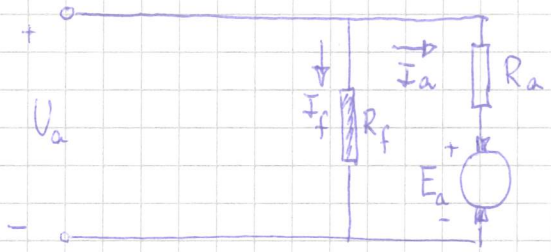
9.1 LM - shuntmagn.

9.1*

$U_a = 240\,V$ - konst. ; $R_a = 0{,}42\,\Omega$

Belastning: $I_a = 35\,A$; $n = 1475$ rpm

$n_0 = ?$; P_0 - försummas



U_a = konst → I_f = konst →

→ ϕ = konst

$E_a = k\,\omega\,\phi$

$E_a = U_a - R_a I_a = 240 - 0{,}42 \cdot 35 = 240 - 14{,}7 = 225{,}3\,V$

$225{,}3 = k\,\phi\,\omega$

$$k\,\phi = \frac{225{,}3 \cdot 60}{2\pi \cdot 1475} = 1{,}46$$

Vid tomgång gäller att $E_0 = U_0 = 240\,V$

$240 = k\,\phi\,\omega_0 \Rightarrow$ $$n_0 = \frac{60\,\omega_0}{2\pi} = \frac{60 \cdot 240}{2\pi \cdot 1{,}46} = 1571\ \text{rpm}$$

9.2 LM som i 9.1

9.2*

$$T = k \phi I_a$$

$$T_1 = k \phi \cdot 35$$

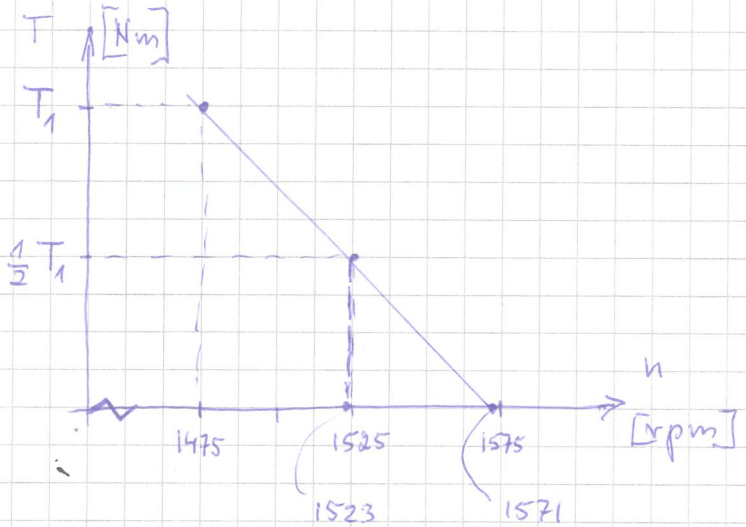
$$T_2 = \frac{1}{2} T_1 = k \phi I_{a2}$$

$$I_{a2} = \frac{1}{2} \cdot 35 = 17{,}5\ A \qquad n_2 = ?$$

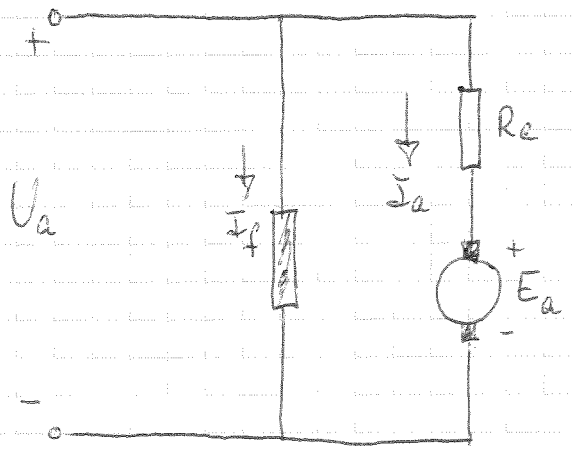
$$E_{a2} = 240 - 0{,}42 \cdot 17{,}5 = 232{,}65\ V$$

$$\left.\begin{aligned} E_{a2} &= k \phi \omega_2 \\ E_{a1} &= k \phi \omega_1 \end{aligned}\right\} \quad \omega_2 = \frac{E_{a2}}{E_{a1}} \omega_1 \Rightarrow$$

$$\Rightarrow n_2 = \frac{E_{a2}}{E_{a1}} n_1 = \frac{232{,}65}{225{,}3} \cdot 1475 = 1523\ rpm$$



9.3



T - konst

$U_a = 240\,V$ $\quad R_{a1} = 0{,}6\,\Omega$

$I_{a1} = 25\,A$ $\quad n_1 = 1100\,rpm$

$I_{a2} = ?$ $\quad n_2 = 900\,rpm$

$R_{a2} = ?$ $\quad (R_{a2} = R_{a1} + R)$

$R = ?$

$T = konst$

$U \rightarrow I_f \rightarrow \phi = konst$ $\Big\}$ $I_a = konst$ $\quad I_{a1} = I_{a2} = I_a$

$$E_{a1} = U_a - R_{a1} I_a = 240 - 0{,}6 \cdot 25 = 225\,V$$

$E_{a1} = k \phi \omega_1$

$E_{a2} = k \phi \omega_2$ $\Big\}$ $\quad E_{a2} = E_{a1} \dfrac{n_2}{n_1}$

$$E_{a2} = 225 \cdot \frac{900}{1100} = 184{,}1\,V$$

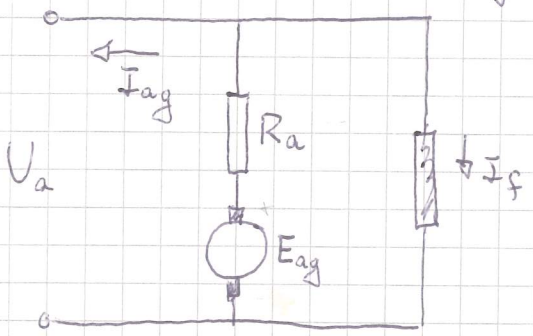
$$E_{a2} = U_a - R_{a2} I_a \Rightarrow R_{a2} = \frac{U - E_{a2}}{I_a} = \frac{240 - 184{,}1}{25} = 2{,}24\,\Omega$$

$$R = R_{a2} - R_{a1} = 1{,}64\,\Omega$$

9.4

9.4*

Generatordrift:



$U_a = 220\ V$

$I_{ag} = 120\ A$; $n_g = 950\ rpm$

I_f – försummas

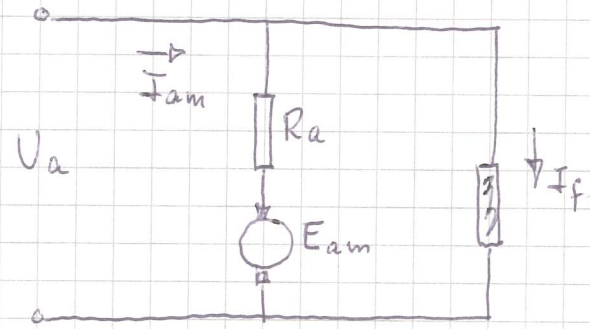
$$E_{ag} = U_a + R_a I_{ag} = 220 + 120 R_a$$

$$E_{ag} = k \phi_g \cdot \omega_g = k \phi_g \frac{\pi \cdot 950}{30}$$

momentet utv. av maskinen verkar bromsande →

→ riktat mot rotationen

Motordrift:



$U_a = 220\ V$

$I_{am} = 10\ A$; $n_m = 890\ rpm$

$$E_{am} = U_a - R_a I_{am} = 220 - 10 R_a$$

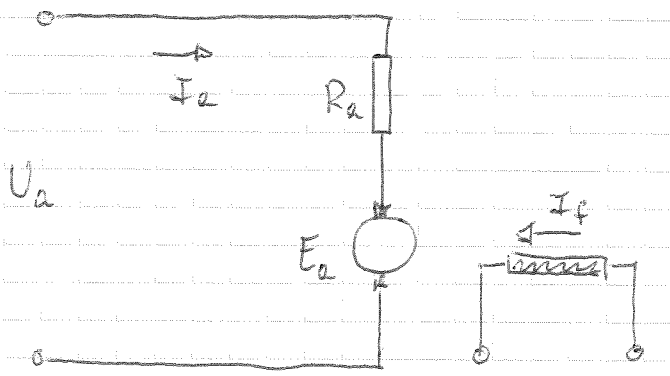
$$E_{am} = k \phi_m \cdot \frac{\pi \cdot 890}{30}$$

men U_a = konst → I_f = konst → ϕ = konst → $\phi_g = \phi_m$

$$\frac{220 + 120 R_a}{220 - 10 R_a} = \frac{k \phi_g \cdot 950}{k \phi_m \cdot 890}$$

$$R_a = \frac{132}{1163} = 0{,}1135\ \Omega$$

9.5 LM - sep. magn. 9.5*



$100 < U_a < 300$ V

$1{,}2 < I_f < 2{,}0$ A

Belastning:

$P \sim n^2$; $P = k_b n^2$

$U_a = 200$ V ; $n = 800$ rpm ; $I_a = 20$ A ; $I_f = 1{,}5$ A

Alla förluster försummas $\Rightarrow$ $R_a = 0$; $E_a = U_a$

a) $? \leq n \leq ?$

b) $? \leq I_a \leq ?$

$$P = E_a I_a = 200 \cdot 20 = 4000 \text{ W} \Rightarrow k_b = \frac{P}{n^2} = \frac{4000}{800^2} = \frac{1}{160}$$

$$E_a = k \omega \phi = k_\phi \omega I_f \; ; \; 200 = k_\phi \frac{2\pi \cdot 800}{60} 1{,}5$$

$$k_\phi = \frac{200}{\frac{2\pi \cdot 800}{60} \cdot 1{,}5} = \frac{1}{6} \frac{60}{2\pi}$$

$$n = \frac{E_a}{k_\phi \frac{2\pi}{60} \cdot I_f} = \frac{E_a}{\frac{1}{6} I_f} \quad [\text{rpm}]$$

$$n_{min} = \frac{U_{amin}}{\frac{1}{6} I_{fmax}} = \frac{100}{\frac{1}{6} \cdot 2} = 300 \text{ rpm}$$

$$\left.\begin{aligned} P_{min} &= U_{amin} \cdot I_{amin} \\ P_{min} &= k_b n_{min}^2 \end{aligned}\right\} \quad I_{amin} = \frac{k_b n_{min}^2}{U_{amin}} = \frac{\frac{1}{160} \cdot 300^2}{100} = 5{,}63 \text{ A}$$

$$n_{max} = \frac{U_{amax}}{\frac{1}{6} I_{fmin}} = \frac{300}{\frac{1}{6} \cdot 1{,}2} = 1500 \text{ rpm}$$

9.5

$$\left.\begin{aligned} P_{max} &= V_{amax} \cdot I_{amax} \\ P_{max} &= k_b \cdot n_{max}^2 \end{aligned}\right\} \quad I_{amax} = \frac{\frac{1}{160} \cdot 1500^2}{300} = 46{,}88\ A$$

$$300 \leq n \leq 1500 \quad rpm$$

$$5{,}63 \leq I_a \leq 46{,}88 \quad A$$

9.6

$I_{amax} = 40A$

9.6*

$I_{amax} = 40A$

$V_{amax} = 300V$

$P_{max} = V_{amax} \cdot I_{amax} = 40 \cdot 300 = 12000\,W$

$P = k_b n^2 \quad ; \quad k_b = \frac{1}{160}$

$12000 = \frac{1}{160} n^2$

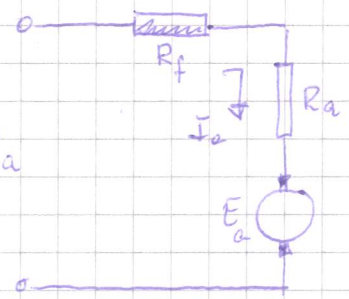
$n = \sqrt{160 \cdot 12000} \approx 1386\ rpm$

$300 \leq n \leq 1386 \quad rpm$

$5{,}63 \leq I_a \leq 40 \quad A$

9.7 LM - seriemagn. 9.7

Märkdata: $U_{an} = 240\,V$; $I_{an} = 36\,A$; $n_n = 1800\,rpm$



$R_a = 0{,}67\,\Omega$

Märkdrift:

$E_a = U_{an} - R_a I_{an} = 240 - 0{,}67 \cdot 36 = 215{,}9\,V$

$E_a = k\,\omega\,\phi = k_\phi\,\omega\,I_a$

$215{,}9 = k_\phi \frac{2\pi \cdot 1800}{60} \cdot 36$ 1)

a) Driftfall 1: $U_a = 240\,V$; $I_{a1} = 30\,A$; $n_1 = ?$

$E_{a1} = 240 - 0{,}67 \cdot 30 = 220\,V$

$E_{a1} = k_\phi\,\omega_1\,I_{a1} \Rightarrow 220 = k_\phi \frac{2\pi n_1}{60} \cdot 30$ 2)

Av 1) och 2):

$$\underline{\underline{n_1}} = \frac{1800 \cdot 36 \cdot 220}{30 \cdot 215{,}9} \approx \underline{\underline{2200\ rpm}}$$

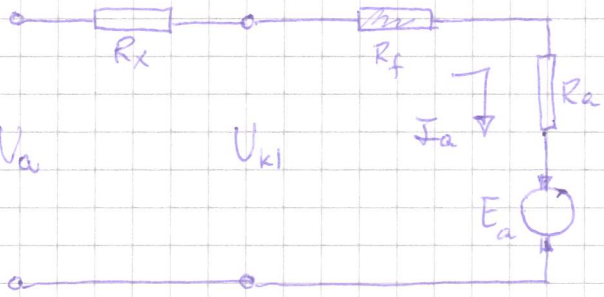
b) c)

Driftfall 2:

$T = k\phi I_a = k_\phi I_a^2$

Belastning: $T = k_b n^2 \Rightarrow k_\phi I_a^2 = k_b n^2 \Rightarrow I_a = \alpha \cdot n$

Enl. driftfall 1: $30 = \alpha \cdot \overset{(2200)}{n_1} \Rightarrow \alpha = \frac{3}{220}$



$n_2 = 1200\,rpm$

$I_{a2} = \alpha \cdot n_2 = \frac{3}{220} \cdot 1200 = 16{,}4\,A$

Enl. driftfall 1: $E_{a1} = k\,\omega_1\,I_{a1} = k \frac{2\pi \cdot 2200}{60} \cdot 30 = 220\,V$

$E_{a2} = k\,\omega_2\,I_{a2} = k \frac{2\pi \cdot 1200}{60} \cdot 16{,}4 = ?$

$\Rightarrow$

9.7

$$\frac{E_{a2}}{220} = \frac{1200 \cdot 16,4}{2200 \cdot 30,0}$$

$$E_{a2} = \frac{220 \cdot 1200 \cdot 16,4}{2200 \cdot 30} = 65,6\ V$$

$$E_{a2} = U_a - R\, I_{a2}$$

$$R = \frac{U_a - E_{a2}}{I_{a2}} = \frac{240 - 65,6}{16,4} = 10,63\ \Omega$$

$$R_x = R - R_a = 10,63 - 0,67 = 9,96 \approx 10,0\ \Omega$$

$$U_{k1} = U_2 - R_x I_{a2} = 240 - 9,96 \cdot 16,4 = 76,7\ V$$

$$U_{k2} = E_{a2} + R_a I_{a2} = 65,6 + 0,67 \cdot 16,4 = 76,6\ V$$

9.8 9.8*

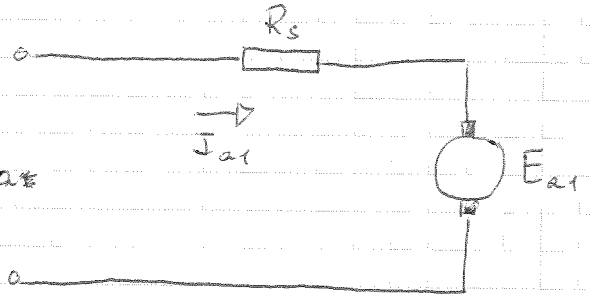
Seriemotor (LM)

$R_{s1} = 1\,\Omega = R_f + R_a$

$U_a = 200\ V$; $n_1 = 800\,rpm$; $I_{a1} = 15\,A$

$n_2 = ?$ då $R_{s2} = R_{s1} + 5 = 6\,\Omega$; $I_{a2} = I_{a1} = I_a$

1)



$I_f = I_a$

$E_{a1} = U_a - R_{s1} I_{a1} = 200 - 1 \cdot 15 = 185\ V$

$E_{a1} = k \cdot \omega_1 \cdot \phi_1 = k\phi\, \omega_1 I_{a1}$

$185 = k\phi \cdot \frac{2\pi \cdot 800}{60} \cdot 15 \Rightarrow k\phi = \frac{185 \cdot 60}{2\pi \cdot 800 \cdot 15} = \frac{15{,}42 \cdot 10^{-3}}{2\pi}$

2) $E_{a2} = 200 - 6 \cdot 15 = 110\ V$

$E_{a2} = k\phi\, \omega_2 I_{a2} = k\phi \frac{2\pi n_2}{60} I_{a2} = 110$

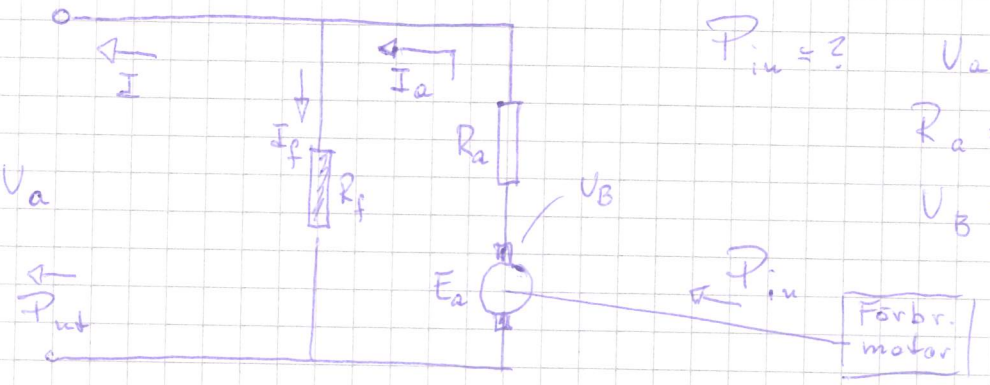
$n_2 = \frac{110 \cdot 60}{15 \cdot 2\pi} \cdot \frac{2\pi}{60 \cdot 15{,}42 \cdot 10^{-3}} \approx 476\,rpm$

9.9

LM - shuntmagn.

itbromsning - LM som generator

9.9*



$P_{in} = ?$ $\quad U_a = 110\,V$; $I = 58\,A$

$R_a = 0{,}05\,\Omega$; $R_f = 55\,\Omega$

$U_B = 2\,V$

Förbränningsmotorns avgivna effekt = shuntgeneratorns tillförda effekt (P_{fr}-förlusterna försummas)

Sök P_{in} genom att summera alla effekter:

$$P_{in} = P_{ut} + P_f + P_{Cu} + P_B =$$

$$= U_a I + \frac{U_a^2}{R_f} + R_a I_a^2 + U_B I_a =$$

$$= U_a I + \frac{U_a^2}{R_f} + R_a \left(I + \frac{U_a}{R_f}\right)^2 + U_B \left(I + \frac{U_a}{R_f}\right) =$$

$$= 110 \cdot 58 + \frac{110^2}{55} + 0{,}05\left(58 + \frac{110}{55}\right)^2 + 2\left(58 + \frac{110}{55}\right) =$$

$$= 6380 + 220 + 180 + 120 = 6900\,W = \underline{6{,}9\,kW}$$

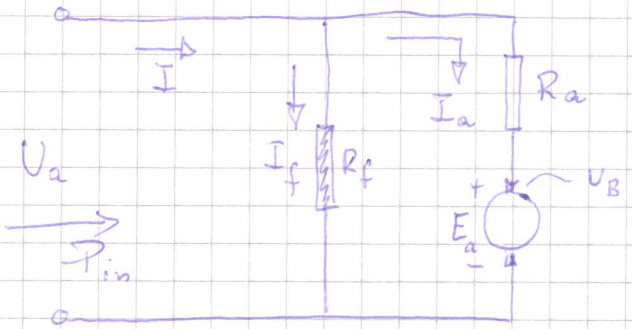
9.10 9.10

LM - shuntmaskin.

$U_a = 440\,V$; $n_m = 1400\,rpm$; $P_{in} = 9240\,W$

$R_f = 440\,\Omega$; $R_a = 0{,}9\,\Omega$; $U_B = 2\,V$

$n_g = ?$ $I_{ag} = 20\,A$



$P_{in} = U_a I \Rightarrow I = \frac{9240}{440} = 21\,A$

$I_f = \frac{U_a}{R_f} = \frac{440}{440} = 1\,A$

$I_a = I - I_f = 20\,A$

$E_{am} = U_a - R_a I_a - U_B = 440 - 0{,}9 \cdot 20 - 2 = 420\,V$ $(n_m = 1400\,rpm)$

Vid generatordrift växlar I_a riktning : $I_{ag} = 20\,A$

$E_{ag} = U_a + R_a I_a + U_B = 440 + 0{,}9 \cdot 20 + 2 = 460\,V$

$E_{am} = k\,\omega_m\,\Phi_m$

$E_{ag} = k\,\omega_g\,\Phi_g$ $\Phi_m = \Phi_g$ då I_f oförändrad

$n_g = \frac{E_{ag}}{E_{am}}\,n_m = \frac{460}{420} \cdot 1400 = 1533\,rpm$