Dane

W początkowej fazie, do układu sprężyn i tłumika przyczepiona jest tylko masa D a układ jest w stanie spoczynku. W chwili t0 podczepiona zostaje masa E i układ zaczyna drgać.

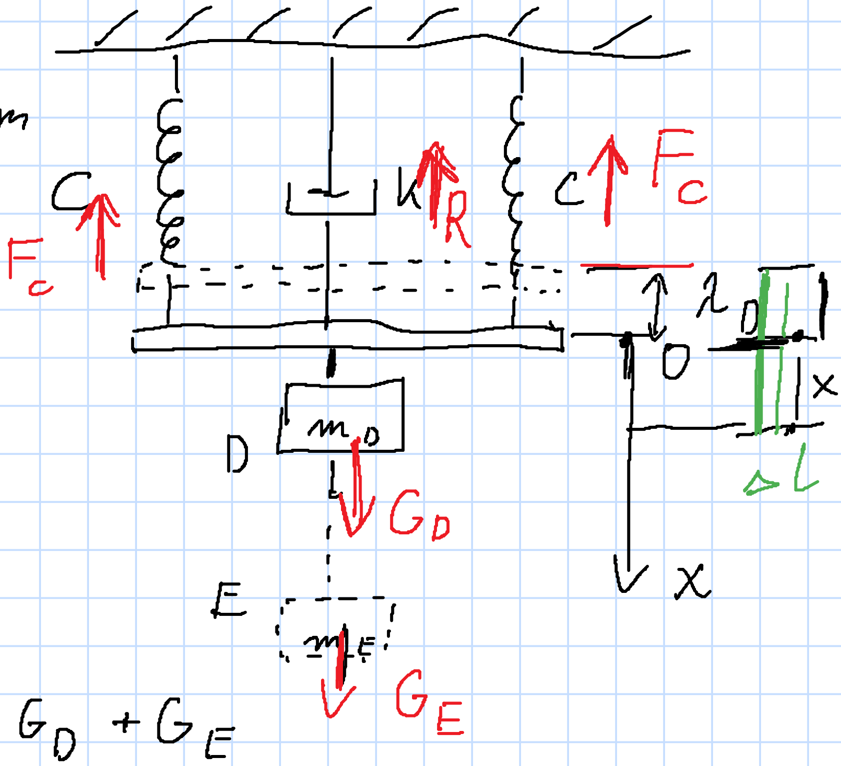
$\omega = 2\pi f$

$m_D = 2\,kg$

$c = 3\,N/cm = 300\,N/m$

$m_E = 1\,kg$

$R = 12\,v$



$(m_D + m_E)$

$$\cancel{m}\,\ddot{x} = -F_c - R - F_c + G_D + G_E$$

$$R = 12\,\dot{x} \quad k$$

$$S = c \cdot \Delta l$$

$$F_c = c\,(x + \lambda_D)$$

$$-F_c - F_c + G_D = 0$$

$$-c \cdot \lambda_D - c\lambda_D + G_D = 0$$

$$2c\lambda_D = G_D$$

$$\lambda_D = \frac{m_D \cdot g}{2c}$$

$$(m_D + m_E)\,\ddot{x} = -2c(x + \lambda_D) - k \cdot \dot{x} + (m_D + m_E)\,g$$

$$= -2cx - \cancel{2c} \cdot \frac{\cancel{m_D \cdot g}}{\cancel{2c}} - k \cdot \dot{x} + (\cancel{m_D} + m_E) \cdot g$$

$$(m_D + m_E) \cdot \ddot{x} = -2cx - k\dot{x} + m_E g$$

$$\ddot{x} = -2\frac{c}{m_D + m_E} \cdot x - \frac{k}{m_D + m_E}\dot{x} + \frac{m_E g}{m_D + m_E}$$

$$m\ddot{x} + \underbrace{\frac{k}{m_D+m_E}}_{h}\cdot\dot{x} + \underbrace{\frac{2c}{m_D+m_E}}_{\omega_0^2}\cdot x = \frac{m_E g}{m_D+m_E}$$

$$x = x^* + x^{**}$$

$$r^2 + h\cdot r + \omega_0^2 \qquad \Delta = h^2 - 4\omega_0^2$$

$$r_{1,2} = \frac{-h \pm \sqrt{\Delta}}{2} \qquad \left(\frac{12}{3}\right)^2 - 4\,\frac{2\cdot 300}{3} < 0$$

$$r_{1,2} = \frac{-h \pm \sqrt{h^2 - 4\omega_0^2}}{2}$$

$$r_{1,2} = -\frac{h}{2} \pm \underbrace{\sqrt{\left(\frac{h}{2}\right)^2 - \omega_0^2}}_{<0} = \overbrace{-\frac{h}{2}}^{\alpha} \pm \overbrace{\sqrt{\omega_0^2 - \left(\frac{h}{2}\right)^2}}^{\beta}\, i$$

$$x^* = e^{\alpha t}\left(C_1 \cos\beta t + C_2 \sin\beta t\right)$$

$$x^{**} = A \qquad \dot{x}^{**} = 0 \qquad \ddot{x}^{**} = 0$$

$$0 + h\cdot 0 + \frac{2c}{\cancel{m_D+m_E}}\cdot A = \frac{m_E g}{\cancel{m_D+m_E}}$$

$$\boxed{A = \frac{m_E\cdot g}{2c}}$$

$$x = e^{\alpha t}(C_1 \cos\beta t + C_2 \sin\beta t) + \frac{m_E \cdot g}{2c}$$

$$\dot{x} = \alpha e^{\alpha t}(C_1 \cos\beta t + C_2 \sin\beta t) +$$

$$+ e^{\alpha t}(-\beta C_1 \sin\beta t + \beta C_2 \cos\beta t)$$

dla $t_0 = 0$ $\quad x_0 = 0 \quad \dot{x}_0 = 0$

$$0 = C_1 + \frac{m_E \cdot g}{2c} \rightarrow C_1 = -\frac{m_E \cdot g}{2c}$$

$$0 = \underline{\alpha \cdot C_1} + 1(+\beta C_2)$$

$$C_2 = -\frac{\alpha \cdot C_1}{\beta} = \cancel{\frac{m_E g}{2c \cdot \beta}}$$

$$x = \underline{e^{-\frac{k}{(m_0+m_E)\cdot 2} t}}\left(-\frac{m_E g}{2c}\cos\sqrt{\omega_0^2 - \left(\frac{k}{2}\right)^2}\cdot t\right.$$

$$\left. + \cancel{\frac{m_E g}{2c\sqrt{}}}\sin\underbrace{\sqrt{\omega_0^2 - \left(\frac{k}{2}\right)^2}}_{\omega}\cdot t\right)$$