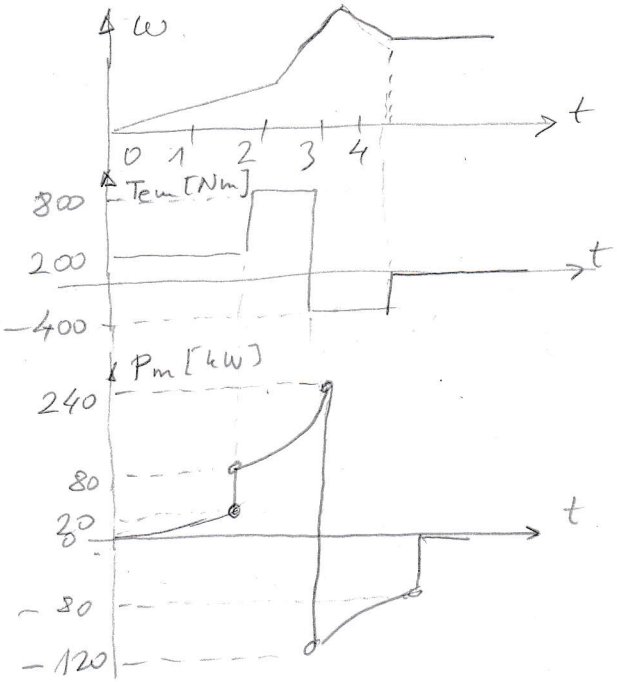
(1.) $J_\Sigma = J_M + J_L = 1{,}5 + 2{,}5 = 4\ kg\,m^2$.

$$T_{em} = J_\Sigma \cdot \frac{d\omega}{dt}$$

$T_{em}(02) = 4 \cdot \frac{100}{2} = 200\ Nm$; $P_M = T_{em}(02) \cdot \omega(t) = [0 \ldots 20kW]$

$T_{em}(23) = 4 \cdot \frac{200}{1} = 800\ Nm$; $P_M = T_{em}(23) \cdot \omega(t) = [80kW \ldots 240kW]$

$T_{em}(34) = 4 \left(-\frac{100}{1}\right) = -400\ Nm$; $P_M = T_{em}(34)\,\omega(t) = [-120kW \ldots -80kW]$



(2.) $T_L = k_T I_a \Rightarrow I_a = \frac{T_L}{k_T} = \frac{4{,}5}{0{,}35} = \underline{12{,}86\ A}$

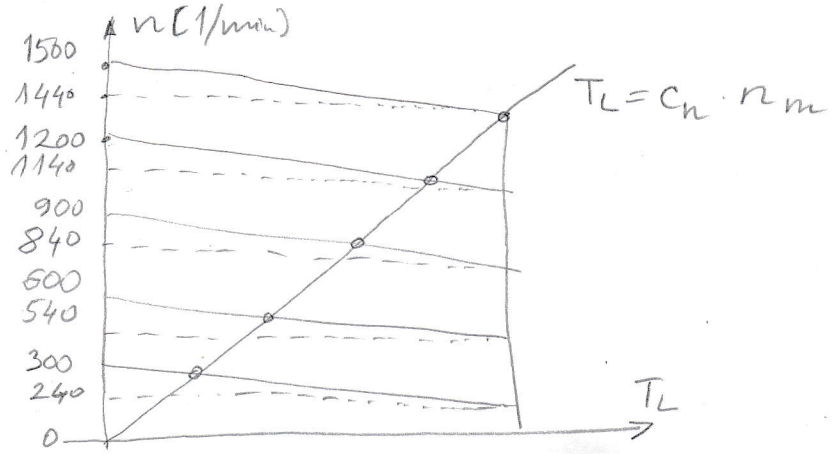
$EMS = k_E \cdot \omega = k_E \cdot n \cdot \frac{2\pi}{60} = 0{,}9 \cdot 1200 \frac{2\pi}{60} = \underline{113{,}1\ V}$

$V_a = R_a I_a + EMS = 0{,}2 \cdot 12{,}86 + 113{,}1 = \underline{115{,}7\ V}$

(3.) $n_{syn,\,rated} = \frac{50 \cdot 60}{p/2} = 1500\ 1/min$

$n_{rated} = 1440$

$n_{slip,\,rated} = 1500 - 1440 = 60\ 1/min$



$$T_{em} = k_{Tn}(n_{syn} - n_m)$$

$$T_{em,rated} = \frac{P}{\omega_{rated}} = \frac{6000}{\frac{n_{rated}}{60} \cdot 2\pi} = 39{,}8\ Nm$$

$$T_{em,rated} = k_{Tn} \cdot (1500 - 1440) \Rightarrow k_{Tn} = \frac{39{,}8}{60} = 0{,}663\ \frac{Nm}{1/min}$$

$$T_{em} = T_L = C_n n_m \Rightarrow C_n = \frac{T_{L,rated}}{n_{m,rated}} = \frac{39{,}8}{1440} = 0{,}0276\ \frac{Nm}{1/min}$$

$$k_{Tn}(n_{syn} - n_m) = C_n n_m$$

$$k_{Tn} n_{syn} - k_{Tn} n_m = C_n n_m$$

$$n_m (C_n + k_{Tn}) = k_{Tn} n_{syn}$$

$$n_{syn1} = 1500 \Rightarrow n_{m1} = \frac{k_{Tn} \cdot n_{syn1}}{C_n + k_{Tn}} = \frac{0{,}663 \cdot 1500}{0{,}0276 + 0{,}663} = 1440\ 1/min$$

$$n_{syn2} = 1200 \Rightarrow n_{m2} = \frac{0{,}663 \cdot 1200}{0{,}0276 + 0{,}663} = 1152\ 1/min$$

$$n_{syn3} = 900 \Rightarrow n_{m3} = \frac{0{,}663 \cdot 900}{0{,}0276 + 0{,}663} = 864\ 1/min$$

$$n_{syn4} = 600 \Rightarrow n_{m4} = \frac{0{,}663 \cdot 600}{0{,}0276 + 0{,}663} = 576\ 1/min$$

$$n_{syn5} = 300 \Rightarrow n_{m5} = \frac{0{,}663 \cdot 300}{0{,}0276 + 0{,}663} = 288\ 1/min$$