۱۲) $f_e = \frac{P}{2} f_s \Rightarrow f_s = \frac{50}{3} \Longrightarrow n_m = (1-s) n_s$, $f = 50Hz$

$P_{ag} = \frac{P_{cu,r}}{s} \Longrightarrow P_{cu,r} = 3 \times 0,1 \times |i_2(t)|^2 = 0,3 \times 2500 \times 2 = 1500W \Rightarrow P_{ag} = \frac{1500}{s} \Rightarrow$

$\omega_s = \frac{100\pi}{3} \Rightarrow$

$S = \frac{n_s - n_r}{n_s} = \frac{\omega_s - \omega_m}{\omega_s} = \frac{\frac{100\pi}{3} - 31,4}{\frac{100\pi}{3}} = \frac{73,32}{\frac{100\pi}{3}} = 0,7$

$\tau_{em} = \frac{P_{ag}}{\omega_s} = \frac{1500}{0,7 \times \frac{100\pi}{3}} = \frac{1500}{73,32} = 20,458$

---

۱۳) $P_L \propto V_L^2 \longrightarrow$ چون امپدانس‌ها ثابت‌اند $\Rightarrow \frac{P_{L1}}{P_{L2}} = \frac{\tau_{e1}}{\tau_{e2}} \times \frac{\omega_{m1}}{\omega_{m2}} \times \left(\frac{\omega_{m1}}{\omega_{m2}}\right)^2 \Rightarrow$

$\left(\frac{V_{L2}}{V_{L1}}\right)^2 = \left(\frac{\omega_{m2}}{\omega_{m1}}\right)^2 \Longrightarrow \omega_{m2} = 0,85 \omega_{m1} \Longrightarrow \omega_{m1} = 0,97\, \omega_s \Rightarrow \omega_{m2} = (0,85 \times 0,97)\omega_s$

$\Longrightarrow S_2 = \frac{\omega_s - \omega_{m2}}{\omega_s} = 0,1755$

$I_s = \frac{V_{th}}{\left(\frac{R_2}{s} + R_{th}\right)^2 + (X_2 + X_{th})^2} \Longrightarrow I_s \propto \frac{V_{th}}{\left(\frac{R_2}{s}\right)^2} \Rightarrow \frac{S_2}{S_1} \times \frac{V_{e2}}{V_{e1}} = \frac{0,1755}{0,03} \times \frac{0,85}{1} =$

$4,98$

بنام آنکه جان را فکرت آموخت

تمرین سری ۶ - تبدیل انرژی های الکتریکی

دکتر رضا قدیری

رضا فارسی

9310539

$$P_{RCL} = I_2^2 \times R_2 \qquad I_2^2 = \frac{V_{th}^2}{\left(\frac{R_2}{S_1}\right)^2 + X_2^2}$$

$$\Rightarrow \frac{V_{th}^2}{\left(\frac{R_2}{S_{Tmax}}\right)^2 + X_2^2} = 4 \times \frac{V_{th}^2}{\left(\frac{R_2}{S_{fl}}\right)^2 + X_2^2} \Rightarrow \frac{R_2^2}{S_{fl}^2} + X_2^2 = 4\frac{R_2^2}{S_{Tmax}^2} + 4X_2^2$$

$$S_{Tmax} = \frac{R_2}{\sqrt{R_{th}^2 + (X_{th} + X_2)^2}} \overset{\text{طبق فرض سوال}}{=} \frac{R_2}{X_2} \quad (1) \Rightarrow S_{fl}^2 = R_2^2/(7X_2^2) \Rightarrow$$

$$\boxed{S_{fl} = \frac{\sqrt{7}}{7}\frac{R_2}{X_2}}$$

$$\frac{T_{fl}}{T_{max}} = \frac{\frac{3V_\phi^2 R_2/S_{fl}}{\omega_s\left[\left(\frac{R_2}{S_{fl}}\right)^2 + X_2^2\right]}}{\frac{3V_\phi^2 R_2/S_{Tmax}}{\omega_s\left[\left(\frac{R_2}{S_{Tmax}}\right)^2 + X_2^2\right]}} = \frac{\left[\left(\frac{R_2}{S_{Tmax}}\right)^2 + X_2^2\right]\frac{1}{S_{fl}}}{\left(\left(\frac{R_2}{S_{fl}}\right)^2 + X_2^2\right)\frac{1}{S_{Tmax}}} \overset{(1)}{=\!=} \frac{S_{Tmax}}{S_{fl}} \times \frac{2}{\left(\frac{S_{Tmax}}{S_{fl}}\right)^2 + 1}$$

$$= \frac{2}{\frac{1}{\frac{1}{\sqrt{7}}} + \frac{1}{\frac{1}{\sqrt{7}}}} = \frac{2}{\frac{1}{\sqrt{7}} + \sqrt{7}} = \frac{\sqrt{7}}{4} = \boxed{0{,}6614 \Leftrightarrow \frac{T_{fl}}{T_{max}}}$$

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۴۷) برای اتوترانسفورماتور ⟸ 60 درصد ⟸

$$I_{auto} = x(V_1)I_{stm} = x\left(\frac{xV_1}{Z}\right) = \frac{x^2 V_1}{Z}$$

$$I_{direct} = V_1/Z$$

$$\frac{I_{auto}}{I_{direct}} = \frac{\frac{x^2 V_1}{Z}}{V_1/Z} = x^2 = 0{,}6^2 = 0{,}36$$

برای ستاره-مثلث ⟸

$$I_{stYp} = \frac{V_1}{Z_{eq}} = \frac{V_L}{\sqrt{3}Z} \Rightarrow I_{stDp} = \frac{V_L}{Z}, \quad I_{stDL} = \sqrt{3}I_{stDp} = \frac{\sqrt{3}V_L}{Z} \Rightarrow$$

$$\frac{\text{جریان راه‌اندازی ستاره مثلث}}{\text{جریان راه‌اندازی مستقیم}} = \frac{I_{stYp}}{I_{stDL}} = \frac{V_L/\sqrt{3}Z}{\frac{\sqrt{3}V_L}{Z}} = \boxed{\frac{1}{3}}$$

" " در راه‌اندازی

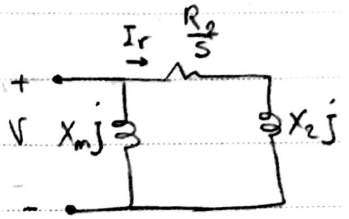
(1) ⇒

Subject

Date

$P_{cu,r}\Big|_{\tau_{max}} = 4\, P_{cu,r}\Big|_{\tau_{full\,load}}$ $\quad \frac{\tau_{max}}{\tau_{full\,load}} = ?$ $\quad Z_s \approx 0$ **سوال ۳**

$P_{cu,r} = 3R_2|I_R|^2 \rightarrow |I_R|\Big|_{\tau_{max}} = 2|I_R|\Big|_{\tau_{fl}}$



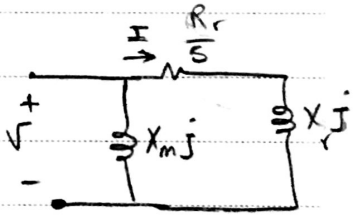
$$\tau = \frac{P_{ag}}{\omega_s} = \frac{P_{cu,r}}{s\omega_s} \quad \frac{\tau_{max}}{\tau_{fl}} = \frac{4 s_{fl}}{s_{\tau_{max}}} = \boxed{\frac{4}{\sqrt{7}}}$$

$$|I_R| = \frac{|V|}{\left|\frac{R_2}{s} + jX_2\right|} = \frac{|V|}{\sqrt{\left(\frac{R_2}{s}\right)^2 + X_2^2}} \qquad s_{\tau_{max}} = \frac{R_2}{\sqrt{R_{th}^2 + (X_2 + X_{th})^2}} = \frac{R_2}{X_2}$$

$$\frac{|I_R|_{\tau_{max}}}{|I_R|_{fl}} = 2 = \frac{\left(\frac{R_2^2}{s_{fl}^2} + X_2^2\right)^{\frac{1}{2}}}{\frac{R_2^2}{\left(\frac{R_2}{X_2}\right)^2} + X_2^2} \Rightarrow \frac{X_2^2 + \frac{R_2^2}{s_{fl}^2}}{2X_2^2} = 4 \rightarrow s_{fl}^2 = \frac{R_2^2}{7X_2^2} \rightarrow \frac{s_{fl}}{s_{\tau_{max}}} = \frac{1}{\sqrt{7}}$$

$\tau_{max} = 3\tau_{fl}$ $\quad R_r = 0.2$ $\quad X_r = 2$ $\quad Z_s \approx 0$ موتور القای قفس سنجاب **سوال ۴**

① $\Delta - Y \rightarrow \frac{\tau_{st}}{\tau_{fl}} = ?$ $\qquad$ ② $AT \rightarrow \tau_{ap}\ 0.6 \rightarrow \frac{\tau_{st}}{\tau_{fl}} = ?$



$$\tau = \frac{3R_r V^2}{s^2\omega_s\left(\frac{R_r^2}{s^2} + X_r^2\right)} \qquad \tau_{st} = \frac{3R_r V^2}{\omega_s(R_r^2 + X_r^2)} = \frac{3V^2}{20.2\omega_s} \quad (s=1)$$

$$\tau_{max} = \frac{3V^2}{2\omega_s X_r} = 3\tau_{fl} \rightarrow \frac{3V^2}{2\omega_s X_r} = \frac{3\times 3\times R_r V_r^2}{s_{fl}^2\omega_s\left(\frac{R_r^2}{s_{fl}} + X_r^2\right)} \rightarrow$$

$$3(0.2)(2)(2) = s_{fl}^2\left(\frac{(0.2)^2}{s_{fl}^2} + 2^2\right) \rightarrow s_{fl} = 0.768 \qquad \tau_{fl} = \frac{V^2}{2\omega_s X_r} = \frac{V^2}{4\omega_s}$$

① Δ-Y : $\frac{\tau_{st}}{\tau_{fl}} = \frac{3\left(\frac{V}{\sqrt{3}}\right)^2}{20.2\omega_s} \times \frac{4\omega_s}{V^2} = 0.198 \qquad \frac{I_{st}}{I_{fl}} = 0.581$

② AT : $\frac{\tau_{st}}{\tau_{fl}} = \frac{3(0.6V)^2}{20.2\omega_s} \times \frac{4\omega_s}{V^2} = 0.223 \qquad \frac{I_{st}}{I_{fl}} = 0.604$

$$I = \frac{V}{\frac{R_r}{s} + X_r j} \qquad \frac{|I_{st}|}{|I_{fl}|} = \frac{\left(\frac{0.2^2}{0.768^2} + 2^2\right)^{\frac{1}{2}}}{\frac{0.2^2}{1} + 2^2} \times \frac{V_{st}}{V_{fl}} = 1.00688\ \frac{V_{st}}{V_{fl}}$$

Subject Energy Conversion HW #5

Date

Rozhin Yasaei
(93106874)

سوال ۱

موتور القایی 3φ $f=50Hz$ $P=6$ $R_{r,1\varphi}=0,1\ \Omega$

$i_r(t)=50\sqrt{2}\sin(31,4t-10^\circ)\ A$ $T_{em}=?$

$$T_{em}=\frac{P_{ag}}{\omega_s} \qquad n_s=\frac{120f}{P}=\frac{120\times50}{6}=1000 \qquad \omega_s=\frac{2\pi}{60}n_s=104.72$$

$$P_{ag}=\frac{1}{s}P_{rotor}=\frac{3}{s}R_r\cdot|I_R|^2=\frac{3}{s}\,0,1\,(50\sqrt{2})^2=\frac{1500}{s}$$

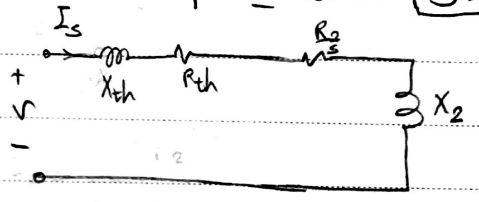
$$\omega_r=31,4 \quad ,\quad \omega_r=\frac{2\pi}{60}n_r \rightarrow n_r=\frac{31,4\times60}{2\pi}=300$$

$$S=\frac{n_s-n_r}{n_s}=\frac{1000-300}{1000}=0,7 \qquad T=\frac{P_{ag}}{\omega_s}=\frac{1500}{0.7\times104.72}=20.46$$

سوال ۲

موتور القایی 3φ $S=0,03$ $T_{load}\propto\omega_r$ $V_1=V_n$

$V_2=0,85\,V_n$ S_2 , $\frac{I_{s2}}{I_{s1}}=?$



$$|V|=|I_s|\left|(X_{th}+X_2)j+\left(\frac{R_2}{S}+R_{th}\right)\right|$$

$$|I_{s1}|=\frac{|V_n|}{\sqrt{(X_{th}+X_2)^2+\left(R_{th}+\frac{R_2}{0.03}\right)^2}}$$

$$\frac{P_{L1}}{P_{L2}}=\frac{T_{l1}}{T_{l2}}\times\frac{\omega_{m1}}{\omega_{m2}}\times\left(\frac{\omega_{m1}}{\omega_{m2}}\right)^2$$

$$V(0^+) = \varepsilon \times 1 = \varepsilon \; V$$

$q = cv$

$\int i \cdot dt$

$$\left.\frac{dv_c}{dt}\right|_{t=0^+}$$

$$i_c + i_L = -12u(t) + \varepsilon$$

$$C\frac{dv_c}{dt} + i_L = \varepsilon - 12u(t)$$ معادله (۱)

$$i_L = \frac{1}{L}\int v_L \cdot dt$$

$$L\frac{di_L}{dt} \leftarrow v_L + i_L \times 1 = v_c + i_c$$

$$\Rightarrow v_L = 4\frac{di_L}{dt} + i_L = v_c + i_c$$ معادله (۲)