Escola Politécnica da USP

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PME 3380 - Modelagem de Sistemas Dinâmicos - Ex. do dia 17/09

Ex 1) $f(x) = \cos x$

Linearizado em torno de x_m com polinomio de Taylor de 1ª ordem:

$$f(x) \approx \cos(x_m) - \operatorname{sen}(x_m)(x - x_m)$$

→ $x_m = 0$ → $f(x) \approx \cos(0) - \operatorname{sen}(0)(x-0) = 1$ //

→ $x_m = \frac{\pi}{4}$ → $f(x) \approx \cos\left(\frac{\pi}{4}\right) - \operatorname{sen}\left(\frac{\pi}{4}\right)\left(x - \frac{\pi}{4}\right) \approx \frac{\sqrt{2}}{2} - \frac{\sqrt{2}}{2}\left(x - \frac{\pi}{4}\right)$

$$f(x) \approx \frac{\sqrt{2}}{2}\left[1 - x + \frac{\pi}{4}\right] \approx \frac{\sqrt{2}}{2}(1{,}785 - x)$$

$$\boxed{f(x) \approx \frac{\sqrt{2}}{2}(1{,}785 - x)}$$ //

Ex 2) $f(i) = F(t) - m\dot{v} + m\dot{x}\dot{r}$

Quando há equilíbrio → $\dot{v} = \dot{r} = \dot{i} = 0$

Aparece $g(x, v, r, \dot{r}, i) = m\dot{x}\dot{r} - mv - m\dot{v} = -F(t)$

Na linearização:

$$g = g + \frac{\partial g}{\partial x}(x - x_m) + \frac{\partial g}{\partial v}(v - v_m) + \frac{\partial g}{\partial r}(r - r_m) + \frac{\partial g}{\partial \dot{r}}(\dot{r} - \dot{r}_m) + \frac{\partial g}{\partial \dot{v}}(\dot{v} - \dot{v}_m)$$

$\frac{\partial g}{\partial x} = m\dot{r} = 0\ (\dot{r} = 0)$ $\quad \frac{\partial g}{\partial r} = -mv$ $\quad \frac{\partial g}{\partial \dot{v}} = -m$

$\frac{\partial g}{\partial v} = -mr = 0\ (r = 0)$ $\quad \frac{\partial g}{\partial \dot{r}} = m\dot{x}$

$$\therefore g = g + 0 + 0 - mv(r - 0) + m\dot{x}(\dot{r} - 0) - m(\dot{v} - 0)$$

$$-mvr + m\dot{x}\dot{r} - m\dot{v} = -F(t)$$

Daí $\boxed{m\dot{v} = F(t) - mvr + m\dot{x}\dot{r}}$ //