

# Resolução

## Questão 01

a)  $N_1 I_1 + N_2 I_2 = H_1 \ell_1 + H_2 \ell_2 \Rightarrow I_2 = (H_1 \ell_1 + H_2 \ell_2 - N_1 I_1) / N_2$

$$\Phi = 9 \times 10^{-5} \text{ Wb}$$

$$B_1 = \Phi / A_1 = 9 \times 10^{-5} / (0,015 \times 0,015) = 0,4 \text{ T} \Rightarrow H_1 = 200 \text{ Ae/m}$$

$$B_2 = \Phi / A_2 = 9 \times 10^{-5} / (0,015 \times 0,010) = 0,6 \text{ T} \Rightarrow H_2 = 300 \text{ Ae/m}$$

$$I_2 = (200 \times 0,14 + 300 \times 0,15 - 200 \times 2,5) / 100 = -4,27 \text{ A}$$

b)  $N_1 I_1 + N_2 I_2 = H_1 \ell_1 + H_2 \ell_2$  e  $B_1 A_1 = B_2 A_2 \Rightarrow B_2 = (A_1 / A_2) B_1 = 1,5 B_1$

$$0,14 H_1 + 0,15 H_2 = 200 \times 1 + 100 \times 1,5 = 350 \quad \left. \begin{array}{l} \\ \end{array} \right\} \text{ Solução iterativa}$$

$$B_2 = 1,5 B_1$$

Parte inferior da curva de magnetização:  $H = 500 \text{ B}$

Parte superior da curva de magnetização:  $H = -2000 + 3000 \text{ B}$

Resolver:

$$0,14 H_1 + 0,15 H_2 = 350 \quad (1)$$

$$B_2 = 1,5 B_1 \quad (2)$$

$$\text{satisfazendo: } H = -2000 + 3000 \text{ B} \quad (3)$$

$$\text{Chute (1): } B_1 = 0,8 \text{ T} \xrightarrow{(2)} B_2 = 1,2 \text{ T}$$

$$\downarrow (3)$$

$$H_1 = 400$$

$$\downarrow (3)$$

$$H_2 = 1600$$

$$\searrow (1) \swarrow$$
$$0,14 \times 400 + 0,15 \times 1600 \neq 350$$
$$(296)$$

$$\text{Chute (2): } B_1 = 0,85 \text{ T} \xrightarrow{(2)} B_2 = 1,275 \text{ T}$$

$$\downarrow (3)$$

$$H_1 = 550$$

$$\downarrow (3)$$

$$H_2 = 1825$$

$$\searrow (1) \swarrow$$
$$0,14 \times 550 + 0,15 \times 1825 = 350,75 \approx 350 \text{ OK}$$

$$\therefore \Phi = B_1 A_1 = B_2 A_2 = 0,85 \times 1,5 \times 1,5 \times 10^{-4} = 1,275 \times 1,0 \times 1,5 \times 10^{-4}$$

$$\Phi = 0,000019125 \text{ Wb} = 0,0191 \text{ mWb}$$

## Questão 02

Prod. energético máximo do alnico =  $H_m B_m$

$$B_m = 0,95 \text{ T} \text{ e } H_m = -\frac{39,9}{0,95} = -42 \text{ kA/m}$$

$$H_m l_m + H_g g = 0 \Rightarrow l_m = -\frac{H_g g}{H_m} = -\frac{B_g}{\mu_0} \frac{g}{H_m} =$$

$$= -\frac{1}{4\pi \cdot 10^{-7}} \frac{0,3 \times 10^{-2}}{-42000} = 5,684 \text{ cm}$$

$$\Phi = B_m A_m = B_g A_g \Rightarrow A_m = \frac{B_g A_g}{B_m} = \frac{1 \times 3 \times 10^{-4}}{0,95} = 3,158 \text{ cm}^2$$

## Questão 03

$$\text{Área geométrica} = A = 5 \times 10 \times 10^{-4} = 0,005 \text{ m}^2$$

$$A_f = 0,95 \text{ A} \text{ e } A_g = 1,075 \text{ A}$$

$$B_g = 1 \text{ T} \Rightarrow B_f A_f = B_g A_g \Rightarrow B_f = B_g \frac{A_g}{A_f} = 1 \frac{1,075}{0,95} = 1,132 \text{ T}$$

Para  $B_f = 1,132 \text{ T}$  na curva do material magnético tem-se

$$H_f = 850 \text{ A/m}$$

$$H_f l_f + H_g l_g = N i = 850 \times 4 \times 15 \times 10^{-2} + \frac{1}{4\pi \cdot 10^{-7}} \times 2 \times 0,005 =$$

$$= 510 + 7957,729 = 8467,729 = 250 i$$

$$a) i = \frac{8467,729}{250} = 33,871 \text{ A}$$

$$b) v = R i = 5 \times 33,871 = 169,355 \text{ V}$$

$$c) \Phi_g = B_g A_g = 1 \times 1,075 \text{ A} = 1,075 \times 0,005 = 0,00538 \text{ Wb}$$

$$d) L_b = \frac{N \Phi_f}{i} = \frac{250 \times B_f A_f}{i} = \frac{250 \times 1,132 \times 0,95 \times 0,005}{33,871} =$$
$$= 39,687 \text{ mH}$$

### Questão 04

$$B_{\max} = 1,13 \sqrt{2} = 1,598 \text{ T} \approx 1,6 \text{ T} \quad \left\{ \begin{array}{l} A_n = 2,0 \text{ VA/kg} \\ p_n = 1,4 \text{ W/kg} \\ q_n = \sqrt{A_n^2 - p_n^2} = 1,428 \text{ VAR/kg} \end{array} \right.$$

$$\text{Volume} = 1,8 \times 10^{-3} \times 0,6 = 0,00108 \text{ m}^3$$

$$\text{massa} = 0,00108 \times 7650 = 8,262 \text{ kg}$$

$$S_m = 2 \times 8,262 = 16,524 \text{ VA}$$

$$P_m = 1,4 \times 8,262 = 11,567 \text{ W}$$

$$Q_m = 1,428 \times 8,262 = 11,798 \text{ VAR}$$

$$c) E = \omega N \phi = \omega N B A = 377 \times 166 \times 1,13 \times 1,8 \times 10^{-3} = 127,292 \text{ V}$$

$$a) R_p = \frac{E^2}{P_m} = \frac{127,292^2}{11,567} = 1400,817 \Omega$$

$$b) X_m = \frac{E^2}{Q_m} = \frac{127,292^2}{11,798} = 1373,390 \Omega$$

$$f) I_p = \sqrt{\frac{P_m}{R_p}} = \sqrt{\frac{11,567}{1400,817}} = 0,091 \text{ A}$$

$$e) I_m = \sqrt{\frac{Q_m}{X_m}} = \sqrt{\frac{11,798}{1373,390}} = 0,093 \text{ A}$$

$$d) I_{\text{exc}} = \sqrt{I_p^2 + I_m^2} = \sqrt{0,091^2 + 0,093^2} = 0,130 \text{ A}$$