ET520U – 2º Sem 2012 – 3ª Prova – Prof. Ruppert

Questão 01

$$i = \frac{120}{6} = 20A$$

$$H_g l_g = \frac{B_g}{\mu_0} l_g = Ni \xrightarrow{(2)} B_g = \frac{\mu_0 Ni}{2g} = \frac{4\pi 10^{-7} \times 300 \times 20}{2 \times 0{,}005} = 0{,}754\,T$$

a) $$W_g = \frac{B_g^2}{2\mu_0} V_{lg} = \frac{0{,}754^2}{2 \times 4\pi . 10^{-7}} 2 \times 0{,}005 \times 0{,}06^2 = 8{,}143\,j$$

b) $$F_m = \frac{\partial}{\partial g} W_g = \frac{\partial}{\partial g} \frac{B_g^2}{2\mu_0} 2g \times 0{,}06^2 = \frac{B_g^2}{2\mu_0} 2 \times 0{,}06^2 = \frac{0{,}754^2}{2 \times 4\pi . 10^{-7}} \times 2 \times 0{,}06^2 =$$

$$= 1628{,}675\,N$$

c) Com corrente alternada aparecerá uma indutância dada por:

$$L = \frac{\lambda}{i} = \frac{N\phi}{i} = \frac{N B_g A}{\frac{H_g l_g}{N}} = \frac{N^2 B_g A}{\frac{B_g}{\mu_0} \frac{2g}{N}} = \frac{\mu_0 N^2 A}{2g} = \frac{4\pi . 10^{-7} \times 300^2 \times 0{,}06^2}{2 \times 0{,}005} =$$

$$= 40{,}715\,mH$$

$$Z = R + j\omega L = 6 + j\,2\pi \times 60 \times 0{,}040715 = 6 + j\,15{,}349\,\Omega$$

$$I = \frac{V}{Z} = \frac{120}{6 + j15{,}349} = \frac{120}{\sqrt{6^2 + 15{,}349^2}} = 7{,}282\,A$$

$$B_g = \frac{4\pi . 10^{-7} \times 300 \times 7{,}282}{2 \times 0{,}005} = 0{,}275\,T$$

$$F_m = \frac{B_g^2}{2\mu_0} \times 2 \times 0{,}06^2 = 216{,}649\,N$$

d) $$H_n l_n + H_g l_g = Ni \;;\; B_g = B_n$$

$$H_n\, 0{,}2 + \frac{B_n}{4\pi . 10^{-7}} \times 0{,}01 = 6000 \Rightarrow 0{,}2 H_n + 7957{,}729\, B_n = 6000$$

P/ $H_n = 1000\,A/m \longrightarrow B_n = 0{,}729\,T$ (Curva do material)

P/ $H_n = 0 \longrightarrow B_n = 0{,}754\,T$

$\Rightarrow H_n \simeq 500$ e $B_n \simeq 0{,}740\,T = B_g$

$$F_m = \frac{0{,}740^2}{2 \times 4\pi . 10^{-7}} 2 \times 0{,}06^2 = 1568{,}755\,N$$

e) O material magnético usado não é dos melhores e pouco influiu no valor da força. Se fosse utilizado um material magnético melhor, com curva BH mais vertical, a influência seria quase nula.

Questão 02

$$T = \frac{1}{2} i^2 \frac{dL_{ss}}{d\theta} = \frac{1}{2} I_m^2 \operatorname{sen}^2(\omega t) \frac{d}{d\theta}\left(L_A + L_B \cos 2\theta\right) =$$

$$= -\frac{1}{2}(10\sqrt{2})^2 \operatorname{sen}^2(\omega t)\, 2 L_B \operatorname{sen} 2(\omega_m t + \theta_0) = -200 \operatorname{sen}^2(\omega t)\, 0{,}27 \operatorname{sen} 2(\omega_m t + \theta_0)$$

$$= -54 \operatorname{sen} 2(\omega_m t + \theta_0) \operatorname{sen}^2(\omega t) = -54 \operatorname{sen} 2(\omega_m t + \theta_0) \frac{1}{2}\left[1 - \cos(2\omega t)\right] =$$

$$= -27 \operatorname{sen} 2(\omega_m t + \theta_0) + 27 \operatorname{sen} 2(\omega_m t + \theta_0) \cos(2\omega t) =$$

$$= -27 \operatorname{sen} 2(\omega_m t + \theta_0) + \frac{1}{2} 27 \left[\operatorname{sen} 2(\omega_m t + \theta_0 + \omega t) + \operatorname{sen} 2(\omega_m t + \theta_0 - \omega t)\right] =$$

$$= -27 \operatorname{sen} 2(\omega_m t + \theta_0) + 13{,}5 \operatorname{sen}\left[2(\omega_m + \omega)t + 2\theta_0\right] + 13{,}5 \operatorname{sen}\left[2(\omega_m - \omega)t + 2\theta_0\right]$$

$\overline{T} \neq 0$ see

$\omega_m = 0$

$\omega_m + \omega = 0 \rightarrow \omega_m = -\omega$

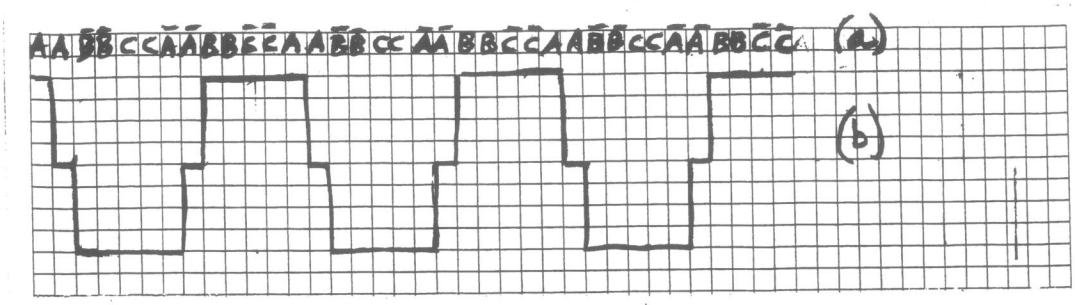
$\omega_m - \omega = 0 \rightarrow \omega_m = +\omega$

$\omega_m = 0 \Longrightarrow \overline{T} = -27 \operatorname{sen}(2\theta_0)$

$\omega_m = -\omega \Longrightarrow \overline{T} = 13{,}5 \operatorname{sen}(2\theta_0)$

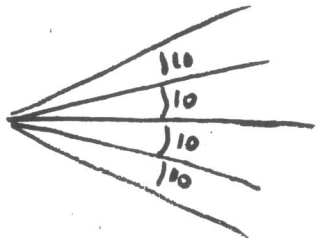
$\omega_m = \omega \Longrightarrow \overline{T} = 13{,}5 \operatorname{sen}(2\theta_0)$

Questão 03



c) Fator de enrolamento

$$\frac{360}{36} = 10°$$



$$\frac{2\cos 10° + 2\cos 20°}{4} = \frac{3{,}849}{4} = 0{,}9623$$

d) $$F_{mm} = \frac{4}{\pi}\,\frac{0{,}9623\,N}{6}\,i_a \cos\left(\frac{6}{2}\theta_a\right)$$

$$H = \frac{F_{mm}}{g} = \frac{4}{\pi}\,\frac{0{,}9623}{6g}\,i_a \cos(3\theta_a)$$

e) $$B = \mu_0 H = \mu_0 \frac{4}{\pi}\,\frac{0{,}9623}{6g}\,i_a \cos(3\theta_a)$$

f) 6 pólos

$$f_e = \frac{P}{2} f_m \qquad n_e = \frac{P}{2} n_m$$

$$60 = \frac{6}{2} f_m \Rightarrow f_m = 20\ Hz$$

$$n_m = \frac{2}{6}\,3600 = 1200\ rpm$$

g) $f = 902 \times 60 = 1{,}2\ Hz$

h) $n_m = 1200 - 0{,}02 \times 1200 = 1178\ rpm$