Formulário P1 - Conversão da Energia

Seção 1.1

$$Hl = Ni \quad [A] \tag{1a}$$
$$B = \mu_0 H \quad [T] \tag{1b}$$
$$\Phi = BA \quad [Wb] \tag{1c}$$
$$\lambda = N\Phi \quad [Wb] \tag{1d}$$
$$e = \frac{d\lambda}{dt} \quad [V] \tag{1e}$$

Seção 1.2

$$\mathcal{F} = Ni \quad [A] \tag{2a}$$
$$\mathcal{F} = Hl \quad [A] \tag{2b}$$
$$\mathcal{R} = \frac{l}{\mu_0 A} \quad [A/Wb] \tag{2c}$$
$$\lambda = N\Phi = NBA = N^2 \frac{i}{\mathcal{R}} \quad [Wb] \tag{2d}$$
$$L = \frac{\lambda}{i} \quad [H] \tag{2e}$$
$$L = \frac{N^2}{\mathcal{R}} \quad [H] \tag{2f}$$
$$e = \frac{d\lambda}{dt} = L\frac{di}{dt} \quad [V] \tag{2g}$$

Seção 1.3

$$w_f = \frac{B^2}{2\mu_0} \quad [J/m^3] \tag{3a}$$
$$W_f = \frac{Li^2}{2} \quad [J] \tag{3b}$$
$$W_f = \frac{\lambda i}{2} = \frac{\lambda^2}{2L} \quad [J] \tag{3c}$$
$$W_f = \frac{\mathcal{R}\Phi^2}{2} = \frac{\mathcal{F}^2}{2\mathcal{R}} = \frac{\mathcal{F}\Phi}{2} \quad [J] \tag{3d}$$
$$\frac{W_{mag}}{Pot/2} = \frac{L}{R} \tag{3e}$$

Seção 1.7

$$\omega_h = \int_{B_a}^{B_b} H\, dB \quad [J/m^3] \tag{4a}$$
$$W_h = \omega_h f \quad [J] \tag{4b}$$
$$P_h = W_h V = \omega_h f V \quad [W] \tag{4c}$$

Seções 1.8 e 1.9

Perdas por correntes de Eddy

$$p_e = \frac{\delta^2}{12\rho}\left(\frac{dB}{dt}\right)^2 \quad [W/m^3] \tag{5a}$$

Perdas totais no Núcleo

$$P_t = P_h + p_e V \quad [W] \tag{6a}$$

Seção 1.10

$$v = Ri + \frac{d\lambda}{dt} \quad [V] \tag{7a}$$
$$V_{rms} = \sqrt{2}\pi f N A B_{max} \quad [V_{rms}] \tag{7b}$$

Seções 3.1 e 3.2

$$\vec{F} = i(\vec{l} \times \vec{B}) \quad [N] \tag{8a}$$
$$\frac{F}{A} = \frac{B^2}{2\mu_0} \quad [N/m^2] \tag{8b}$$

Seção 11.6

$$T = \frac{dW_0}{d\beta} \quad [N.m] \tag{9a}$$
$$\Delta\beta = \frac{\pi}{P_s} \tag{9b}$$
$$\bar{T} \approx \frac{W_0}{\Delta\beta} = \frac{W_0 P_s}{\pi} \quad [N.m] \tag{9c}$$

Obs: P_s é a quantidade de polos do estator da máquina de relutância chaveada

Seção 3.6

$$dW_e = dW_0 + dW_f \quad [J] \tag{10a}$$
$$F = \frac{dW_0}{dx} \tag{10b}$$

Movimento Rápido (λ const.)

$$dW_0 = -dW_f \quad [J] \tag{11a}$$
$$F_x = \frac{dW_0}{dx} = -\frac{dW_f}{dx} \quad [N] \tag{11b}$$
$$W_f = \frac{\lambda^2}{2L} = \frac{\mathcal{R}\Phi^2}{2} \quad [J] \tag{11c}$$
$$F_x = \frac{\lambda^2}{2L^2}\frac{dL}{dx} \quad [N] \tag{11d}$$
$$F_x = -\frac{\Phi^2}{2}\frac{d\mathcal{R}}{dx} \quad [N] \tag{11e}$$

Movimento Lento (i const.)

$$dW_0 = dW_e - dW_f \quad [J] \tag{12a}$$
$$dW_f = \frac{i^2}{2}dL \quad [J] \tag{12b}$$
$$dW_e = id\lambda = i^2 dL \quad [J] \tag{12c}$$
$$F_x = \frac{dW_0}{dx} = \frac{i^2}{2}\frac{dL}{dx} \quad [N] \tag{12d}$$
$$F_x = \frac{i^2}{2}\frac{dL}{dx} \quad [N] \tag{12e}$$

Seção 3.7

$$d = 2g \quad [m] \tag{13a}$$
$$A = lr\beta \tag{13b}$$
$$B = \mu_0 \frac{Ni}{2g} \quad [T] \tag{13c}$$
$$T = \frac{dW_0}{d\beta} = \frac{i^2}{2}\frac{dL}{d\beta} = \quad [N.m] \tag{13d}$$
$$T = \frac{\mu_0 N^2 lr}{4g} i^2 \quad [N.m] \tag{13e}$$
$$P_0 = T\omega_0 \quad [W] \tag{13f}$$

OBS: $l \longrightarrow$ largura do rotor
$r \longrightarrow$ raio do rotor

Seção 1.11

$$0 = H_m l_m + H_g g \quad [A] \tag{14a}$$
$$\mathcal{R}_g = \frac{g}{\mu_0 A} \quad [A/Wb] \tag{14b}$$
$$\Phi = B_m A_m = B_g A_g \quad [Wb] \tag{14c}$$
$$B_g = \frac{B_r}{\frac{A_g}{A_m} + \mu_r \frac{g}{l_m}} \quad [T] \tag{14d}$$

Anotações

$$B_m = B_r + \mu_0 \mu_r H_m \quad [T] \tag{15a}$$
$$B_m = \frac{B_r}{2} \quad [T] \tag{15b}$$
$$H_m = -\frac{B_r}{2\mu_0\mu_r} \quad [A/m] \tag{15c}$$
$$V_m = A_m l_m = \frac{B_g^2 V_g}{\mu_0 |B_m H_m|} \quad [m^3] \tag{15d}$$
$$W_g = \frac{B_g^2}{2\mu_0} V_g = \frac{|B_m H_m| V_m}{2} \quad [J] \tag{15e}$$

Vermelho $\rightarrow$ encontradas derivando o produto $B_m H_m$ por H_m

Fitzgerald

Reta de Carga:

$$0 = H_m l_m + H_g g \tag{16a}$$
$$B_m A_m = B_g A_g = \mu_0 H_g A_g \tag{16b}$$
$$B_m = -\mu_0 \left(\frac{A_g}{A_m}\right)\left(\frac{l_m}{g}\right) H_m \tag{16c}$$