① (1) Linear de 2ª ordem Homogênea

(2) Linear de 2ª ordem Ñ Homogênea

(3) Não Linear de 2ª ordem Homogênea

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② $m\ddot{x} + b\dot{x} + Kx = F$

$$\ddot{x} + \frac{b}{m}\dot{x} + \frac{K}{m}x = F$$

$$\gamma = \frac{b}{2m} \qquad \omega^2 = \frac{K}{m}$$

Homogênea Associada

$$\ddot{x} + 2\gamma\dot{x} + \omega^2 x = 0$$

$$\Delta = 4\gamma^2 - 4\omega^2 = 4(\gamma^2 - \omega^2)$$

$$m = -\gamma \pm \sqrt{\gamma^2 - \omega^2}$$

$$x = b_1 e^{(-\gamma + \sqrt{\gamma^2 - \omega^2})t} + b_2 e^{(-\gamma - \sqrt{\gamma^2 - \omega^2})t}$$

$$\gamma = \frac{b}{2m} = \frac{1{,}4}{2 \cdot 1} = 0{,}7$$

$$\omega^2 = \frac{k}{m} = 1 \qquad \omega = 1$$

$$\sqrt{\gamma^2 - \omega^2} = \sqrt{0{,}49 - 1} = \sqrt{0{,}51}\, i$$

$$x_h = b_1 e^{-0{,}7t} \cos(\sqrt{0{,}51}\, t) + b_2 e^{-0{,}7t} \operatorname{sen}(\sqrt{0{,}51}\, t)$$

Caso particular:

$$x_p = a \longrightarrow \dot{x} = 0 \longrightarrow \ddot{x} = 0$$
$$a \in \mathbb{R}$$

$$0 + 0 + ka = F \qquad a = \frac{F}{k} = 1$$

$$x_p = 1$$

$$x = x_h + x_p = e^{-0{,}7t}\left(b_1 \cos(\sqrt{0{,}51}\, t) + b_2 \operatorname{sen}(\sqrt{0{,}51}\, t)\right) + 1$$

$$x(0) = 0 \qquad 0 = 1 \cdot (b_1 + 0) + 1 \qquad b_1 = -1$$

$\dot{x}(0)=0 \quad 0=-0{,}7(b_1+0)+\sqrt{0{,}51}(0+b_2)$

$-0{,}7=\sqrt{0{,}51}\,b_2 \quad b_2=\frac{-0{,}7}{\sqrt{0{,}51}}$

③ $x=x_1$

$\dot{x}=x_2$ A EDO vira:

$m\dot{x}_2+bx_2+Kx_1=F$

$$\frac{d}{dt}\begin{bmatrix}x_1\\x_2\end{bmatrix}=\begin{bmatrix}a_1 & a_2\\a_3 & a_4\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix}+\begin{bmatrix}b_1\\b_2\end{bmatrix}F$$

$$\dot{x}_1=x_2$$

$$\dot{x}_2=-\frac{K}{m}x_1-\frac{b}{m}x_2+F$$

$$\dot{x}_1=a_1x_1+a_2x_2+b_1F$$

$a_1=0 \quad a_2=1 \quad b_1=0$

$$\dot{x}_2=a_3x_1+a_4x_2+b_2F$$

$$a_3 = -\frac{k}{m} \quad a_4 = -\frac{b}{m} \quad b_2 = 1$$

$$A = \begin{bmatrix} 0 & 1 \\ -\frac{k}{m} & -\frac{b}{m} \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

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$$ml\ddot{\theta} + b\dot{\theta} + mg\,\text{sen}\,\theta = 0$$

$$\theta_1 = \theta$$

$$\theta_2 = \dot{\theta} \qquad \dot{\theta}_2 = -\frac{b}{ml}\theta_2 - \frac{g}{l}\,\text{sen}\,\theta_1$$

$$\dot{\theta}_1 = \theta_2$$