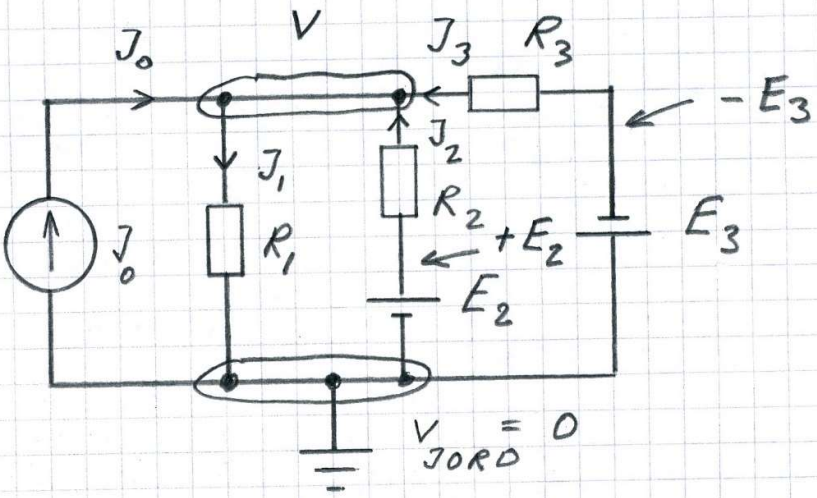
Lösningsförslag till tentamen TSFS13 Elektroteknik 2025-06-04

1. NODANALYS:



$$J_1 = \frac{V-0}{R_1} \quad \ldots (1)$$

$$J_0 - J_1 + J_2 + J_3 = 0 \rightarrow$$

$$J_0 - \frac{V-0}{R_1} + \frac{E_2 - V}{R_2} + \frac{-E_3 - V}{R_3} = 0$$

$$\rightarrow V = +2{,}25\ V$$

INS. (1) $\rightarrow$ $J_1 = 1{,}5\ A$

2a)

OM KONDENSATORN ÄR BORTKOPPLAD

$$\underline{I} = \frac{\underline{U}}{R + j\omega L}$$

$$\underline{I} = \frac{230\sqrt{2} \cdot e^{j0^\circ}}{24 + j100\pi \cdot 0{,}10} \approx 5{,}8\sqrt{2}\, e^{-j53^\circ} \text{ A}$$

$$\underline{i(t) = 5{,}8\sqrt{2} \sin(100\pi t - 53^\circ) \text{ A}}$$

$$P = R \cdot I^2 \rightarrow P = 24 \cdot 5{,}8^2 \approx \underline{0{,}81 \text{ kW}}$$

$$Q = Q_L = \omega L \cdot I^2 \rightarrow Q = 100\pi \cdot 0{,}10 \cdot 5{,}8^2 \approx \underline{1{,}1 \text{ kVAr}}$$

2b) OM KONDENSATORN ÄR INKOPPLAD

$Q = Q_L - Q_C$ DÄR

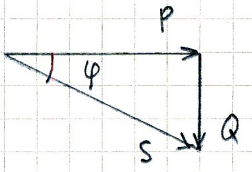
$$Q_C = \frac{U^2}{X_C} = / X_C = \frac{1}{\omega C} / = \omega C U^2$$

$$Q_C = 314 \cdot 150 \cdot 10^{-6} \cdot 230^2 = 2{,}5 \text{ kVAr}$$

$$Q = 1{,}1 - 2{,}5 \approx \underline{-1{,}4 \text{ kVAr}}$$

STRÖMMEN GENOM R OCH L PÅVERKAS INTE OM C KOPPLAS IN DVS. P ÄR DENSAMMA SOM FÖRUT.

$\underline{P = 0{,}81 \text{ kW}}$



SKENBARA EFFEKTEN

$$S = \sqrt{P^2 + Q^2} \Rightarrow S \approx 1{,}6 \text{ kVA}$$

$$S = U \cdot J \Rightarrow 1{,}6 \cdot 10^3 = 230 \cdot J \rightarrow J = 7{,}0 \text{ A}$$

$$\tan\varphi = \frac{Q}{P} \rightarrow \varphi \approx -60^\circ$$

$\varphi = \arg \mathcal{U} - \arg \mathcal{I}$ $\quad -60^\circ = 0^\circ - \arg \mathcal{I}$

$\rightarrow \arg \mathcal{I} = 60^\circ$

ALLTSÅ $\underline{i(t) \approx 7{,}0\sqrt{2}\sin(100\pi t + 60^\circ) \text{ A}}$

3a)

$$\frac{N_1}{N_2} = \frac{\hat{U}_1}{\hat{U}_2} = \frac{\hat{U}_1}{U_C + 2 \cdot 0{,}70}$$

$$\Rightarrow \frac{N_1}{N_2} = \frac{230\sqrt{2}}{15 + 1{,}4} \approx \underline{\underline{20}}$$

3b)

$$U_C - R \cdot J_R - U_Z = 0 \quad \ldots (1)$$

$$P_{ZMAX} = U_Z \cdot J_{ZMAX} \quad \ldots (2)$$

$$(2) \Rightarrow 2{,}0 = 12 \cdot J_{ZMAX} \rightarrow J_{ZMAX} \approx 0{,}17\,A$$

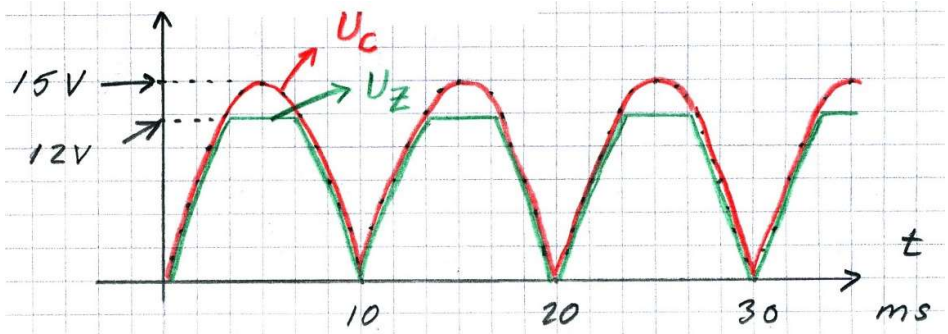
"NÄR LAST SAKNAS BLIR J_Z MAXIMAL OCH LIKA MED J_R."

$$(1) \Rightarrow 15 - R \cdot 0{,}17 - 12 = 0$$

$$\Rightarrow \underline{\underline{R = 18\ \Omega}} \ (R_{MIN})$$

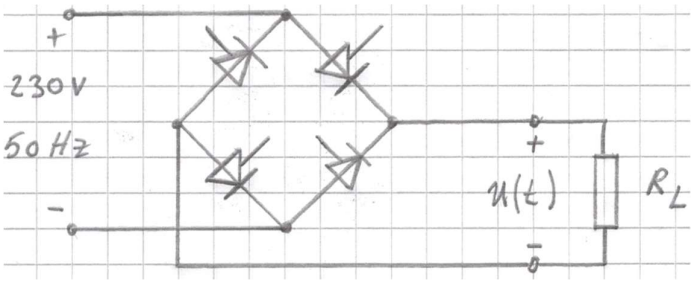
3c)

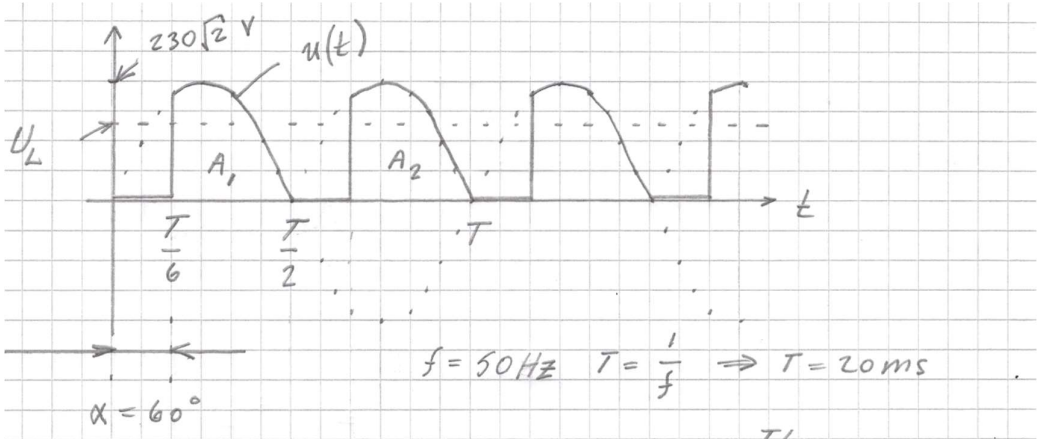
TIDSDIAGRAM FÖR U_C OCH U_Z DÅ GLÄTTNINGSKONDENSATORN GÅTT SÖNDER.



$\omega = 100\pi$ RAD/S $\quad \omega = \frac{2\pi}{T} \rightarrow T = 20\,ms$

4a)





$f = 50\,Hz \quad T = \frac{1}{f} \Rightarrow T = 20\,ms$

$$U_L = \frac{1}{T}\int_0^T u(t)\,dt = \left| A_1 = A_2 \right| = \frac{2}{T}\int_{T/6}^{T/2} 230\sqrt{2}\sin(\omega t)\,dt =$$

$$= \left| \omega = \frac{2\pi}{T} \rightarrow T = \frac{2\pi}{\omega} \right| = \frac{2\omega}{2\pi}\int_{\frac{\pi}{3\omega}}^{\pi/\omega} 230\sqrt{2}\sin(\omega t)\,dt =$$

$$= \frac{\cancel{2\omega}}{\pi} \cdot 230\sqrt{2}\left[\frac{-\cos(\omega t)}{\cancel{\omega}}\right]_{\frac{\pi}{3\omega}}^{\pi/\omega} =$$

$$= \frac{230\sqrt{2}}{\pi}\left[-\cos\pi + \cos\frac{\pi}{3}\right] \approx \underline{\underline{155\ V}}$$

4b)

$\alpha = MAX\ (180°) \Rightarrow U_L = 0$

$\alpha = MIN\ (0°) \Rightarrow$

$$U_L = \frac{1}{T}\int_0^T u(t)\,dt = |A_1 = A_2| = \frac{2}{T}\int_0^{T/2} 230\sqrt{2}\sin(\omega t)\,dt =$$

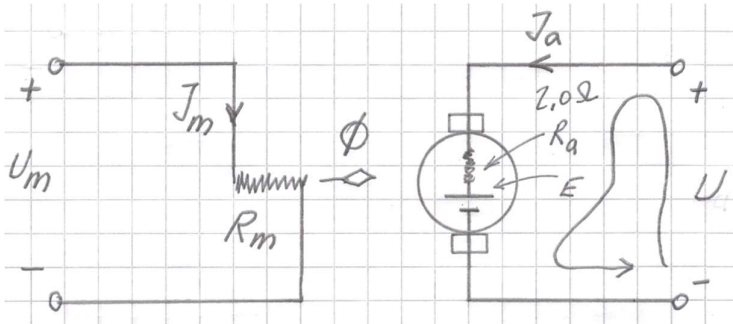
$$= \left| \omega = \frac{2\pi}{T} \Rightarrow T = \frac{2\pi}{\omega} \right| = \frac{2\omega}{2\pi}\int_0^{\frac{\pi}{\omega}} 230\sqrt{2}\sin(\omega t)\,dt =$$

$$= \frac{230\sqrt{2}\,\omega}{\pi}\left[\frac{-\cos(\omega t)}{\omega}\right]_0^{\frac{\pi}{\omega}} =$$

$$= \frac{230\sqrt{2}}{\pi}\left[-\cos\pi + \cos 0\right] \approx 207\ V$$

ALLTSÅ $\underline{0V < U_L < 207\ V}$

5. Separatmagnetiserad likströmsmotor



FALL I

$U_I = 200\ V$

$J_{aI} = 10\ A$

$E_I = ?$

$n_I = 1000\ RPM$

FALL II

$U_{II} = 170\ V$

$J_{aII} = ?$

$E_{II} = ?$

$n_{II} = ?$

a) SAMMA MOMENT OCH MAGNETISKT FLÖDE I DE TVÅ FALLEN.

$$\left.\begin{aligned} M &= k_2 \Phi J_{aI} \\ M &= k_2 \Phi J_{aII} \end{aligned}\right\} \Rightarrow J_{aII} = J_{aI} = \underline{10A}$$

b) KIRCHHOFFS SPÄNNINGSLAG →

$$+U_I - R_a J_{aI} - E_I = 0 \rightarrow E_I = \underline{180V}$$

$$+U_{II} - R_a J_{aII} - E_{II} = 0 \rightarrow E_{II} = \underline{150V}$$

c) $$\frac{E_I}{E_{II}} = \frac{k_1 \Phi n_I}{k_1 \Phi n_{II}} \rightarrow n_{II} = \underline{833\ RPM}$$