Ex 1

$P_n = 7{,}46\,KW$; $U = 220\,V$; $1000\,Tr/mi$; $\eta_n = 85\%$

$R_{sc} = 100\,\Omega$; $R_{a} = 0{,}4\,\Omega$

1°) $$\eta_n = \frac{P_u}{P_a} = \frac{P_u}{U_n I_n + U_n I_{sc_n}} = \frac{P_u}{U_n I_{a_n} + \frac{U_n^2}{R_{sc}}}$$

$$\Rightarrow I_{a_n} = \left(\frac{P_u}{\eta_n} - \frac{U_n^2}{R_{sc}}\right)\frac{1}{U_n} = \left(\frac{7460}{0{,}86} - \frac{220^2}{100}\right)\frac{1}{220} = 37{,}7\,A$$

$$K\phi_n = \frac{U_n - I_{a_n} R_a}{\omega_n} = \frac{220 - 37{,}7 \times 0{,}4}{104{,}66} = 1{,}957\ V.s/rd.$$

$$C_{em_n} = K\phi_n I_{a_n} = 1{,}957 \times 37{,}7 = 73{,}8\,N.m.$$

1°) $K\phi$ et R_a : cst

$C_r = K\omega^2$; au régime permanent $C_r = C_{em}$.

donc $\cancel{C_{em}}$ $$\left.\begin{array}{l} C_r = K\omega^2 \\ C_n = K\omega_n^2 \end{array}\right. \Rightarrow \frac{C_r}{C_n} = \left(\frac{\omega}{\omega_n}\right)^2 \Rightarrow C_r = C_n\left(\frac{\omega}{\omega_n}\right)^2$$

$$C_r = 73{,}8 \cdot \left(\frac{0{,}5\,\omega_n}{\omega_n}\right)^2 = 73{,}8\,(0{,}5)^2 = 18{,}45\,N.m.$$

$$\omega = \frac{U}{K\phi} - \frac{C R_a}{K\phi^2} \Rightarrow U = K\phi\,\omega + \frac{C R_a}{K\phi} = 1{,}95 \times 52{,}36 + \frac{18{,}45 \cdot 0{,}4}{1{,}95}$$

$$\boxed{U = 105{,}9\,V}$$

2°) $K\phi$ et U : cst

$$\left.\begin{array}{l} C_r = k'\omega \\ C_n = k'\omega_n \end{array}\right\} \Rightarrow \frac{C_r}{C_n} = \frac{k'\omega}{k'\omega_n} \Rightarrow C_r = C_n\left(\frac{\omega}{\omega_n}\right) = 0{,}5\,C_n = 36{,}9\,N.m$$

$$\omega = \frac{U}{K\phi} - \frac{C\,(R_a + R_{ad})}{K\phi^2} \Rightarrow R_{ad} = \left(\left[U - K\phi\,\omega\right]\frac{K\phi}{C}\right) - R_a$$

$$R_{ad} = (220 - 1{,}95 \times 52{,}36)\,\frac{1{,}95}{36{,}9} - 0{,}4 = 5{,}83\,\Omega$$

3°) U et R_a : cst

$$\left.\begin{array}{l} C_r = \frac{A}{\omega} \\ C_n = \frac{A}{\omega_n} \end{array}\right\} \Rightarrow \frac{C_r}{C_n} = \left(\frac{\omega_n}{\omega}\right) \Rightarrow C_r = \left(\frac{\omega_n}{\omega}\right) \cdot C_n = \left(\frac{1000}{2000}\right) \cdot C_n$$

$$\boxed{C_r = 36{,}9\,N.m}$$

Suite (Ex 1)

$$\omega = \frac{U}{K\phi} - \frac{C\,R_a}{K\phi^2} \Rightarrow K\phi^2\omega - K\phi U + C\,R_a = 0$$

$$\Rightarrow 209{,}33\,K\phi^2 - 220\,K\phi + 14{,}76 = 0$$

Equation de seconde ordre de forme $ax^2 + bx + c = 0$

$$\sqrt{\Delta} = \sqrt{(220)^2 - 4(14{,}76)\cdot 209{,}33} = 189{,}84$$

$$K\phi = \frac{220 + 189{,}84}{2 \times 209{,}33} = 0{,}978\ \text{V.s/rad} \quad ; \quad I_a = \frac{C}{K\phi} = \frac{36{,}9}{0{,}978} =$$

4°/ $U = 110\,V$; $K\phi = 0{,}975$; $\omega = 52{,}36$ rd/s

$$\omega = \frac{U}{K\phi} - \frac{C\,(R_a + R_{ad})}{K\phi^2} \Rightarrow C = \left(\frac{110}{0{,}975} - 52{,}36\right)\frac{(0{,}975)^2}{2{,}4} \simeq 24\ \text{N.m}$$

$\Rightarrow$ ~~Rad~~ =

Ex 2 pour $U = U_n$

1°/ $$C_{d_1} = \frac{3U_n^2 R_2'}{\omega_0\left[(R_1 + R_2')^2 + X_{cc}^2\right]}$$

pour $U = 90\%\,U_n = 0{,}9\,U_n$

$$C_{d_2} = \frac{3(0{,}9)^2 U_n^2 R_2'}{\omega_0\left[(R_1 + R_2')^2 + X_{cc}^2\right]}$$

$$\frac{C_{d_2}}{C_{d_1}} = (0{,}9)^2 \Rightarrow C_{d_2} = 0{,}81\,C_{d_1}$$

La variation du couple de demarrage est de 19% par rapport au couple de demarrage à pleine tension

2°/ pour que $C_d = C_{max} \Rightarrow R_{ad} = ?$

$g_{max} = g_d = 1$ (au demarrage $\omega = 0 \Rightarrow g_d = \frac{\omega_0 - 0}{\omega_0} = 1$)

$$g_{max} = \frac{(R_2' + R_{ad})}{\sqrt{R_1^2 + X_{cc}^2}} \Rightarrow R_{ad} = g_{max}\sqrt{R_1^2 + X_{cc}^2} - R_2' =$$

$$R_{ad} = 1\sqrt{3^2 + 10^2} - 2 = 8{,}44\ \Omega$$

Ex 3 ; Il faut ajouter ~~les~~ données qui manquent $\cos\varphi = 0{,}8$
$\eta_n = 0{,}9$

1°/ Pour demarrage direct :

$$\frac{C_d}{C_n} = ? \qquad g_n = \frac{N_0 - N_n}{N_0} = \frac{1000 - 950}{1000} = 0{,}05$$

$$I_n = \frac{P_{an}}{\sqrt{3}\,U_n \cos\varphi_n} \quad ; \quad \eta_n = \frac{P_{un}}{P_{an}} \Rightarrow P_{an} = \frac{P_{un}}{\eta_n}$$

$$\Rightarrow I_n = \frac{P_{un}}{\eta_n \cdot \sqrt{3}\,U_n \cos\varphi_n} = \frac{100.10^3}{0{,}9 \times 0{,}8 \times \sqrt{3} \times 400} = 200{,}46\,A$$

$$\left.\begin{array}{l} C_n = \dfrac{3 R_2'}{g_n \omega_s} \cdot I_{2n}'^2 = \\ C_d = \dfrac{3 R_2'}{\omega_s}\, I_{2d}'^2 \end{array}\right\} \Rightarrow \frac{C_d}{C_n} = g_n \left(\frac{I_{2d}'}{I_{2n}'}\right)^2 \Rightarrow \frac{C_d}{C_n} = g_n \left(\frac{I_{1d}}{I_{1n}}\right)^2$$

$$\frac{I_{2d}'}{I_{2n}'} \simeq \frac{I_{1d}}{I_{1n}}$$

$$\frac{C_d}{C_n} = 0{,}05 \left(\frac{1203}{200{,}46}\right)^2 = 1{,}8 \Rightarrow \boxed{C_d = 1{,}8\, C_n}$$

2°/ Pour demarrage Etoile - Triangle

~~$\frac{I_Y}{I_n}$ = $\frac{I_\Delta}{\sqrt{3}}$ courant de dem~~

- On pose I_{dy} : courant de demarrage etoile.
  I_{dd} : " " direct

On peut dire que $I_{dy} = x\, I_{dd}$. $\quad \frac{C_d}{C_n} = \left(\frac{I_{dy}}{I_n}\right)^2 \cdot g_n$

on peut ecrire alors que :

$$\left(\frac{C_d}{C_n}\right) = x^2 \left(\frac{I_{dd}}{I_n}\right)^2 \cdot g_n$$

Si le demarrage est direct $x = 1$

Si le demarrage est en etoile $x = \frac{1}{\sqrt{3}}$

(la tension appliquée à chaque enroulement est divisé par $\sqrt{3}$.)

$$\Rightarrow \frac{C_d}{C_n} = \left(\frac{1}{\sqrt{3}}\right)^2 1{,}8 = 0{,}6$$