$$\begin{cases} F = i_в w \\ \Phi = \Phi_0 + \Lambda(F) \\ i_н R_0 = i_в r_в + w \dfrac{d\Phi}{dt} \\ c_e \omega \Phi = i_г r_я + L_я \dfrac{di_г}{dt} + i_н R_0 \\ J \dfrac{d\omega}{dt} = M_в - c_M \Phi i_г \end{cases}$$

· Форма Коши:

$$\begin{cases} \dfrac{d\Phi}{dt} = \dfrac{i_н R_0 - i_в r_в}{w} = \dfrac{i_н R_0 - \dfrac{F}{w} r_в}{w} = \\ \dfrac{i_н R_0 - \dfrac{\Lambda^{-1}(\Phi)}{w} r_в}{w}; \quad (F = \Lambda^{-1}(\Phi)) \\ \dfrac{di_г}{dt} = \dfrac{c_e \omega \Phi - r_я \cdot i_г - i_н R_0}{w} \\ \dfrac{d\omega}{dt} = \dfrac{M_в - c_M \Phi i_г}{J} \end{cases}$$

· Ур-ие статич. режимов:

$$\begin{cases} i_н R_0 - \dfrac{\Lambda^{-1}(\Phi)}{w} r_в = 0 \\ c_e \omega \Phi - i_г \cdot r_я - i_н R_0 = 0 \\ M_в - c_M \Phi i_г = 0 \end{cases}$$

$\Lambda^{-1}(\Phi) \sim p(\Phi)$ (к.л.-1)

$$\begin{cases} i_н R_0 - \dfrac{p(\Phi)}{w} r_в = 0 \\ c_e \omega \Phi - i_г r_я - i_н R_0 = 0 \\ M_в - c_M \Phi i_г = 0 \end{cases}$$

перем. сост.: $X = [x_1 \; x_2 \; x_3]^T =$

$= [\Phi \; i_г \; \omega]^T$

вход. перем: $u = [u_1 \; u_2]^T = [M_в \; R_0]^T$

• нормирование:

$p(\bar{\Phi}) = -0{,}0014 \cdot x^5 + 0{,}1628 \cdot x^4 - 0{,}4707 \cdot x^3 +$

$+ 0{,}4731 x^2 - 0{,}0316 x^1 + 0 \cdot x^0$

$$\begin{cases} i_н R_{0н} \cdot \bar{R}_0 - \dfrac{p(\Phi)}{w} = 0 \\ c_e \omega_н \cdot \bar{\omega} \cdot \Phi_н \bar{\Phi} - i_{г_н} \cdot \bar{i}_г \cdot r_я - i_н R_{0н} \cdot \bar{R}_0 = 0 \\ M_{в_н} \cdot \bar{M}_в - c_M \cdot \Phi_н \cdot \bar{\Phi} \cdot i_{г_н} \cdot \bar{i}_г = 0 \end{cases}$$

$$\begin{cases} i_н u_2 - \dfrac{p(\bar{\Phi})}{w} = 0 \\ c_e x_3 x_1 - x_2 \cdot r_я - i_н \cdot u_2 = 0 \\ u_1 - c_M \cdot x_1 \cdot x_2 = 0 \end{cases}$$

$$F = \begin{cases} i_н u_2 - \dfrac{(-0{,}0014 \cdot x^5 + 0{,}1628 \cdot x^4 - 0{,}4707 x^3 + 0{,}4731 x^2 - 0{,}0316 x^1 + 0 x^0)}{w} \\ c_e x_3 x_1 - r_я x_2 - i_н \cdot u_2 \\ u_1 - c_M x_1 x_2 \end{cases}$$

$$G = \begin{bmatrix} \partial f_1/\partial x_1 & \partial f_1/\partial x_2 & \partial f_1/\partial x_3 \\ \partial f_2/\partial x_1 & \partial f_2/\partial x_2 & \partial f_2/\partial x_3 \\ \partial f_3/\partial x_1 & \partial f_3/\partial x_2 & \partial f_3/\partial x_3 \end{bmatrix} =$$

$$= \begin{bmatrix} \frac{-(-0{,}0014 \cdot 5x^4 + 0{,}1628 \cdot 4x^3 - 0{,}4704 \cdot 3x^2 + 0{,}4731 \cdot 2x - 0{,}0316)}{3000} & 0 & 0 \\ 130 x_3 & r_x = 0{,}05 & 130 x_1 \\ -C_M^{=120} x_2 & -C_M^{=120} x_1 & 0 \end{bmatrix}$$