$$\begin{cases} \dot{\omega} = -\frac{b_m}{J}\omega + \frac{k_N}{J} i_a \\ \dot{i} = -\frac{k_N}{L}\omega - \frac{R_a}{L} i_a + \frac{u}{L} \end{cases}$$

No estado estacionário, $\dot{\omega} = \dot{i} = 0$:

$$-\frac{b_m}{J}\Delta\bar{\omega} + \frac{k_N}{J}\Delta\bar{i}_a = 0 \Rightarrow \varphi = \frac{\Delta\bar{i}_a}{\Delta\bar{\omega}} = \frac{b_m}{k_N} \text{ (Constante)}$$

$$\frac{k_N \Delta\bar{\omega}}{L} + \frac{R_a \Delta\bar{i}_a}{L} = \frac{\Delta\bar{u}}{L} \Rightarrow \begin{cases} k_N \Delta\bar{\omega}_1 + R_a \Delta\bar{i}_{a1} = \Delta\bar{u}_1 & \text{(step 40} \to \text{50)} \\ k_N \Delta\bar{\omega}_2 + R_a \Delta\bar{i}_{a2} = \Delta\bar{u}_2 & \text{(step 40} \to \text{60)} \\ k_N \Delta\bar{\omega}_3 + R_a \Delta\bar{i}_{a3} = \Delta\bar{u}_3 & \text{(step 40} \to \text{70)} \end{cases}$$

* $\Delta\bar{\omega}_i = \bar{\omega}_i - \bar{\omega}_{40\%}$, $i \in \{50; 60; 70\}$
* $\Delta\bar{i}_{ai} = \bar{i}_{ai} - \bar{i}_{a40\%}$
* $\Delta\bar{u}_i = \bar{u}_i - \bar{u}_{40\%}$

Usando $\Delta\bar{u}_1$ e $\Delta\bar{u}_2$, temos:

$$k_N = \frac{R_a \Delta\bar{i}_{a2} \frac{\Delta\bar{u}_1}{\Delta\bar{u}_2} - R_a \Delta\bar{i}_{a1}}{\Delta\bar{\omega}_1 - \frac{\Delta\bar{u}_1}{\Delta\bar{u}_2}\Delta\bar{\omega}_2} \Rightarrow b_m = k_N \varphi$$

Fazendo $\dot{i}_a \to 0$ (Corrente varia pouco e varia rápido)

$$\dot{\omega}_a = -\frac{b_m}{J}\omega + \frac{k_N}{J} i_a \; ; \; \dot{i}_a^{\,0} = -\frac{k_N}{L}\omega - \frac{R_a}{L} i_a + \frac{u}{L} \Rightarrow i_a = \frac{u}{R_a} - \frac{k_N}{R_a}\omega$$

$$\dot{\omega}_a = -\omega\left(\frac{b_m}{J} + \frac{k_N^2}{J R_a}\right) + \frac{k_N}{J R_a} u \;\; \therefore \;\; \omega(t) = \frac{k_N}{J R_a} \cdot \frac{1}{p}\left(1 - e^{-pt}\right) u(t)$$

(Laplace)

$$p = \frac{b_m}{J} + \frac{K_N^2}{\Omega_a J} \Rightarrow \boxed{J = \frac{b_m}{p} + \frac{K_N^2}{\Omega_a p}}$$

$* \underline{t_{99\%}} = 5\bar{\tau}_2 = \frac{5}{p}$

Tempo de 99% do valor estacionário (no olho)

∴ Resumo:

$\Omega_a, l_a \Rightarrow$ medidos

$$\boxed{K_N = \Omega_a \frac{\bar{D}_{i2}}{\bar{D}_{\omega 2}} \frac{\bar{D}_{M1} - \Omega_a \bar{D}_{i a1}}{\bar{D}_{\omega 1} - \frac{\bar{D}_{M1}}{\bar{D}_{M2}} \bar{D}_{\omega 2}}}$$

, onde $\bar{D}_{ii}$ e $\bar{D}_{M_i}$ são medidas extraídas dos gráficos indiretamente.

$$\boxed{b_m = K_N \cdot \left(\frac{\bar{D}_{i a i}}{\bar{D}_{\omega i}}\right)} \quad ; \quad \boxed{J = \frac{b_m}{p} + \frac{K_N^2}{\Omega_a p}} \quad * p = \frac{5}{t_{99\%}}$$

1ª medida