5 A $n = 330$ ... $R_a = 0.7\ \Omega$

1. auditorne (3. tjedan)

Istosmjerni strojevi (s nez. uzbudom)

$U = c_e \cdot \omega + I \cdot R_a$

$M_{em} = c_m \cdot I_a$ (moment u zračnom rasporu -> energija koja prelazi na rotor)

$M_m = \frac{P_n}{\omega_m}$

zanemarivo

$M_{em} = M_m + M_{fiv}$

-> uzet ćemo ga kao konst. i sadržan je u ... u nazivnom radu ...

$c_e = k_e \cdot \Phi$ $c_m = k_m \cdot \Phi$

moment -> Nm
brzina -> rad/s
} $c_e = c_m$

moment -> Nm
brzina -> o/min
} $\frac{c_e}{c_m} = \frac{2\pi}{60}$

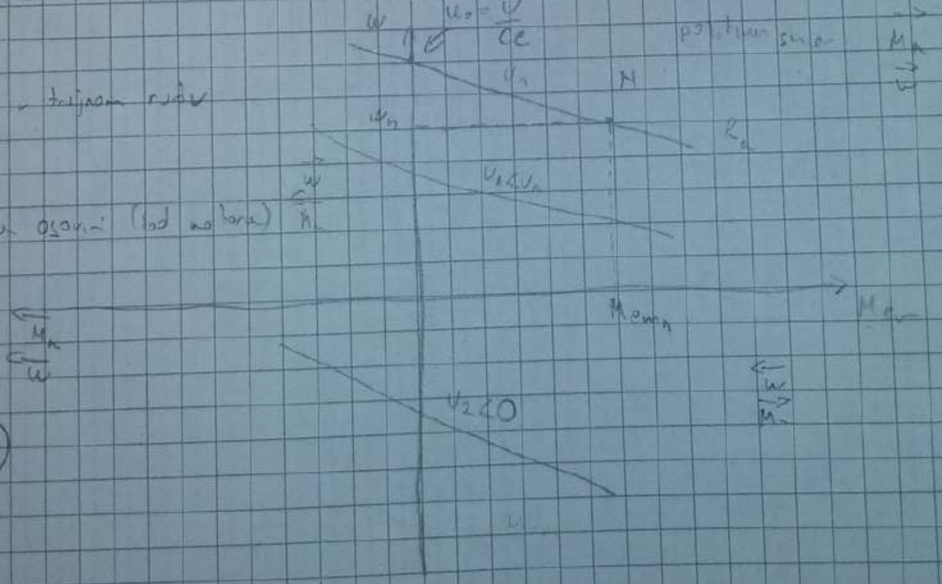
prazni hod - nema tereta

pozitivan smjer $\vec{M_m}$ $\vec{\omega}$ motorski rad

Plosila

... struja u trajnom radu

max ... snaga na osovini (kod motora)



$\omega = \frac{U - I \cdot R_a}{c_e}$ (1)

2. a-diforne

2.) $P_n = 28\ kW$

$U_n = 400\ V$

$I_n = 80\ A$

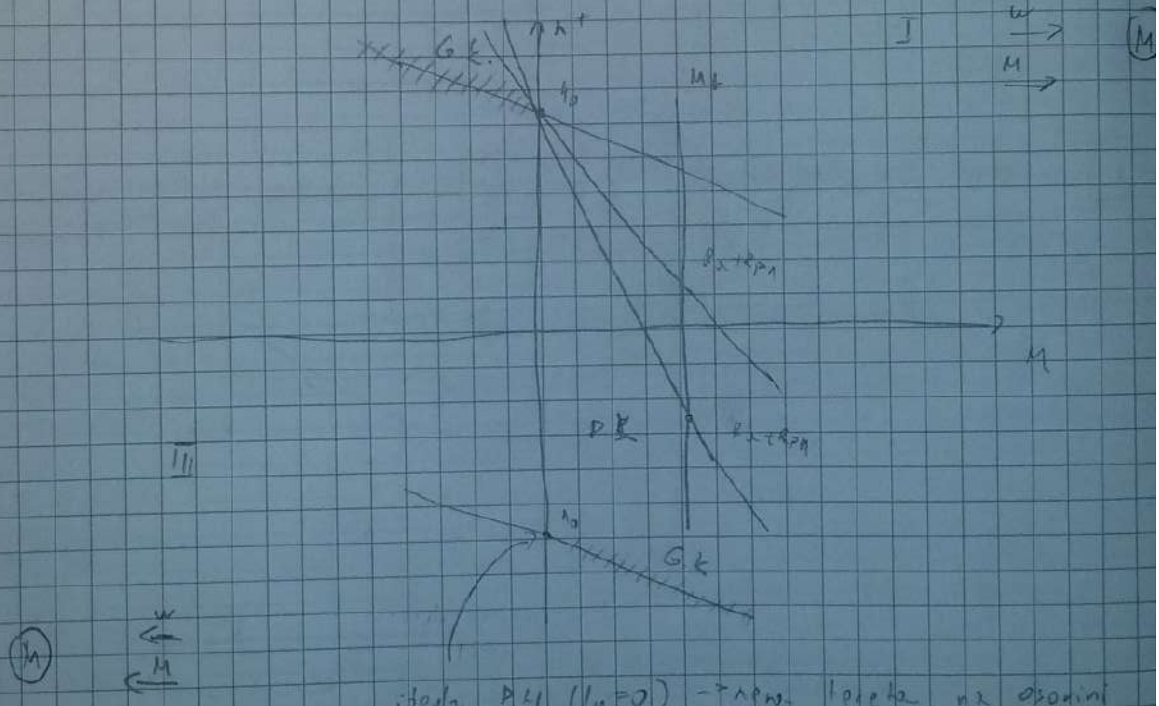
$n_n = 1000\ min^{-1}$

$R_a = 0.27\ \Omega$

b) $R_p = 13\ \Omega$

$I = 60\ A$

$w = ?$, $M_{as} = ?$ $P_{mr} =$ $P_{g} = ?$



ibodn. ALI ($I_a = 0$) → nema kočenja na osovini

Elektrodinamičko kočenje

- odspojimo izvor i dobijemo otpor

Gen kočenje

- stroj radi kao generator

↳ može nastati na osovini, ili motor dosli protupnost ...

↳ $n > n_0$ za (G.k) i $E > U$

(...)

$U = C_e \omega + I_a (R_a + R_p)$

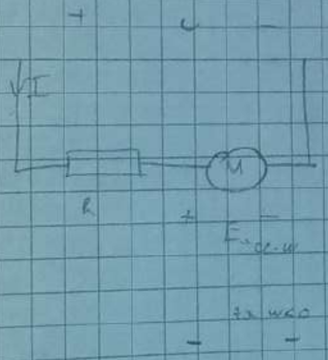
od prošlih režima preostalo nam je samo – M.R
– P.k

Protustrujno kočenje

P.k. $I_a \cdot (R_a + R_p) > U$ (dolazi do promjene smjera vrtnje)

$60 \cdot (0.27 + 13) = 796.2\,V > 400\,V$

→ protustrujno kočenje



Imamo veći pad napona na otporima nego napon izvora

⇓ zašto?

Budući da je moment tereta nadvladao moment motora, motor se počinje vrtiti u smjeru djelovanja tereta

→ na motoru se inducira obrnuti napon koji potpomaže struji

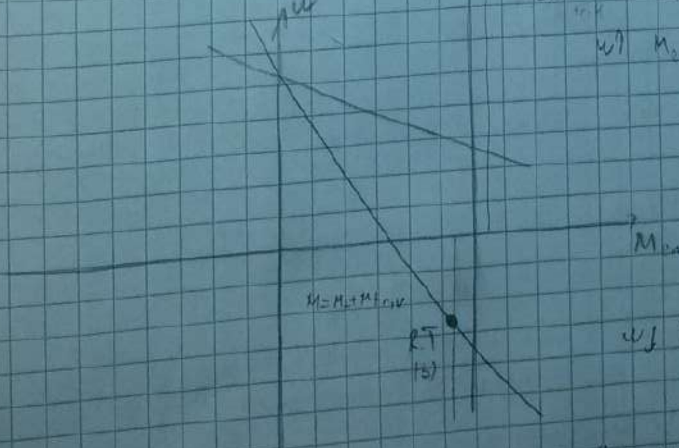
$\omega = \dfrac{U - I_a \cdot (R_a + R_p)}{C_e} = \dfrac{400 - 60 \cdot 13.27}{3.61} = -109.75\ rad/s$

M_t

$n = -1048\ min^{-1}$

$M_{em} = M_t + M_{tr,v}$

$\omega \uparrow\ M_{em} \uparrow\ M_t \downarrow\ M_{tr,v} \downarrow$



veće ... brzine vrtnje

$\omega \downarrow\ M_{em} \uparrow\ M_t \downarrow\ M_{tr,v} \uparrow$

$M_{em} = M_t - M_{tr,v}$

$M_{em} = C_m \cdot I_1 = 3.61 \cdot 60 = 216.6\ N$

$M_{es} = M_{em} + M_{tr,v} = 216.6 + 21.42 = 238.02\ Nm$

$P_{mreže} = U_1 \cdot I_1 = 400 \cdot 60 = 24\ kW$

$P_{gubitci} = I^2 \cdot (R_2 + R_p) = 60^2 \cdot (13.27) = 47.772\ kW$

↓

Snaga iz mreže i [illegible] na otporima

↳ IZRAZITO NEEKONOMIČNO

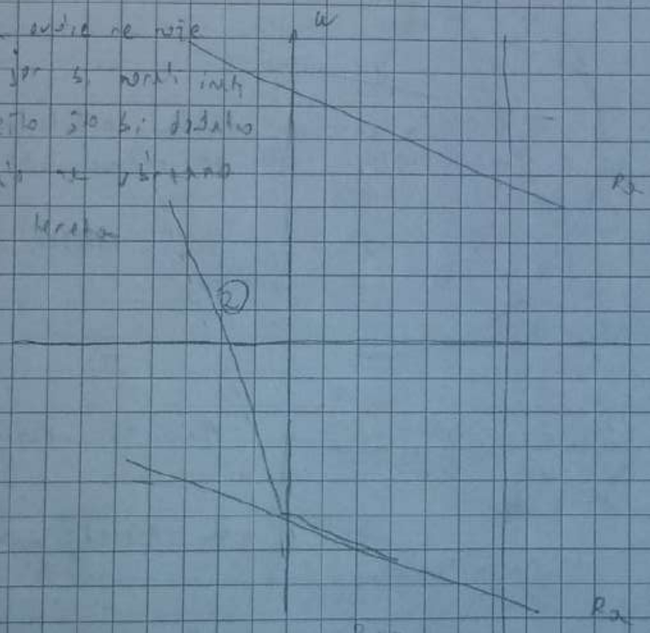
c) pri G.K.

$n = 1100\ min^{-1}$ → kočenje → brzina je suprotna $-1100\ min^{-1}$

$R_p = \emptyset$

$I = ?$

[illegible]



GK [illegible] moment koji djeluje [illegible] brzine ili [illegible] brzine

• dizalica ima GK samo pri spuštanju $n > n_0$

promjena brzine rada → promjena [illegible] karakteristike ω

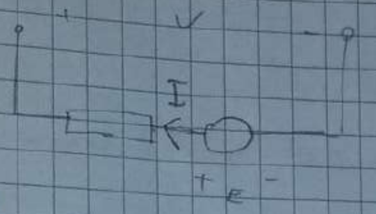
→ [illegible]

[illegible]

[illegible] brzina [illegible] ②

$U = C_e \cdot \omega + I \cdot R_a$ $\qquad \omega = \frac{n\pi}{30} = -115.19$

$I = \frac{U - C_e \cdot \omega}{R_a} = \frac{-400 - 3.61\,(-115.19)}{0.27} = 58.65\ A$



jer je napon suprotnog polariteta od smjera struje

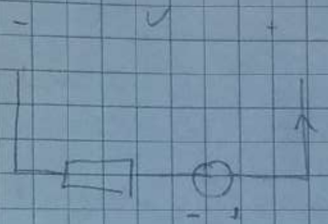
Elektrodinamičko kočenje

$\rightarrow U_2 = 0$

$\rightarrow$ smjer struje suprotan, $I_a < 0$

G.K. $E > U$ $\rightarrow$ vraćamo struju u mrežu

ili



3) $P_n = 32\ kW$

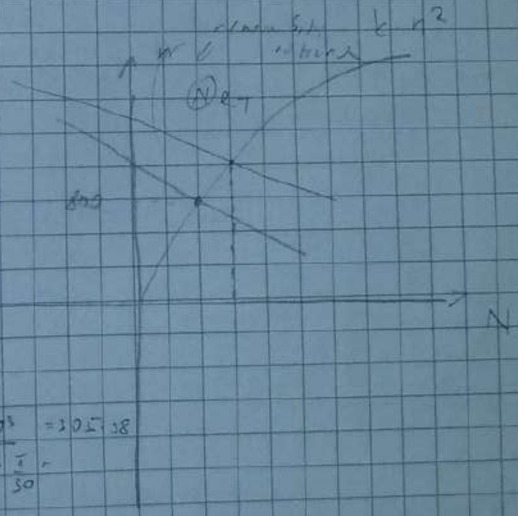
$U_n = 440\ V$

$I_n = 80\ A$

$n_n = 1000\ min^{-1}$

$R_a = 0.32\ \Omega$

$M_t = k \cdot n^2$



$M_n = \frac{P_n}{\omega_n} = \frac{32 \cdot 10^3}{1000 \cdot \frac{\pi}{30}} = 305.58$

$M_t = M_n = k \cdot n_n^2 \qquad k = \frac{M_n}{n_n^2} = 3.0557 \cdot 10^{-4}$

$M_t = k \cdot 800^2 = 195.56\ Nm$

$U = C_e \cdot \omega + I_a \cdot R_a$ $\qquad \omega_n = \frac{n_n \pi}{30}$

$C_e = \frac{U_n - I_n \cdot R_a}{\omega_n} = \frac{440 - 80 \cdot 0.32}{104.72}$

$Ce = C_n = 3.957$

$M_n = \frac{P_n}{w_n} = \frac{32 \cdot 103}{104,8} = 305.57$

$M_{em} = C_e \cdot I_n = 3.957 \cdot 80 = 316.56$

$M_{fr,v} = M_{em} - M_{oc} = 10.99\ N_m$

$I = \frac{M_n + M_{fr,v}}{C_m} = \frac{195.56 + 10.99}{3.957} = 52.20\ A$

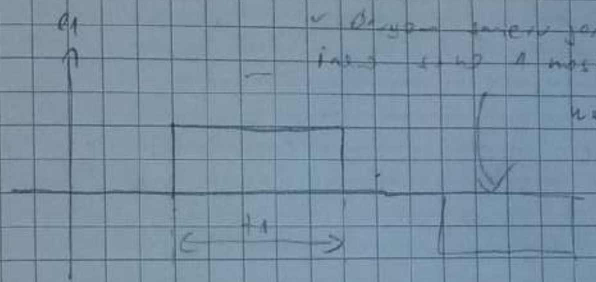
$V = 348.2\ V$

Aud. brze

tiristorski sklopovi – struja samo u 1 smjeru

2 tiristora → antiparalelni spoj

ne može teći struja
u drugom smjeru jer
ima samo 1 most

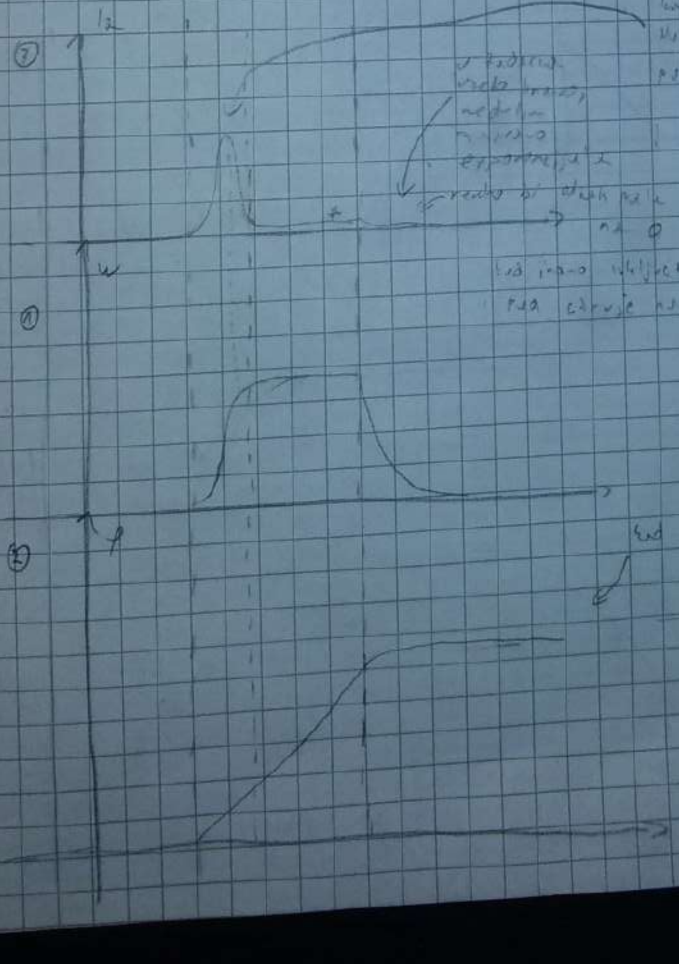


$n = \frac{U - I_a R_a}{C_e} = k \cdot U$

! ne znamo nas prijelazne pojave $\omega = \frac{d\psi}{dt}$

* isto, a realno mala struja za ventilac.

$i_a(t)$, $\omega(t)$, $\psi(t)$



$t \cdot f$ –

kad ima porast brzine imamo i porast struje

$k = J \frac{d\omega}{dt}$

$k \cdot I = J \frac{d\omega}{dt}$

kada $\omega = konst$ $I = 0$

1) $\omega = k \cdot U$

2) $\varphi = \int \omega \, dt$

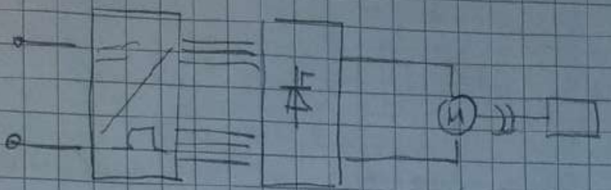
3) $I = \frac{d\omega}{dt}$

kod momenta trenja bit ovisnost ...

Osnovne obilježene – ... oblik
je ... pomaka u jednom odnosu
drugu struju

bit je integral brzine
a integral ... linearno ...

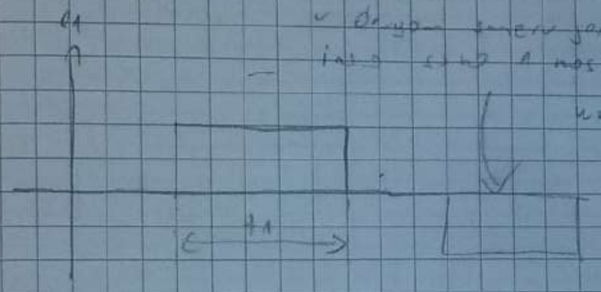
Auditorne



tiristorski sklopovi – struja samo u 1 smjeru

2 tiristora → antiparalelni spoj

ne može teći struja
u drugom smjeru jer
imamo samo 1 most



$n = \frac{U - I_a R_a}{C_e} = k \cdot U$

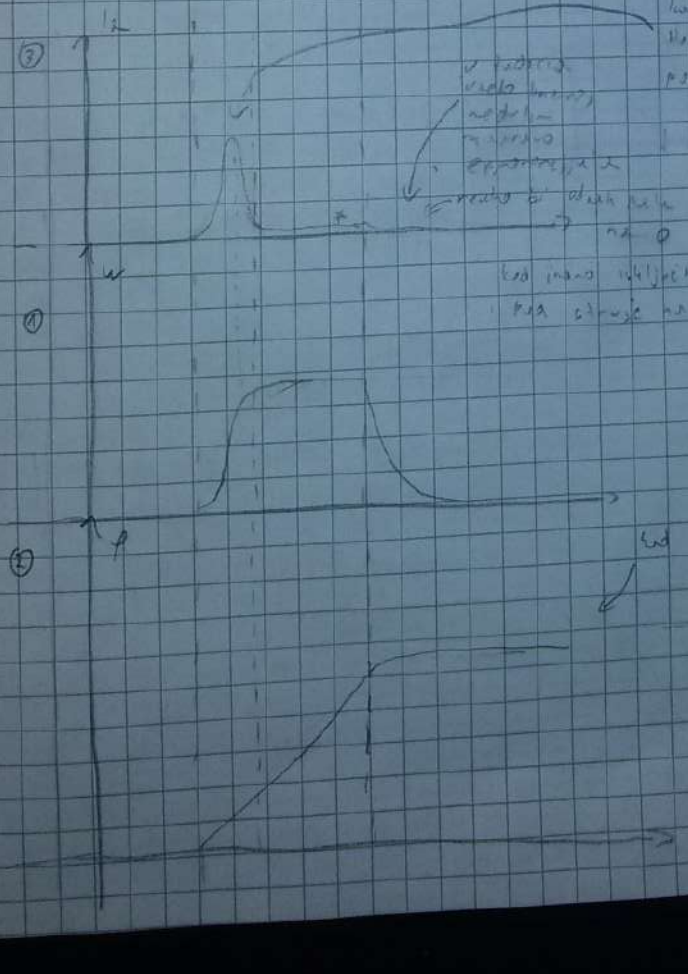
t_r - ϕ

ne zanima nas prijelazne pojave $u = \frac{d\psi}{dt}$

* idealno, a realno mala struja za [illegible]

$i_a(t)$, $\omega(t)$, $\varphi(t)$

kut -



kad imamo porast [illegible] imamo i porast struje

u idealnom slučaju [illegible] eksponencijalno realno bi otišlo [illegible] na 0

kad imamo isključenje napajanja pada struja na 0

$h = J \frac{d\omega}{dt}$

$k I = J \frac{d\omega}{dt}$

za $\omega = konst.$ $I = 0$

1) $\omega = k U$

2) $\varphi = \int \omega \, dt$

3) $I = \frac{d\omega}{dt}$

kad moment brzine kut ostaje isti

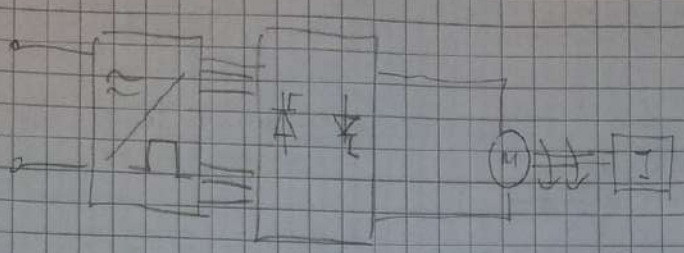
Osovina [illegible] – [illegible] se točka pomakla u jednu odnosno drugu stranu

kut je integral brzine
brzina integral [illegible]

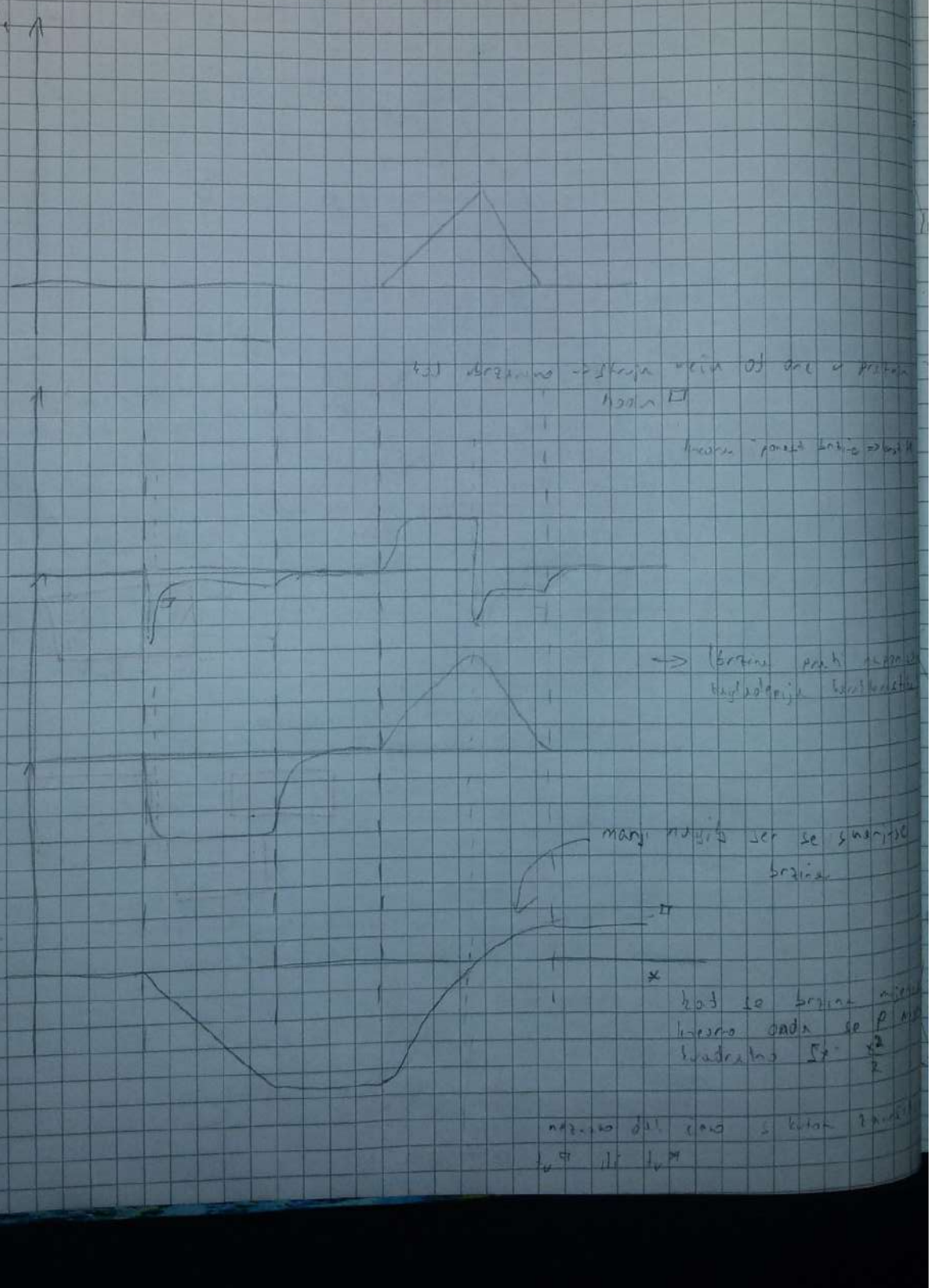
$P_n = 12$ kW $U_n = 440$ V $I_n = 27.5$ A $n = 310$ o/min $r_a = 0.7\,\Omega$

$J = 90$ kgm² $i = 10$ $\eta_{tr} = 0.8$ $\eta_b = 0.95$ $r_b = 2.6\,\Omega$ $U_{dc} = 440$ V

a)



potpuno upravljani ispravljač koji vodi struju u oba smjera

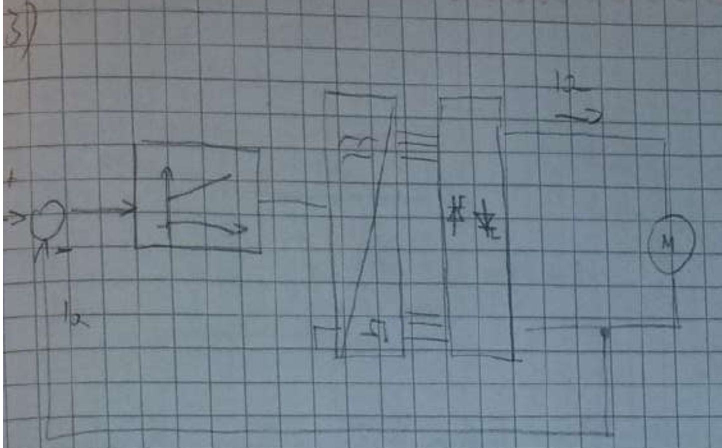


manji nagib jer se smanjuje brzina

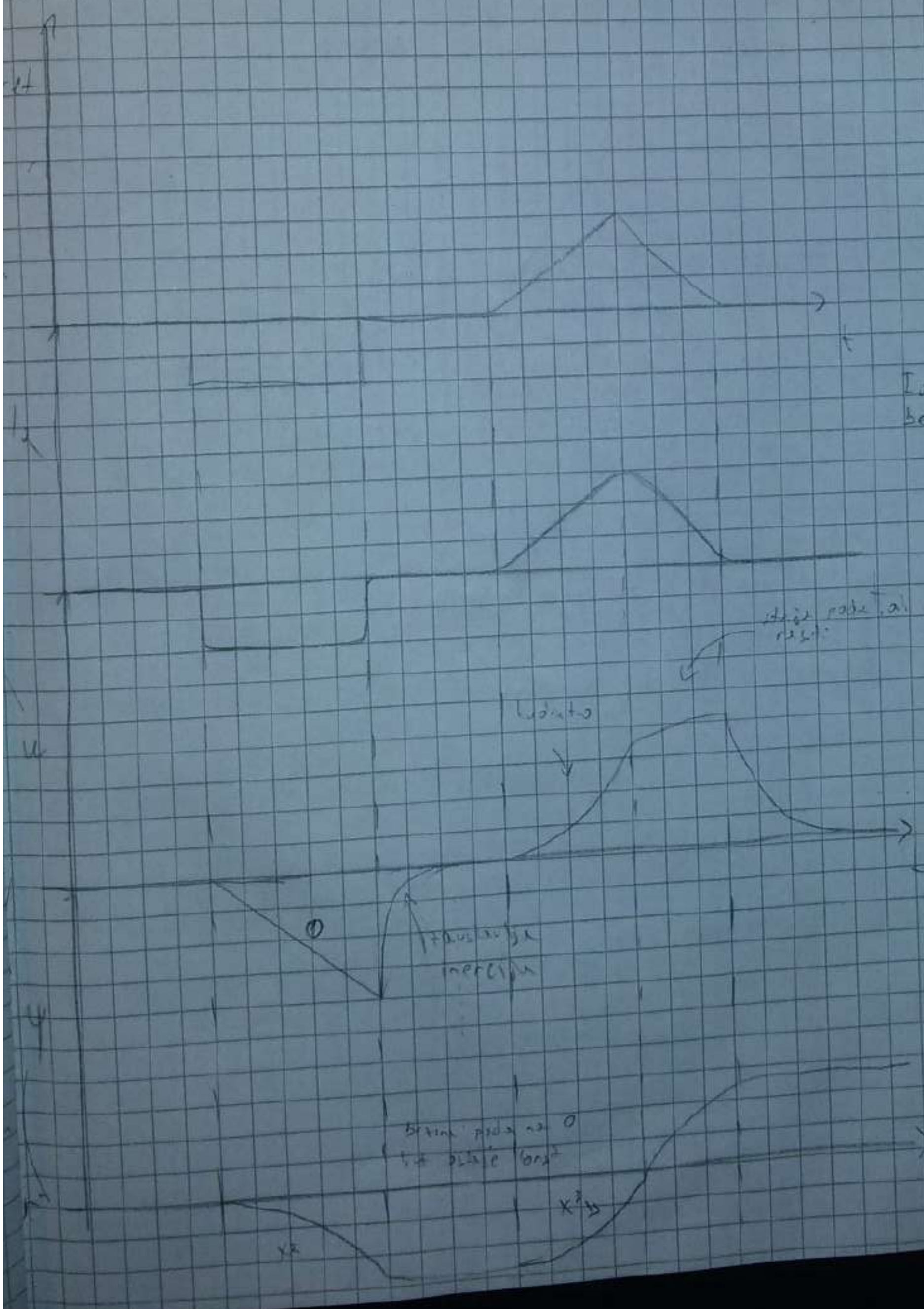
kod kojeg se brzina mijenja linearno onda se P mijenja kvadratno $\frac{x^2}{2}$

3)

Strujno upravljanje momentom



$I_a \sim M_{em}$



Ia prati kret samo bez ispeive

① kad imamo konst struju M brzina linearno raste

$M = J\frac{d\omega}{dt} \Rightarrow \omega = \int M\,dt$

$\varphi = \int \omega\,dt$

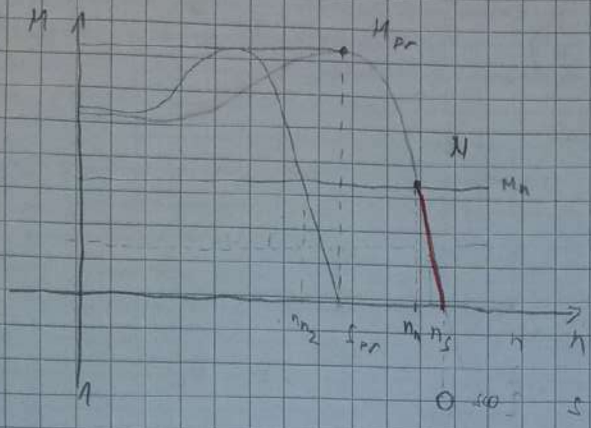
$V_n = 1120\,V$ $I_n = 22.5\,A$ $n = 310\,min^{-1}$ $r_a = 0.7\,\Omega$

$i = 10$ $\eta_{pr} = 0.8$ $\eta_b = 0.95$ $r_b = 2.6\,\Omega$ $V_{01} = 1120\,V$

ASINKRONI STROJ

Asinkroni stroj

- kavezni asinkroni stroj



radimo samo na lijevoj strani kod
↳ stabilnog upravljanja

→ u praznom hodu motor se
približi sinkronoj

→ na sinkronoj brzini motor ne može
ostvariti moment jer

$n_s = \frac{60 f}{p}$

$s = \frac{n_s - n}{n_s}$ s_{max} 7% (u radnom režimu)

$P_n = 560\,kW$

$n_n = 1490\,min^{-1}$

! ako je MOMENT drugačiji od nazivnog n nije nazivna

$$M_{pr} = f\left(\frac{V}{f}\right)^2 \quad \text{samo za prekretni moment}$$

$$M = f(V)^2$$

! M_{pr} ostaje konstantan za $f < f_n$ za veće od f_n
napon više ne možemo povećavati pa M_{pr} pada

Mijenjanjem f mijenja se i s_{pr}

$I_n = 77.5\ A$ $n = 310$ ... $r_2 = 0.7\ \Omega$

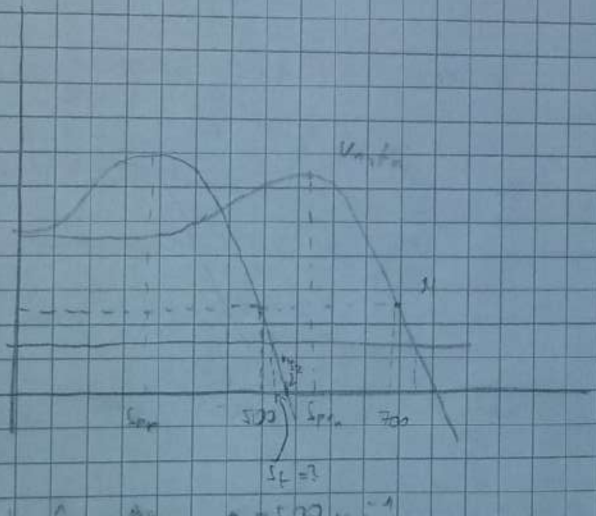
$$\frac{s_{pr1}}{s_{pr2}} = \frac{f_2}{f_1}$$

$$M = \frac{2\ M_{pr}}{\frac{s}{s_{pr}} + \frac{s_{pr}}{s}}$$

možemo imati M_{pr} za točku na karakteristici za koju računamo moment (točnije kada je $M_{pr} < M_{pr_n}$)

1) $P_n = 5\ kW$ $U_n = 400\ V$ $n_n = 700\ min^{-1}$ $f_n = 50\ Hz$

$\frac{M_{pr}}{M_n} = 3$ $M_t = 40\ Nm$ (potencijalni)



odrediti f da $n = 500\ min^{-1}$

$$\omega_n = \frac{n_n \pi}{60} = \frac{700\ \pi}{30} = 73.3\ rad/s$$

snaga na osovini

$$M_n = \frac{P_n}{\omega_n} = \frac{5000}{73.3} = 68.21\ N/m$$

$M_{pr} = 3\ M_n = 204.63\ Nm$

$$n_s = \frac{60 \cdot f}{p} = \frac{60 \cdot 50}{4} = \frac{3000}{4} = 750\ min^{-1}$$

$$s = \frac{n_s - n_n}{n_s} = \frac{750 - 700}{750} = 6.67\ \%$$

$p = 1$	$n_s = 3000$
$p = 2$	$n_s = 1500$
$p = 3$	$n_s = 1000$
$p = 4$	$n_s = 750$

[illegible] za [illegible] [illegible] [illegible] – ovdje je to naštimana

$$M_n = \frac{2 M_{pr}}{\frac{s_n}{s_{pr_n}} + \frac{s_{pr_n}}{s_n}}$$

$$\frac{s_{pr}}{s_{pr_n}} = \frac{f_n}{f}$$

$$x = \frac{s_n}{s_{pr_n}}$$

$$M_n = \frac{2 M_{pr_n}}{x + \frac{1}{x}} \Rightarrow M_n = \frac{2 M_{pr_n}}{\frac{x^2+1}{x}} \quad / : M_n$$

$$1 = \frac{2 \frac{M_{pr_n}}{M_n}}{\frac{x^2+1}{x}} \quad (x^2+1) \Rightarrow x^2+1 =$$

$$x^2 - 2 \frac{M_{pr}}{M_n} x + 1 = 0$$

$$x^2 - 6x + 1 = 0$$

~~$x_1 = 5.83$~~ ← $x_2 = 0.172$

biramo x koji je fizikalno prihvatljiv

$$x = \frac{s_n}{s_{pr_n}} \qquad s_{pr_n} > s_n \qquad x \text{ mora biti manji od } 1$$

$$s_{pr_n} = \frac{s_n}{x} = \frac{0.0567}{0.172} = 0.33$$

$$\frac{s_{pr}}{s_{pr_n}} = \frac{f_n}{f}$$

$$M_1 = \frac{2 M_{pr}}{\frac{s_1}{s_{pr}} + \frac{s_{pr}}{s_1}}$$

$$x = \frac{s_1}{s_{pr}}$$

$x_1 = 0.0093$

$x_2 = 10.727$

$$s_{pr} = \frac{f_n}{f} s_{pr_n} = \frac{50}{f} \cdot 0.33 = \frac{16.55}{f}$$

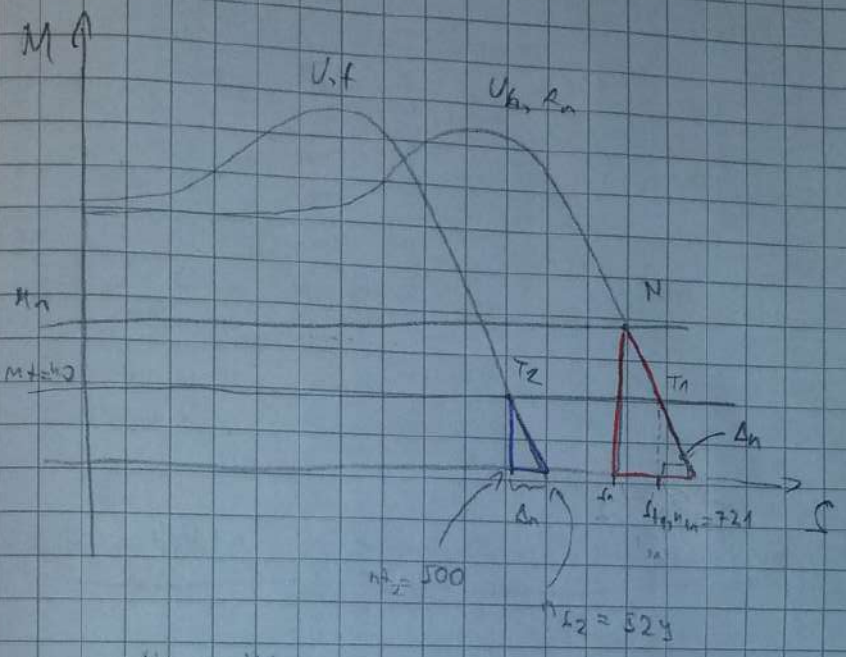
$$s_1 = x \cdot s_{pr} = \frac{n_{s_2} - n_1}{n_{s_2}} = \frac{\frac{60 f}{p} - n_1}{\frac{60 f}{p}}$$

$$0.0093 \cdot \frac{16.55}{f} = \frac{\frac{60 f}{4} - 500}{\frac{60 f}{4}}$$

dobije se [illegible]

$f = 35.15$ Hz

Jednosbarvije



$$\frac{M_n}{f_n} = \frac{M_{t=0}}{f_1}$$

T_1: $\quad \frac{f_1}{f_n} = \frac{M_t}{M_n} \quad s_n = \frac{40}{682} \cdot 0,0662 = 0,0391$

$$n_{t_1} = (1 - s_n) \cdot n_s \overset{t=0}{=} 721$$

$$\Delta_n = 750 - 721 = 29 \ min^{-1}$$

$$\Delta_{n_2} = \Delta_{n_1} = 29 \ min^{-1}$$

$$n_{s_2} = n_{t_2} + \Delta_n = 529 \ min^{-1}$$

$$n_s = \frac{60 f}{p}$$

$$f = \frac{p \cdot n_{s_2}}{60} = 35,26 \ Hz$$

2)

$U = 400$ V

$P = 5$ kW

$n_n = 1430 \ min^{-1}$

$f_n = 50$ Hz

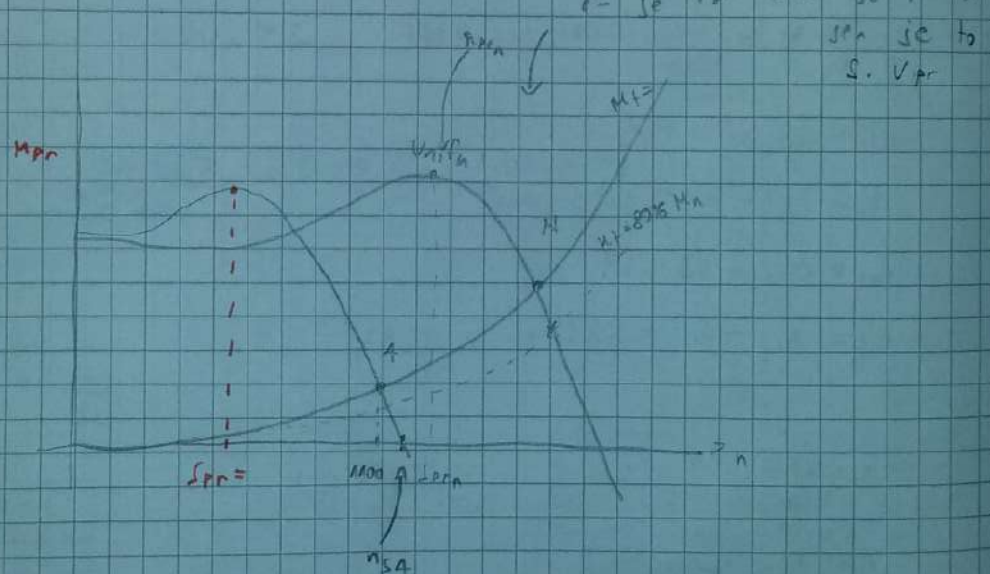
* $\frac{M_{pr}}{M_n} = 3$

$M_t = k n^2$ ventilator)

pri nazivnoj frekv i nazivnom naponu motor je opterećen nazivnim mom…

$n = 1100 \ min^{-1}$ $f_1 = ?$

$M_t = ?$ za $n = 1100 \ min^{-1}$



$M_t = M_n$ kada je brzina nazivna ($n_n = 1430$) (kada se može tereti i ma… struje u nazivnoj R.T)

$M_t = M_n = k \cdot n_n^2$

$k = \frac{M_n}{n^2} = \frac{33.34}{1430^2} = 1.632 \cdot 10^{-5}$

$\omega_n = n_n \frac{\pi}{30} = 1430 \cdot \frac{\pi}{30} = 149.75$ rad/s

$M_n = \frac{P_n}{\omega_n} = \frac{5 \cdot 10^3}{149.75} = 33.34$ Nm

$$s_n = \frac{n_s - n_n}{n_s} = \frac{1500 - 1430}{1500} = 0.0466 \qquad s_n = 4.67\%$$

$$n_s = \frac{60 f}{p} = 1500$$

p = 2

$$M_{t_{1100}} = k \cdot n^2 = 1.632 \cdot 10^{-5} \cdot 1100^2 = 19.76 \text{ Nm}$$

najveće frekvencije preko klizača

- za kliza nam treba M_{pr} i s_{pr}

! za sve frekvencije manje od nazivne $M_{pr} = M_{prn}$

$$\frac{M_n}{M_{prn}} = \frac{2}{\frac{s_n}{s_{prn}} + \frac{s_{prn}}{s_n}} \qquad x = \frac{s_n}{s_{prn}} \qquad s_n < s_{prn}$$

$$x^2 - 2\frac{M_{pr}}{M_n} x + 1 = 0 \quad \Rightarrow \quad x = 0.1716$$

$$s_{prij} = \frac{s_n}{x} = \frac{0.00467}{0.1716} = 0.272$$

! $M_{pr} = \left(\frac{U}{f_1}\right)^2 = konst$

$$\frac{M_{pr}}{M_{prn}} = \left(\frac{\frac{U}{f_1}}{\frac{U_n}{f_n}}\right)^2 = \frac{U_n^2}{f^2}$$

$$M_{pr} = \frac{f_n^2}{f^2} \cdot M_{prn} =$$

$$\frac{s_{pr}}{s_{prn}} = \frac{f_n}{f} \qquad \text{(obrnuto proporcionalno)}$$

$$s_{pr} = s_{prn} \frac{f_n}{f} = 0.272 \frac{50}{f} = \frac{13.5}{f}$$

$$\frac{M_t}{M_{pr}} = \frac{2}{\frac{s_t}{s_{pr}} + \frac{s_{pr}}{s_t}} \qquad x = \frac{s_t}{s_{pr}}$$

$$x^2 - 2\frac{M_{pr}}{M_t} x + 1 =$$

$$x = 0.1$$

$$s_t = 0.1\, s_{pr} = \frac{n_{is} - n_t}{n_{is}}$$

(4) $n = n_t$

$s = s_t$

$$0.1 \cdot \frac{13.5}{f} = \frac{\frac{60 \cdot f}{2} - 1100}{\frac{60 f}{2}}$$

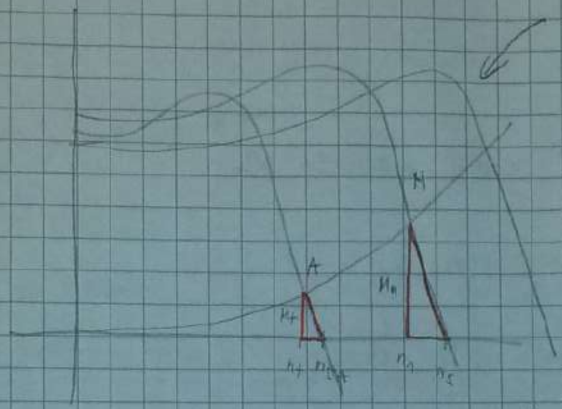
$$f = 38.02 \text{ Hz}$$

$s = \frac{n_{is} - n}{n_{is}}$

2004

$P_n = 12$ kW $U_n = 120$ V $I_n = 27.5$ A $n = 380$ min^{-1} $R_2 = 0.7\,\Omega$

! za sve f manje f_n ... da su karakteristike paralelne



ako je ... konstantan ... su jednaki

$$\frac{M_n}{\Delta n_n} = \frac{M_t}{\Delta n_A}$$

$\Delta n_n = n_s - n_n = 1500 - 1430 = 70$

$\Delta n_A = n_{sA} - n_t$

vrijednost zaokružujemo

$$\frac{33.33}{70} = \frac{19.76}{\Delta n_A} \qquad \Delta n_A = 41.42 \approx 41 \text{ min}^{-1}$$

$n_{sA} = n_t + \Delta n_A = 1100 + 41 = 1141$ min^{-1}

$$n_{sA} = \frac{60 f}{p} \qquad f = \frac{p\, n_{sA}}{60} = \frac{2 \cdot 1141}{60} = \boxed{38.03 \text{ Hz}}$$

! Kloss se koristi za frekvencije iznad nazivne frekvencije

Oko 30 min govori o razlikama otpora, zakretanje polja

SKALARNO UPRAVLJANJE U AS S UTISNUTIM NAPONOM

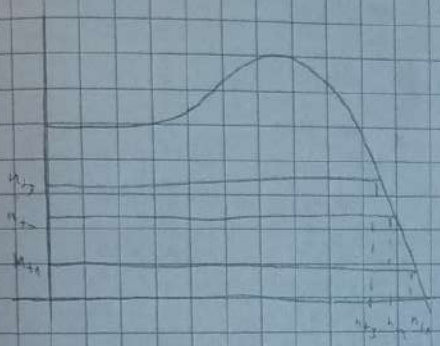
- Otvorena petlja upravljanja asinkronim strojem

-> zadajemo referentnu brzinu koja se preračunava u referentnu f. statora

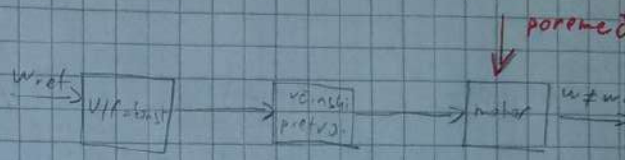
-> regulator napon s obzirom na odabranu f. zadaje napon

-> mi zapravo ne reguliramo brzinu već samo odabiremo karakteristiku (M

- samo u praznom hodu vrtimo se zadanom brzinom
- ako stroj opteretimo sa određenim teretom njegova brzina će past

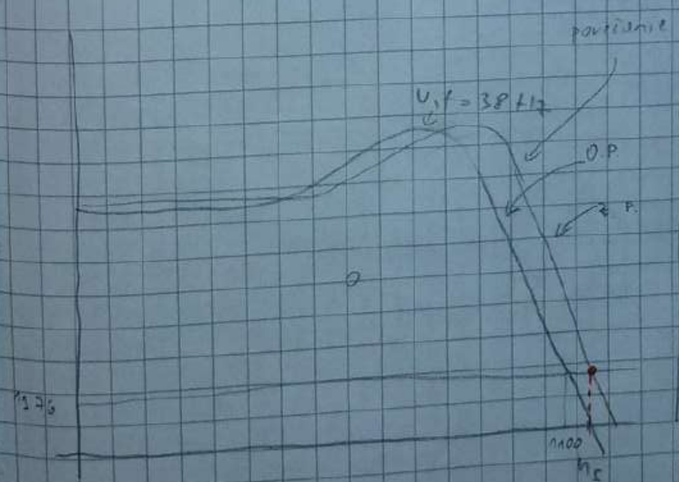


$n_{t_1} < n_{t_2} < n_{t_3}$ $\quad n_{t_1} > n_{t_2} > n_{t_3}$



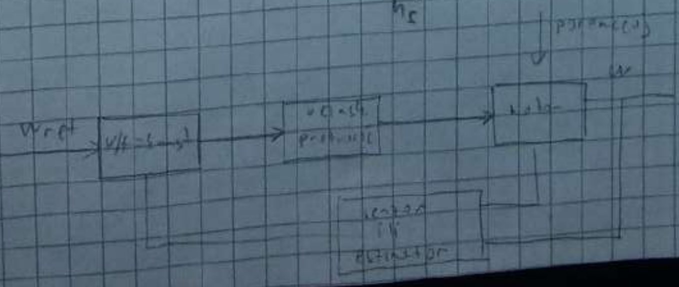
Svaka promjena momenta tereta ili ump... statora uzrokovat će promjenu brzine vrtnje stroja

- Zatvorena petlja upravljanja asinkronim strojem



- kakvu brzinu zadamo, tom brzinom će se vrtit motor

↳ ako pri zadanoj brzini dodatno opteretimo stroj dodatnim teretom PI regulator će povećavati frekvenciju sve dok god se ne bi vrtili zadanom brzinom (pomaknut će karakteristiku da se ona siječe sa momentom tereta na zadanoj brzini)



2004.

MU $P_n = 1.2$ kW $U_n = 220$ V $I_n = 22.5$ A $n = 380$ min^{-1} $r_a = 0.7\,\Omega$

brzina okretnog polja

2.) $n = 2310$ min^{-1} VEKTORSKO UPRAVLJANJE

$I_n = 20$ A

$M_t = M_n$

$i_{sa} = I_m \sin(\omega t)$ $I_m = I_n \cdot \sqrt{2} = 20\sqrt{2} = 28.28$ A

$i_{sb} = I_m \sin(\omega t - \frac{2\pi}{3})$

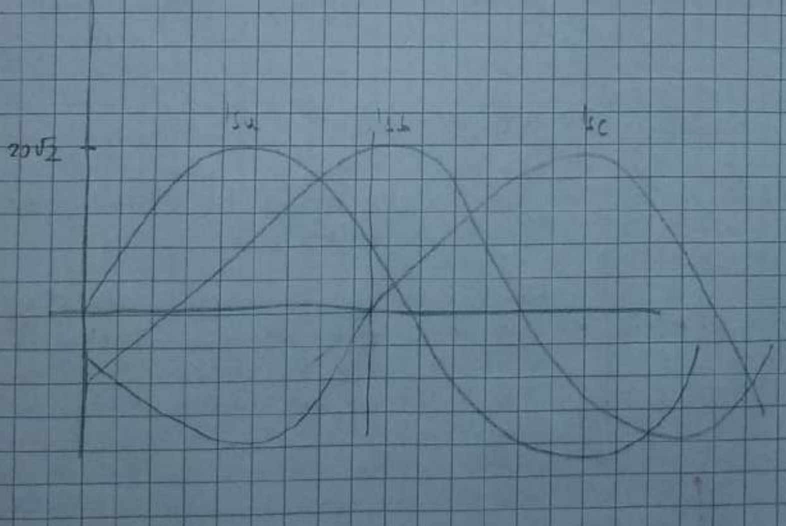
$i_{sc} = I_m \sin(\omega t + \frac{2\pi}{3})$

$t = 0.014$ s $\quad \gamma = \frac{2\pi}{3}$

a) $i_{sa}, i_{sb}, i_{sc}, i_{sd}, i_{sq}, i_{sd}, i_{sq}$ $t = 0.014$ s

~~$\vec{i_s} = \frac{2}{3}\left(i_{sa} + i_{sb}\, e^{+j\frac{2\pi}{3}} + i_{sc}\, e^{j\frac{2\pi}{3}}\right)$~~ nikad točnih u zadacima

struja nazivna određena za tečno nazivnu struju (efektivna vrijednost struje)



$\omega_s = 314.16$ rad/s

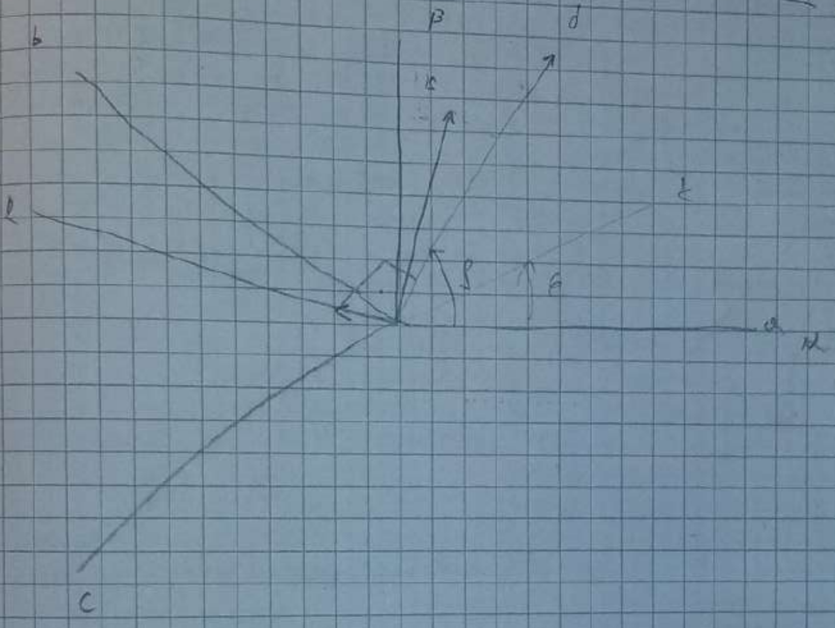
$n_s = 3000$ min^{-1}

$i_{sa} = 28.28 \sin(314.16 \cdot 0.014) = -26.9$ A (ωs, t)

$i_{sb} = 21.02$ A

$i_{sc} = 5.88$ A

kalkulator mora biti u radijanima



2-β - mirujući sustav

- sve 3-fazne veličine su postale dvofazne

dq - sustav koji rotira

$$i_{s\alpha} = i_{sa} = -26.9 \text{ A}$$

$$i_{s\beta} = \frac{i_{sb} - i_{sc}}{\sqrt{3}} = 8.74 \text{ A}$$

$$i_{sd} = i_{s\alpha} \cos\vartheta + i_{s\beta} \cdot \sin\vartheta = 21.02 \text{ A}$$

i ne može biti negativan (struja)

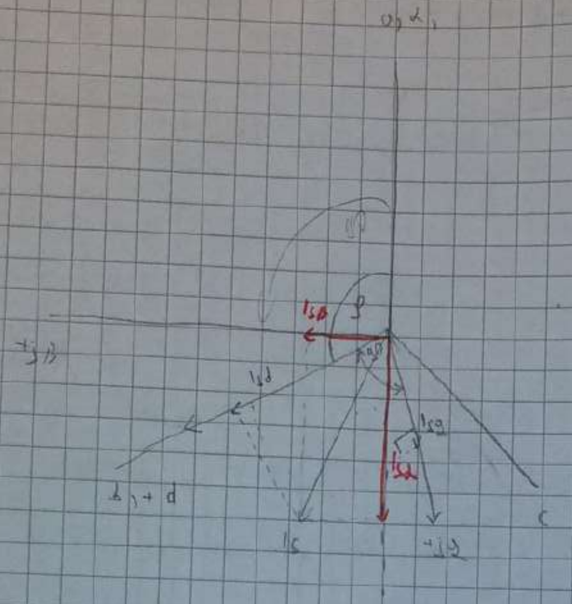
$$i_{sq} = -i_{s\alpha} \sin\vartheta + i_{s\beta} \cdot \cos\vartheta = 18.43 \text{ A}$$

! i_{sq} + motorski RR

i_{sq} − generatorski RR

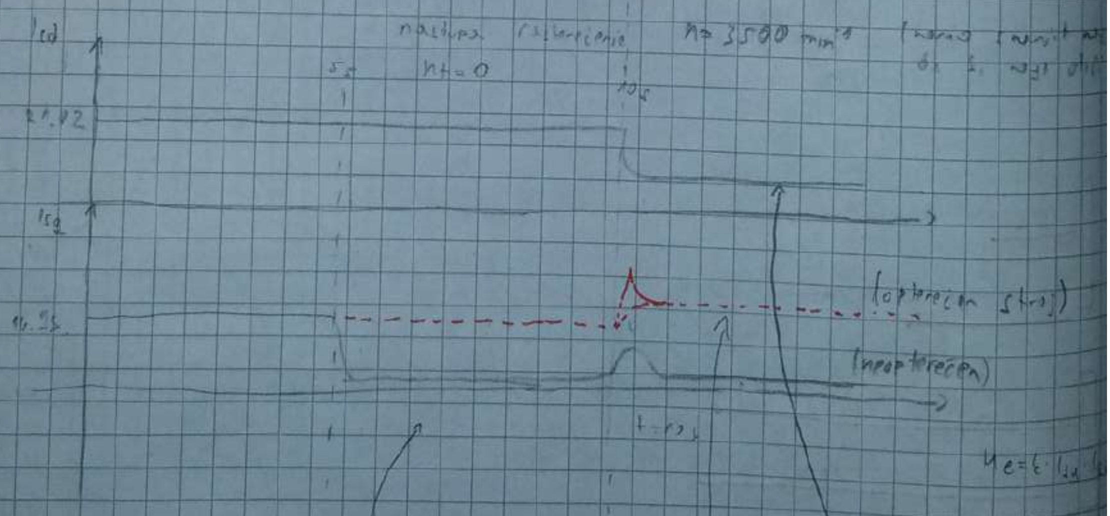
MI 2009.

AM = MU $P_n = 112$ kW $U_n = 110$ V $I_n = 27.5$ A $n = 3?0$ min^{-1} $R_a = 0.9\ \Omega$



7. t = 0.5 s I_{sq} i Isd se ne mijenjaju (ostale ds

t = 0.5 s ne nastupi rasterećenje



- I_{sq} se smanjio skoro na 0 (nije 0 jer treba i kompenzacije)
- Isd se nije promijenio jer nas tako nastojao držati konstantnim

- smanjeno Isd tako je smanjio, odnosno ovako bi porastao brzinu iznad nazivne
- Isq se povećava tako ... konstantni ...

($M_e = k \cdot I_{sq} \cdot I_{sd}$ ...
I_{sq} ...

I_{sq}

I_{sd}

I_{sq}

I_{sd}

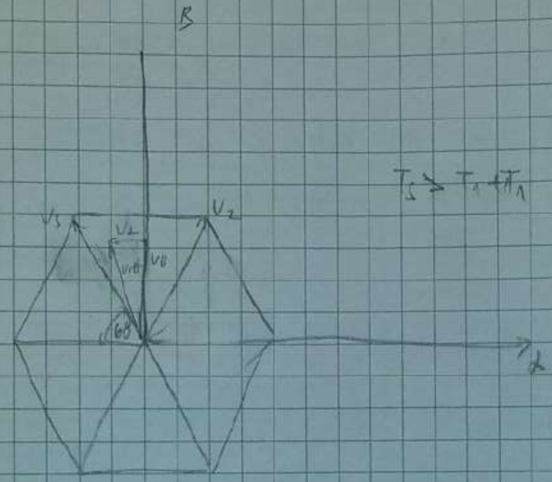
2004.

$P_n = 2.2$ kW $V_n = 220$ V $I_n = 27.5$ A $n = 320$ ... $r_s = 0.7\,\Omega$

⊗ 700

V0Φ LETEĆI START snimka 27 min

7 zavoditorne



$T_s > T_1 + T_1$

Vektorska modulacija

t_a +

$v_a = -97.55$ V

$v_b = 221.98$ V

$v_c = -124.13$ V

$v_\alpha, v_\beta = ?$ $T_s = 2\,\mu s$ $V_{DC} = 600$ V

t_a, t_b, t_c (vrijeme u kojem vodi pojedina sklopka)

nacrtati ..

u kojem se sektoru nalazi V_{ref}?

(naponi na statoru jednaki referentnom vektoru napona)

$v_\alpha = v_a = -97.55$ V

$v_\beta = \frac{1}{\sqrt{3}}(v_b - v_c) = \frac{221.48 + 124.13}{\sqrt{3}} = 149.83$ V

v_α, v_β tvore referentni vektor

$$tg\,\alpha = \frac{v_\beta}{v_\alpha} = \frac{144.83}{-97.55} = -2.048 \approx 116.03°$$

$-63.97 + 180$ ... II ... IV kvadrant

↗ ... 2 ... gledat predznake α i β komponenti

$$V_{ref} = v_2 \cdot \frac{T_2}{T_s} + v_3 \cdot \frac{T_3}{T_s}$$

sektor 2

$$v_2 = \frac{V_{DC}}{3} + j\frac{V_{DC}}{\sqrt{3}}$$

$$v_3 = -\frac{V_{DC}}{3} + j\frac{V_{DC}}{\sqrt{3}}$$

$$V_{ref} = \left(\frac{V_{DC}}{3} + j\frac{V_{DC}}{\sqrt{3}}\right)\frac{T_2}{T_s} + \left(-\frac{V_{DC}}{3} + j\frac{V_{DC}}{\sqrt{3}}\right)\frac{T_3}{T_s} = v_\alpha + j v_\beta$$

$$v_\alpha = \frac{V_{DC}}{3T_s} \cdot (T_2 - T_3)$$

$$v_\beta = \frac{V_{DC}}{\sqrt{3}T_s} \cdot (T_2 + T_3)$$

$$T_2 = \frac{1}{2} T_s \frac{3}{V_{DC}} + \left(\frac{v_\alpha + v_\beta}{\sqrt{3}}\right) = \frac{1}{2} \cdot 2\,ms\,\frac{3}{600}\left(-97.55 + \frac{144.83}{\sqrt{3}}\right)$$

$$T_2 = 0.089\,ms$$

$$T_3 = \sqrt{3} \cdot \frac{T_s}{2V_{DC}}\left(-\sqrt{3}\,v_\alpha + v_\beta\right)$$

$$T_3 = \sqrt{3} \cdot \frac{2}{2 \cdot 600} \cdot -\sqrt{3} \cdot (-97.55) + 144.83$$

$$T_3 = 1.065\,ms$$

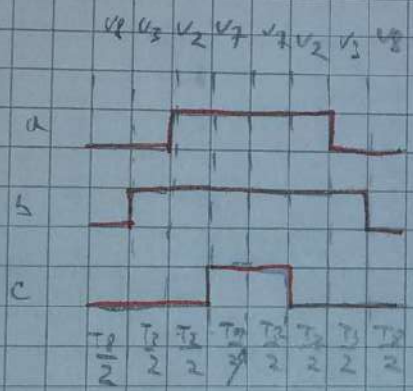
$$T_0 = T_s - T_2 - T_3 = 0.846\,ms$$ (vrijeme držanja nul-vektora)

$$T_7 = T_8 = \frac{T_0}{2} = \frac{0.846}{2} = 0.423\,ms$$

↗ nul vektori

2004:

	c	b	a
V_8	0	0	0
V_3	0	1	0
V_2	0	1	1
V_7	1	1	1



$T_c = T_7 = 0.423\ \mu s$

$t_0 = T_c - T_8 = 1.077\ \mu s$

$t_x = T_5 - T_8 - T_3 = 0.5n2\ \mu s$