Alumno:...ME 23-junio-2014

Ejercicio: Un motor de inducción trifásico de 380 V, %0 Hz, 1.425 rpm, con el estator en estrella, se somete a ensayos y se obtienen los siguientes resultados:

- Ensayo de vacío: 380 V, 6 A, 950 W
- Ensayo a rotor bloqueado: 70 V, 18 A, 1.100 W
- Medida de la resistencia del estator en caliente = 0,60 Ω
- Pérdidas mecánicas= 470 W, que se consideran constantes a las diferentes velocidades.

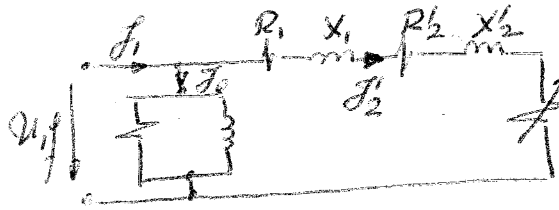
Determinar:

a) Parámetros del circuito equivalente aproximado no lineal.

b) Corrientes de arranque y de plena carga, así como sus correspondientes fdp (cosφ).

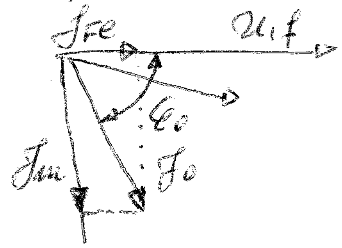
c) Pares de arranque, plena carga y máximo.

d) Velocidad del motor cuando consume una corriente del 75% de la de arranque y par interno desarrollado por el motor en esa situación.



$$s = \frac{1500-1425}{1500} = 0,05$$

a) $P_{Fe} = P_0 - P_{mec} - 3R_1 I_0^2 = 950 - 470 - 3\cdot 0,60\cdot 6^2 = 415,2$ W



$$P_{Fe} = \sqrt{3}\cdot U_1 \cdot I_0 \cdot \cos\varphi_0$$

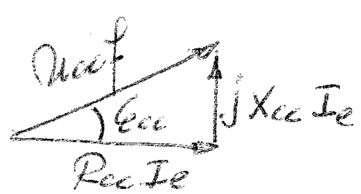
$$\cos\varphi_0 = \frac{P_{Fe}}{\sqrt{3}\, U_1 I_0} = \frac{415.2}{\sqrt{3}\cdot 380\cdot 6} = 0,105 \begin{cases} \varphi_0 = -83,96^\circ \\ \operatorname{sen}\varphi_0 = -0,994 \end{cases}$$

1-λ

$$\left.\begin{aligned} I_m &= I_0\cdot \operatorname{sen}\varphi_0 = 6\cdot 0,994 = 5,964\ A \\ I_{Fe} &= I_0 \cdot \cos\varphi_0 = 6\cdot 0,105 = 0,63\ A \end{aligned}\right\} I_0 = 0,63 - j5,964$$

1-λ

$$R_{Fe} = \frac{U_{1f}}{I_{Fe}} = \frac{\frac{380}{\sqrt{3}}}{0,63} = \underline{\underline{349,21\ \Omega}} \qquad X_\mu = \frac{U_{1f}}{I_m} = \frac{\frac{380}{\sqrt{3}}}{5,964} = \underline{\underline{36,89\ \Omega}}$$



$$P_{cc} = \sqrt{3}\, U_{cc} I_{cc} \cdot \cos\varphi_{cc}$$

$$\cos\varphi_{cc} = \frac{P_{cc}}{\sqrt{3}\cdot U_{cc} I_{cc}} = \frac{1100}{\sqrt{3}\cdot 70\cdot 18} = 0,504 \begin{cases} \varphi_{cc} = 59,73^\circ \\ \operatorname{sen}\varphi_{cc} = \\ = 0,8637 \end{cases}$$

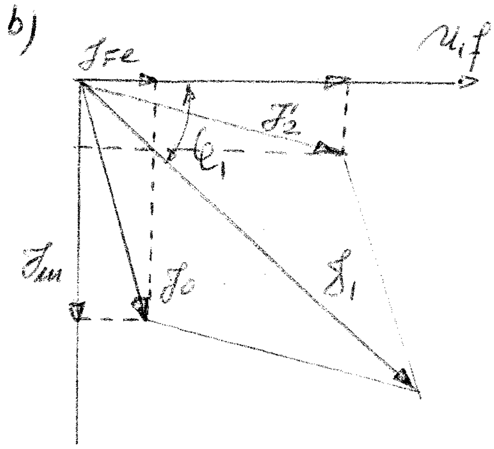
1-λ

$$U_{ccf}\cdot\cos\varphi_{cc} = R_{cc}I_e \Rightarrow R_{cc} = \frac{U_{ccf}\cdot\cos\varphi_{cc}}{I_e} = \frac{\frac{70}{\sqrt{3}}\cdot 0,504}{18} = \underline{\underline{1,13\ \Omega}}$$

$$R_{cc} = R_1 + R'_2 \Rightarrow R'_2 = R_{cc} - R_1 = 1,13 - 0,60 = \underline{\underline{0,53\ \Omega}}$$

$$U_{ccf}\cdot\operatorname{sen}\varphi_{cc} = X_{cc}I_e \Rightarrow X_{cc} = \frac{U_{ccf}\cdot\operatorname{sen}\varphi_{cc}}{I_e} = \frac{\frac{70}{\sqrt{3}}\cdot 0,8637}{18} = \underline{\underline{1,94\ \Omega}}$$

b)



$\boxed{R'_c} = R'_2 \frac{(1-s)}{s} = 0,53 \; \frac{1-0,05}{0,05} = \underline{10,07\,\Omega}$

$Z_1 = (0,60 + 0,53 + 10,07) + j1.94 =$

$= 11.2 + j1.94 = 11,37 \angle 9.83$

$I'_{2n} = \frac{U_{1f}}{Z_1} = \frac{220\angle 0}{11,37\angle 9,83} = 19,35\angle -9.83$

$= 19,07 - j3,30$

$I_{1fn} = I_0 + I'_{2n} = (0,63 + 19,07) - j(5.964 + 3,30) = 19,7 - j9,264$

$= 21.77 \angle -25.18°$

$1-\lambda \Rightarrow I_{1n} = I_{1nf} = \underline{21.77\,A} \Rightarrow \cos\varphi_1 = \cos(-25,18) = \underline{0,905}$

Arranque

$Z_{1a} = (0,60 + 0,53) + j1.94 = 1.13 + j1.94 = 2.245 \angle 59.78°$

$I'_{2a} = \frac{U_{1f}}{Z_{1a}} = \frac{220\angle 0°}{2,245\angle 59,78°} = 98\angle -59,78 = 49,33 - j84,68$

$I_{1fa} = I_0 + I'_{2a} = (0,63 + 49,33) - j(5.964 + 84,68) = 49,96 - j90,644$

$= \underline{103,50} \angle -61.14 \Rightarrow \cos\varphi_a = \underline{0,4827}$ $\quad I_{1a} = I_{1fa}$ $(1-\lambda)$

c) $s=1$

$\boxed{M_a} = \frac{3\,\frac{R'_2}{s}\cdot I'^2_{2fa}}{\frac{2\pi n_s}{60}} = \frac{3\cdot\frac{0,53}{1}\cdot 98^2}{\frac{2\pi\cdot 1500}{60}} = \underline{97,214\ Nm}$

$s=0,05$

$\boxed{M_n} = \frac{3\cdot\frac{0,53}{0,05}\cdot 19,35^2}{\frac{2\pi\cdot 1500}{60}} = \underline{75,80\ Nm}$

$s_m = \frac{R'_2}{\sqrt{R_1^2 + X_{cc}^2}} = \frac{0,53}{\sqrt{0,60^2 + 1,94^2}} \rightarrow$

$s_m = 0,261$

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$\boxed{M_{max}} = \frac{3 \times \frac{0,53}{0,261}\cdot\left(\frac{380}{\sqrt{3}}\right)^2}{\frac{2\pi\cdot 1500}{60}\left[\left(0,60 + \frac{0,53}{0,261}\right)^2 + 1.94^2\right]} = \underline{175.69\ Nm}$

d) $I_2' = \frac{3}{4} \cdot 97{,}99 = 73{,}49\,A.$

$$X = \frac{R_2'}{s} = \frac{0{,}53}{s} \qquad 73{,}49 = \frac{\frac{380}{\sqrt{3}}}{\sqrt{(0{,}60+X)^2 + 1{,}94^2}}$$

$$73{,}49 \cdot \sqrt{(0{,}60+X)^2 + 1{,}94^2} = 220$$

$$\sqrt{(0{,}60+X)^2 + 1{,}94^2} = \frac{220}{73{,}49}$$

$$(0{,}60+X)^2 + 1{,}94^2 = \left(\frac{220}{73{,}49}\right)^2$$

$$X^2 + 1{,}20X + 0{,}36 + 1{,}94^2 = 8{,}846$$

$$X^2 + 1{,}20X - 4{,}7224 = 0$$

$$X = \frac{-1{,}20 \pm \sqrt{1{,}20^2 + 4 \times 4{,}7224}}{2} = \frac{-1{,}20 \pm 4{,}51}{2} = \begin{cases} 1{,}654 \\ -2{,}855 \end{cases}$$

$$s = \frac{0{,}53}{X} = \begin{cases} 0{,}32 \\ -0{,}186 \text{ GENERADOR} \end{cases}$$

$$n_r = n_s(1-s) = 1500\,(1-0{,}32) = \underline{\underline{1.020}}\ \text{rpm}$$

$$M = \frac{3 \cdot \frac{0{,}53}{0{,}32} \cdot 73{,}49^2}{\frac{2\pi \cdot 1500}{60}} = \underline{\underline{170{,}84\ \text{Nm}}}$$

4ΔoR