

ELESUS 1.MI 2011./12.

1. $P_n = 10 \text{ kW}$
 $U_n = 220 \text{ V}$
 $I_n = 47.5 \text{ A}$
 $n_n = 390 \text{ rpm}$
 $R_a = 0.2 \Omega$
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$$\omega_n = \frac{n_n}{60} 2\pi = 40.84 \frac{\text{rad}}{\text{s}}$$

$$M_n = \frac{P_n}{\omega_n} = \frac{10000}{40.84} = 244.85 \text{ Nm}$$

$$M_t = \frac{M_n}{2} = 122.43 \text{ Nm}$$

$$U_n = I_n R_a + E_n \rightarrow E_n = 210.5 \text{ V}$$

$$c_e = c_m = \frac{E_n}{n_n} = \frac{210.5}{40.84} = 5.154 \frac{\text{Vs}}{\text{rad}}$$

$$\frac{U_n}{n_0} = \frac{E_n}{n_n} \rightarrow n_0 = 407.6 \text{ rpm}$$

$$U_t = 0.9 U_n = 198 \text{ V}$$

$$\phi = 0.7 \phi_n \rightarrow c'_e = 0.7 c_e = 3.6078 \frac{\text{Vs}}{\text{rad}}$$

$$I_t = \frac{M_t}{c'_m} = \frac{122.43}{3.6078} = 33.935 \text{ A}$$

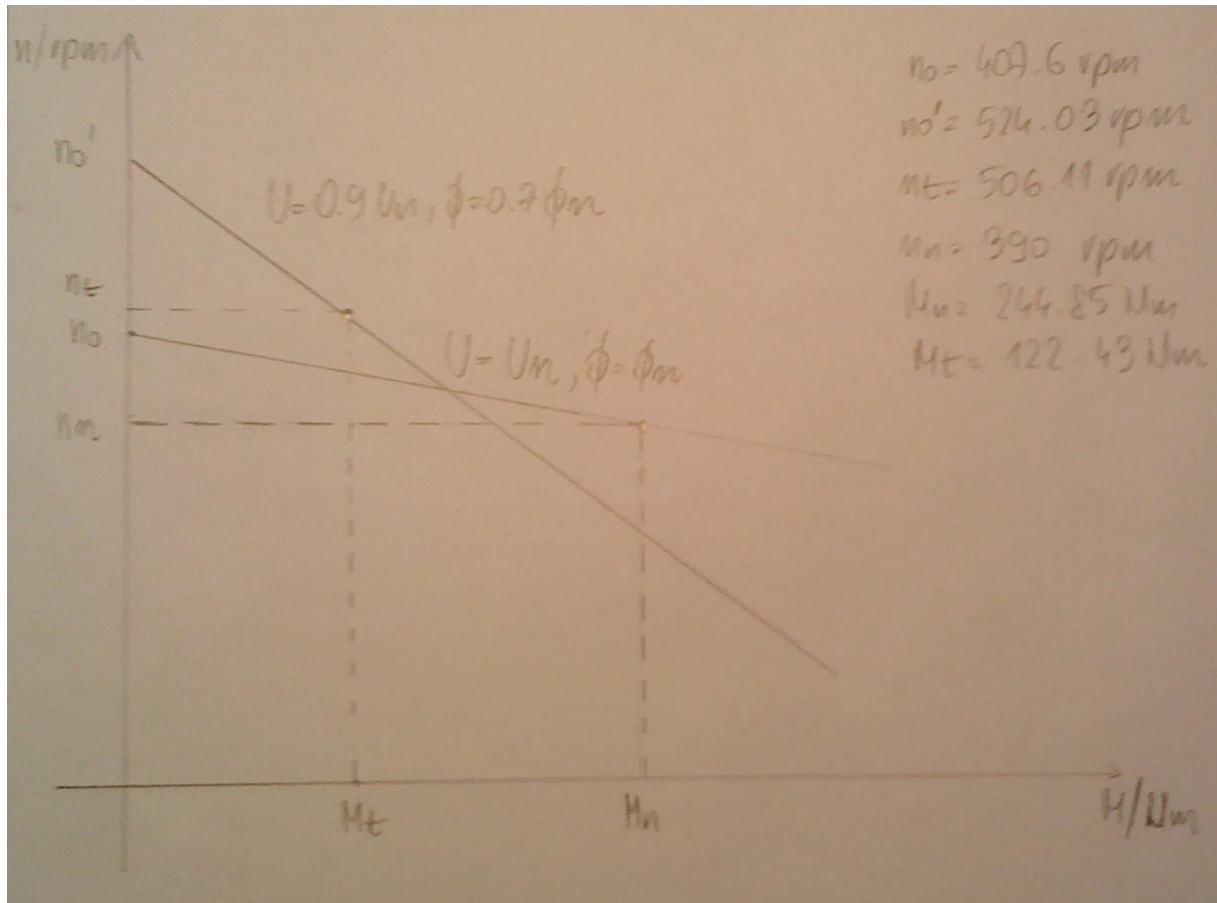
$$U_t = I_t R_a + E_t \rightarrow E_t = 191.213 \text{ V}$$

$$\omega_t = \frac{E_t}{c'_e} = \frac{191.213}{3.6078} = 53 \frac{\text{rad}}{\text{s}}$$

$$n_t = \frac{60 \omega_t}{2\pi} = 506.11 \text{ rpm}$$

$$\frac{U_t}{n'_0} = \frac{E_t}{n_t} \rightarrow n'_0 = 524.03 \text{ rpm}$$

Graf :



n_0 i n'_0 su izračunate radi lakšeg crtanja grafa

2. Asinkroni :

$$P_n = 120 \text{ kW}$$

$$f = 50 \text{ Hz}$$

$$U_n = 440 \text{ V}$$

$$n_n = 1440 \text{ rpm}$$

Istosmjerni :

$$P_n = 13.5 \text{ kW}$$

$$I_n = 65.2 \text{ A}$$

$$U_n = 220 \text{ V}$$

$$n_n = 1450 \text{ rpm}$$

$$R_a = 0.2 \Omega$$

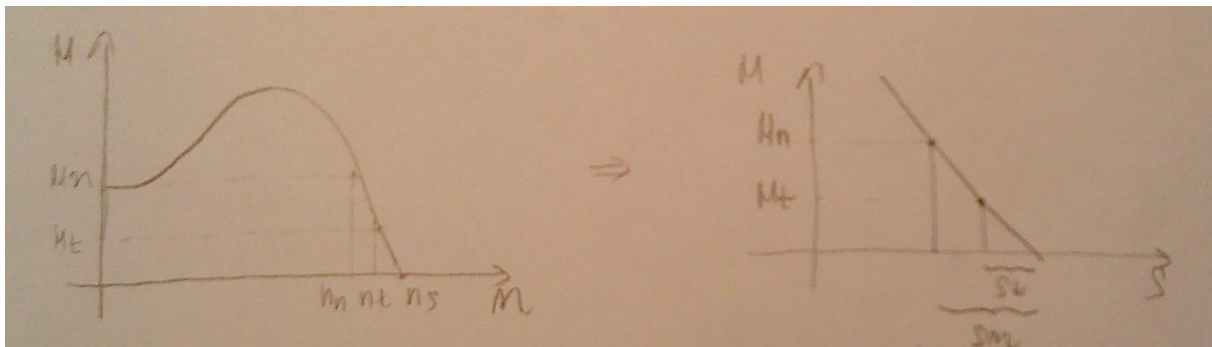
Oba motora podižu teret brzinom:

$$n_t = 1460 \text{ rpm}$$

Za asinkroni motor :

$$\omega_n = 2\pi \frac{n_n}{60} = 150.796 \frac{\text{rad}}{\text{s}}$$

$$M_n = \frac{P_n}{\omega_n} = 79.577 \text{ Nm}$$



$$n_s = 1500 \text{ rpm (najbliže brzini tereta, } p = 2 \text{)}$$

$$s_n = \frac{n_s - n_n}{n_s} = 0.04$$

$$s_t = \frac{n_s - n_t}{n_s} = 0.026$$

$$\frac{M_n}{s_n} = \frac{M_t}{s_t} \rightarrow M_t = \frac{s_t}{s_n} M_n = 53.05 \text{ Nm}$$

Ovaj odnos proizlazi iz linearnost radne karakteristike stroja (sličnost trokuta na slici iznad).

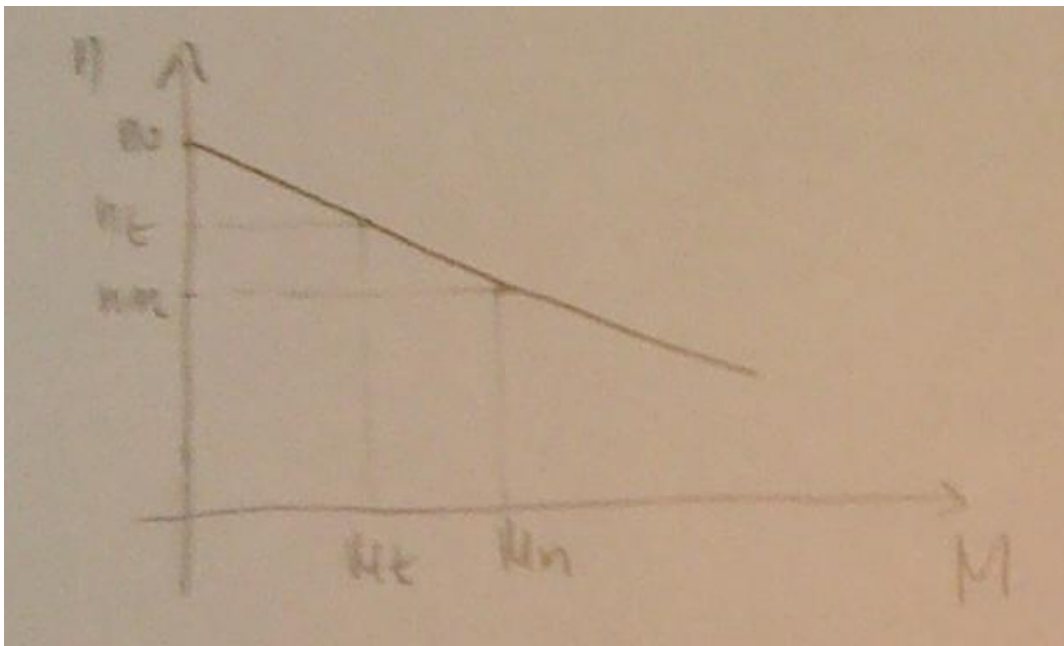
$$\epsilon_1 = \frac{P_t}{P_n} = \frac{M_t \omega_t}{P_n} = \frac{53.05 \left(2\pi \frac{1460}{60} \right)}{12000} = 0.6759$$

Za istosmjerni motor:

$$\omega_n = 2\pi \frac{n_n}{60} = 2\pi \frac{1450}{60} = 151.84 \frac{\text{rad}}{\text{s}}$$

$$M_n = \frac{P_n}{\omega_n} = \frac{13500}{151.84} = 88.907 \text{ Nm}$$

$$n_t = 1460 \text{ rpm (zadano)}$$



$$U_n = I_n R_a + E_n \rightarrow E_n = 206.96 \text{ V}$$

$$\frac{E_n}{n_n} = \frac{U_n}{n_0} \rightarrow n_0 = 1541.36 \text{ rpm}$$

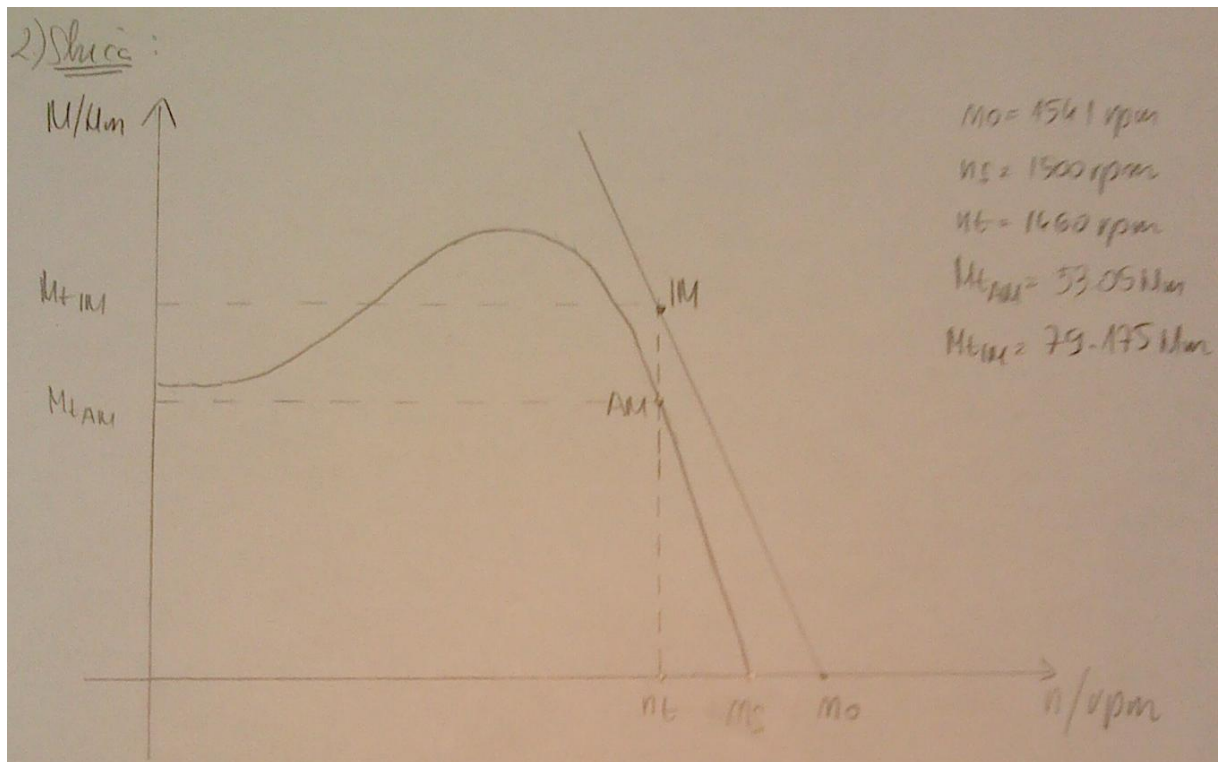
Iz slike vidimo iduću sličnost trokuta :

$$\frac{n_0 - n_t}{M_t} = \frac{n_0 - n_n}{M_n} \rightarrow M_t = 79.175 \text{ Nm}$$

$$\epsilon_2 = \frac{P_t}{P_n} = \frac{M_t \omega_t}{P_n} = \frac{79.175 \left(2\pi \frac{1460}{60} \right)}{13500} = 0.897$$

$$M_{uk} = M_{tAM} + M_{tIM} = 132.22 \text{ Nm}$$

Skica:

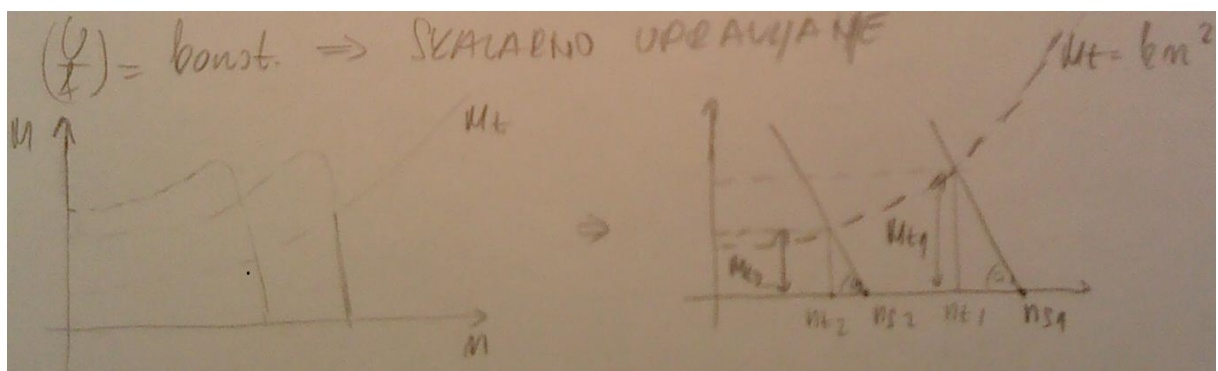


3. $M_t = kn^2$

$f = 50 \text{ Hz} \rightarrow n_{t1} = 1450 \text{ rpm}$ ($n_{s1} = 1500 \text{ rpm}$) $\rightarrow p = 2$

$f = ? \rightarrow n_{t1} = 1100 \text{ rpm}$

$\left(\frac{U}{f}\right) = \text{konst.} \rightarrow \text{skalarno upravljanje}$



$$\frac{M_{t1}}{n_{s1} - n_{t1}} = \frac{M_{t2}}{n_{s2} - n_{t2}} \rightarrow \text{sličnost trokuta}$$

$$k \frac{1450^2}{1500 - 1450} = k \frac{1100^2}{n_{s2} - 1100}$$

$$n_{s2} - 1100 = \left(\frac{1100}{1450} \right)^2 (1500 - 1450)$$

$$n_{s2} = 1128.775 \text{ rpm}$$

vrijedi :

$$n_s = \frac{60}{p} f \rightarrow f_2 = \frac{n_{s2}}{60} p = 37.625 \text{ Hz}$$

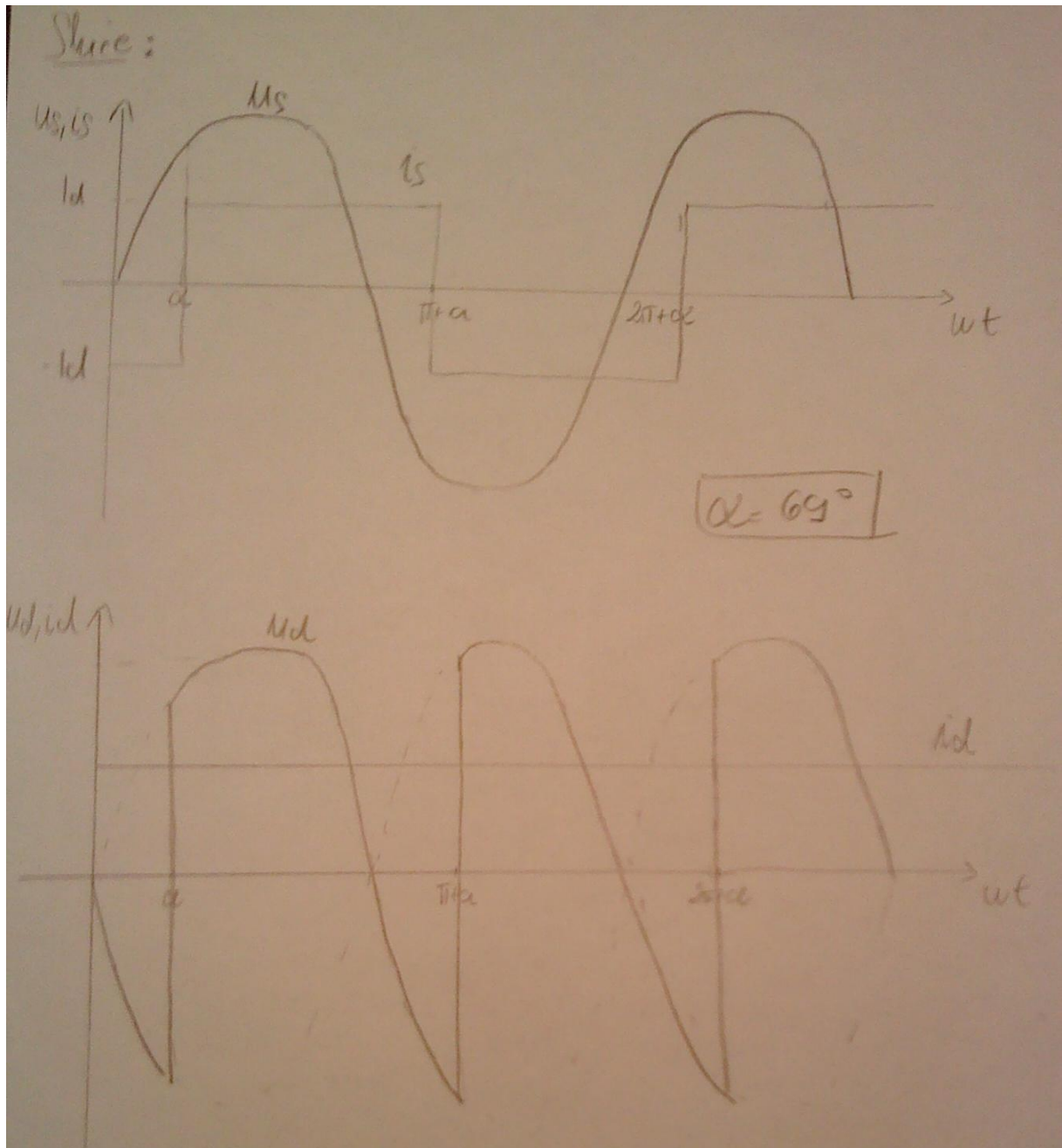
4. $U_b = 70V$
 $R_u = 1 \Omega$
 $P_B = 300W$
 $U_s = 230 \sqrt{2} \sin \omega t \text{ V}$
 $f = 50 \text{ Hz}$
 $\omega L \gg R$
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$$P_B = U_B I_d \rightarrow I_d = \frac{300}{70} = 4.2857 \text{ A}$$

$$I_d = \frac{U_d - U_B}{R_u} \rightarrow U_d = 74.2857 \text{ V}$$

$$U_d = \frac{2U_s}{\pi} \cos \alpha \rightarrow \alpha = \arccos \left(\frac{U_d \pi}{2U_s} \right) = \arccos \left(\frac{74.2857 \pi}{2 \cdot 230 \sqrt{2}} \right) = 68.977^\circ \approx 69^\circ$$

Skica:



By : Shin_ & Miha the mighty