

$$y_h = e^{-b_1 \Omega t} (A \cos \Omega_b \cdot t + B \sin \Omega_b \cdot t)$$

$y_{p1} = C$ (pro g) ODTHAD

$\dot{y}_{p1} = \ddot{y}_{p1} = 0$

$$0 + \frac{b}{m} 0 + \frac{c_1 + c_2}{m} \cdot C = g$$

$$C = \frac{m \cdot g}{c_1 + c_2} \quad \left(\begin{matrix}\text{stat. rovnov.} \\ \text{poloha}\end{matrix}\right)$$

$y_{p2} = r \cos(\omega t - \varphi)$ (pro $\frac{F_0}{m} \cos \omega t$)

$\dot{y}_{p2} = -r\omega \sin(\omega t - \varphi)$ } fáz. zp.

$\ddot{y}_p = -r\omega^2 \cos(\omega t - \varphi)$

$\sin(\alpha \pm \beta) = \sin\alpha \cos\beta \pm \cos\alpha \sin\beta$

$\cos(\alpha \pm \beta) = \cos\alpha \cos\beta \mp \sin\alpha \sin\beta$

$$-r\omega^2 \cos(\omega t - \varphi) - 2 b_1 \Omega r \omega \sin(\omega t - \varphi) +$$
$$+ \Omega^2 r \cos(\omega t - \varphi) = \frac{F_0}{m} \cos \omega t \longrightarrow \cos(\omega t - \varphi + \varphi)$$

$$\frac{F_0}{m} \left[\cos(\omega t - \varphi) \cdot \cos\varphi - \sin(\omega t - \varphi) \sin(\varphi) \right]$$

$$\cos(\omega t-\varphi): -r\omega^2 + r\Omega^2 = \frac{F_0}{m}\cos\varphi$$

$$\sin(\omega t-\varphi): -2b_r\Omega r\omega = -\frac{F_0}{m}\sin\varphi$$

$$r(\Omega^2-\omega^2) = \frac{F_0}{m}\cos\varphi$$

$$2b_r\Omega r\omega = \frac{F_0}{m}\sin\varphi \qquad \frac{\frac{1}{\Omega^2}}{\frac{1}{\Omega^2}}$$

$$\operatorname{tg}\varphi = \frac{\sin\varphi}{\cos\varphi} = \frac{2b_r\Omega\omega}{(\Omega^2-\omega^2)} = \frac{2b_r\zeta}{1-\zeta^2}$$

činitel naladění $\zeta = \frac{\omega}{\Omega}$

$$\left.\begin{aligned} r^2(\Omega^2-\omega^2)^2 &= \left(\frac{F_0}{m}\right)^2\cos^2\varphi \\ (2b_r\Omega r\omega)^2 &= \left(\frac{F_0}{m}\right)^2\sin^2\varphi \end{aligned}\right\} +$$

$$r^2(\Omega^2-\omega^2)^2 + 4b_r^2\Omega^2 r^2\omega^2 = \left(\frac{F_0}{m}\right)^2$$

$$r^2 = \frac{\left(\frac{F_0}{m}\right)^2}{(\Omega^2-\omega^2)^2 + (2b_r\Omega\omega)^2}$$

$$r = \frac{\frac{F_0}{m}}{\sqrt{(\Omega^2-\omega^2)^2 + (2b_r\Omega\omega)^2}}$$

$$r = \frac{\frac{F_0}{m}}{\sqrt{(1-\xi^2)^2 + (2b_r\xi)^2}}$$

Całkowite rozwiązanie:

$$y_c = e^{-b_r \Omega t}(A\cos\Omega_b \cdot t + B\sin\Omega_b \cdot t) + C$$

$$+ r \cdot \cos(\omega t - \varphi)$$

Konstanty A, B zdecydowanie dopasowujemy rozwiązanie początkowe

$$t = 0 ; \underbrace{y = y_0 , \dot{y} = v_0}$$

$$\left.\begin{aligned} y_c &= \dots \\ \dot{y}_c &= \dots \end{aligned}\right\} A, B$$