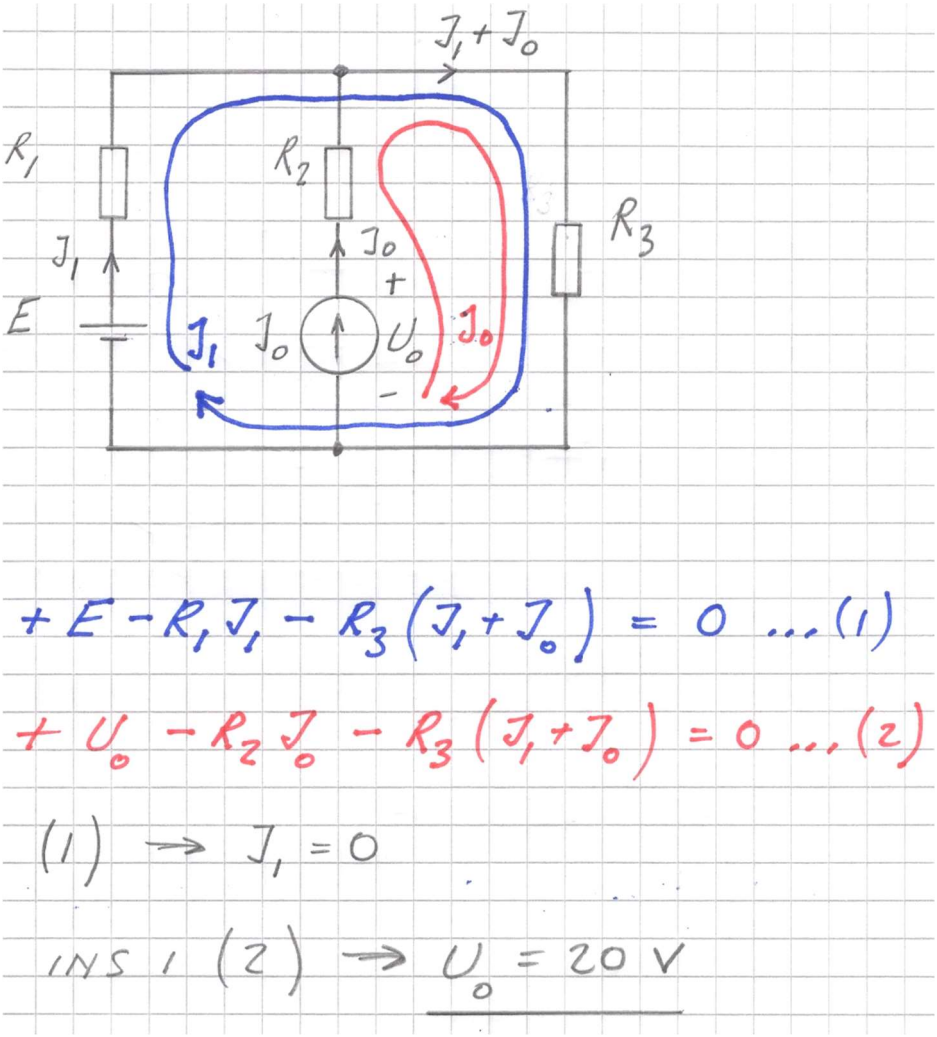
Lösningsförslag till tentamen TSFS13 Elektroteknik 2024-01-02

1.



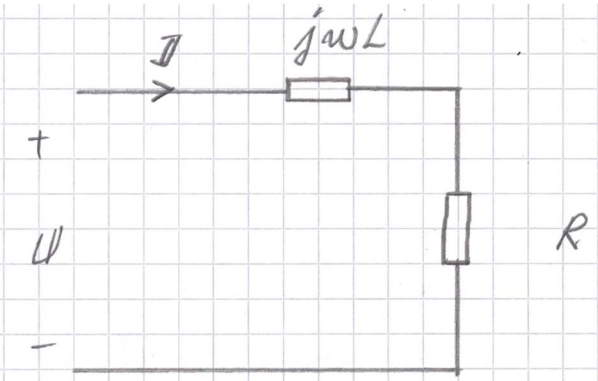
$$+E - R_1 J_1 - R_3 (J_1 + J_0) = 0 \quad \ldots (1)$$

$$+U_0 - R_2 J_0 - R_3 (J_1 + J_0) = 0 \quad \ldots (2)$$

$(1) \rightarrow J_1 = 0$

INS I $(2) \rightarrow \underline{U_0 = 20\ \text{V}}$

2a)



$$u(t) = 230\sqrt{2}\sin(100\pi t + 0^\circ)\,V \rightsquigarrow \underline{U} = 230\sqrt{2}\,e^{j0^\circ}\,V$$

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

$$\underline{I} = \frac{230\sqrt{2}\,e^{j0^\circ}}{24{,}0 + j\,100\pi \cdot 0{,}0573} =$$

$$= \frac{230\sqrt{2}\,e^{j0^\circ}}{\sqrt{24^2 + 18^2}\cdot e^{j\arctan\frac{18}{24}}} = 7{,}67\sqrt{2}\,e^{-j37^\circ}\,A$$

$$\rightsquigarrow i(t) = 7{,}67\sqrt{2}\sin(100\pi t - 37^\circ)\,A$$

2b)

$$I = \frac{\hat{I}}{\sqrt{2}} = 7{,}67\,A$$

$$P = R I^2 \rightarrow \underline{P = 1{,}41\,kW}$$

(Q_L)

$$Q = X_L I^2 = |X_L = \omega L| = \underline{1{,}06\,kVAr}$$

$$S = \sqrt{P^2 + Q^2} \Rightarrow \underline{S = 1{,}76\,kVA}$$

ALTERNATIVT SÄTT ATT RÄKNA:

$P = U \cdot J \cdot \cos\varphi$

$(Q_L)\quad Q = U \cdot J \cdot \sin\varphi$

$S = U \cdot J$

$\varphi = \arg U - \arg J = 37°$

$\uparrow \quad \uparrow$

$0° \quad -37°$

$U = \frac{\hat{U}}{\sqrt{2}} = 230\ V$

2c)

$Q = Q_L - Q_C$

$Q = 0 \Rightarrow Q_C = Q_L$

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

$1{,}06 \cdot 10^3 = 230^2 \cdot 100\pi \cdot C \Rightarrow \underline{C = 63{,}7\ \mu F}$

2d)

$Q = 0 \Rightarrow S = P$ OCH $\cos\varphi = 1 \rightarrow \varphi = 0°$

$S = U \cdot J \rightarrow 1{,}41 \cdot 10^3 = 230 \cdot J$

$\rightarrow J = 6{,}13\ A \quad \hat{J} = 6{,}13\sqrt{2}\ A$

$\Rightarrow \underline{i(t) = 6{,}13\sqrt{2}\sin(100\pi t)\ A}$

($\varphi = 0°$ INNEBÄR ATT $\arg J = \arg U$)

3a)

$$\frac{N_1}{N_2} = \frac{\hat{U}_1}{\hat{U}_2} \quad \text{DÄR} \quad \hat{U}_2 = U_c + 2 \cdot 0{,}70 \text{ V}$$

$$\rightarrow \quad \frac{N_1}{N_2} = \frac{230\sqrt{2}}{15 + 1{,}4} \approx 20 \; (19{,}8)$$

3b) "ÖVRE LÄGET" $\rightarrow$

$$U_z = U_{ut} \cdot \frac{R_3 + R_4}{R_2 + R_3 + R_4}$$

$$5{,}6 = 6{,}6 \cdot \frac{R_3 + R_4}{30000 + R_3 + R_4} \rightarrow$$

$$R_3 + R_4 = 168000 \; \Omega$$

NEDRE "LÄGET" $\rightarrow$

$$U_z = U_{ut} \cdot \frac{R_4}{R_2 + R_3 + R_4}$$

$$5{,}6 = 13{,}2 \cdot \frac{R_4}{30000 + 168000} \rightarrow$$

$$R_4 = 84 \text{ k}\Omega \rightarrow R_3 = 84 \text{ k}\Omega$$

"SPÄNNINGEN ÄR NOLL MELLAN PLUS- OCH MINUSINGÅNGEN PÅ OPERATIONSFÖRSTÄRKAREN."

3c) $U_{OP} - U_{BE} = U_{ut} \rightarrow U_{OP} = U_{ut} + U_{BE}$

$U_{BE} \approx 0{,}70\ V$

$U_{ut} = 6{,}6\ V \rightarrow U_{OP} = 7{,}3\ V$

$U_{ut} = 13{,}2\ V \rightarrow U_{OP} = 13{,}9\ V$

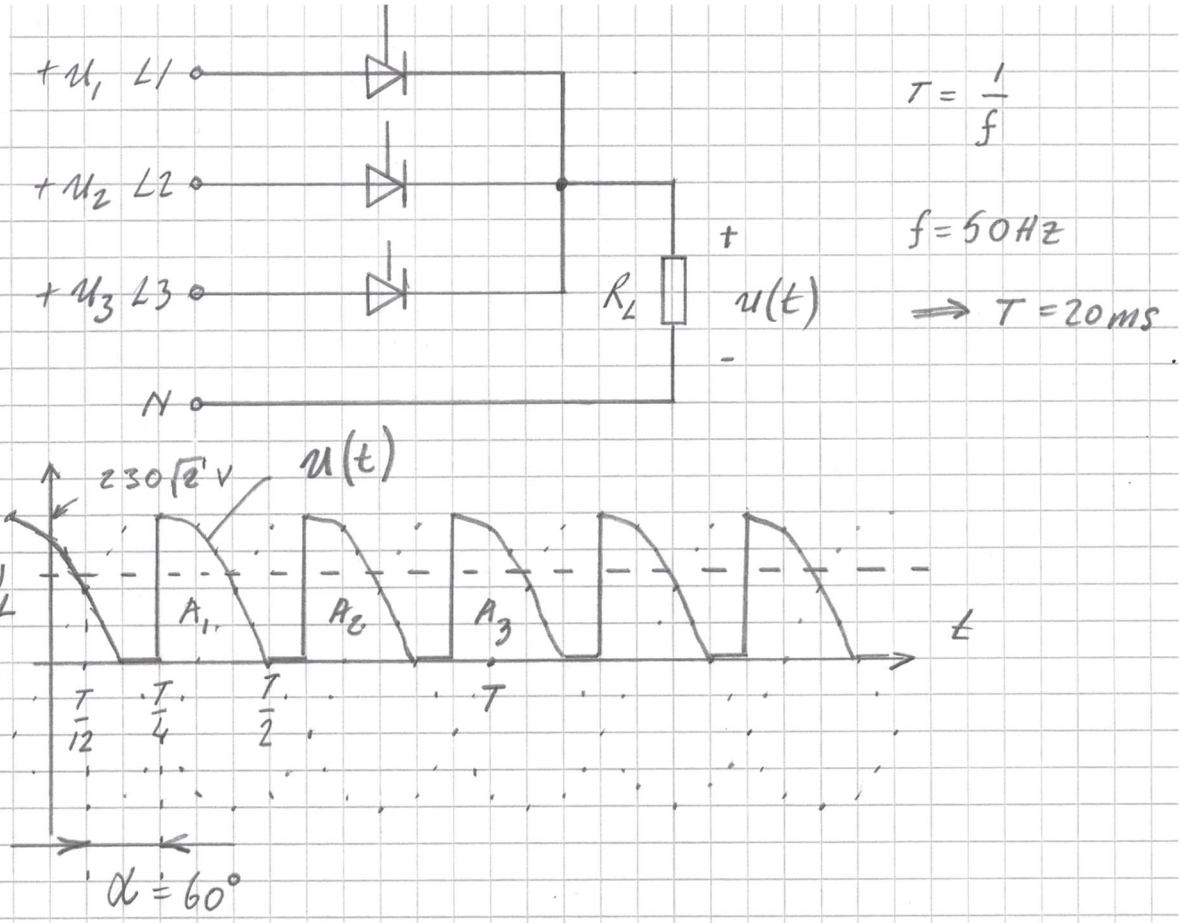
3d) $I_{R1} = I_Z$ "STRÖMMEN IN TILL OP'NS PLUSINGÅNG ÄR NOLL."

$$R_1 = \frac{U_{R1}}{I_{R1}} = \frac{U_{in} - U_Z}{I_Z}$$

$$R_1 = \frac{15 - 5{,}6}{0{,}030} = 313\ \Omega$$

"VÄLJ R_1 STRAX UNDER" 313 Ω

4a)



$$T = \frac{1}{f}$$

$$f = 50\,Hz$$

$$\Rightarrow T = 20\,ms$$

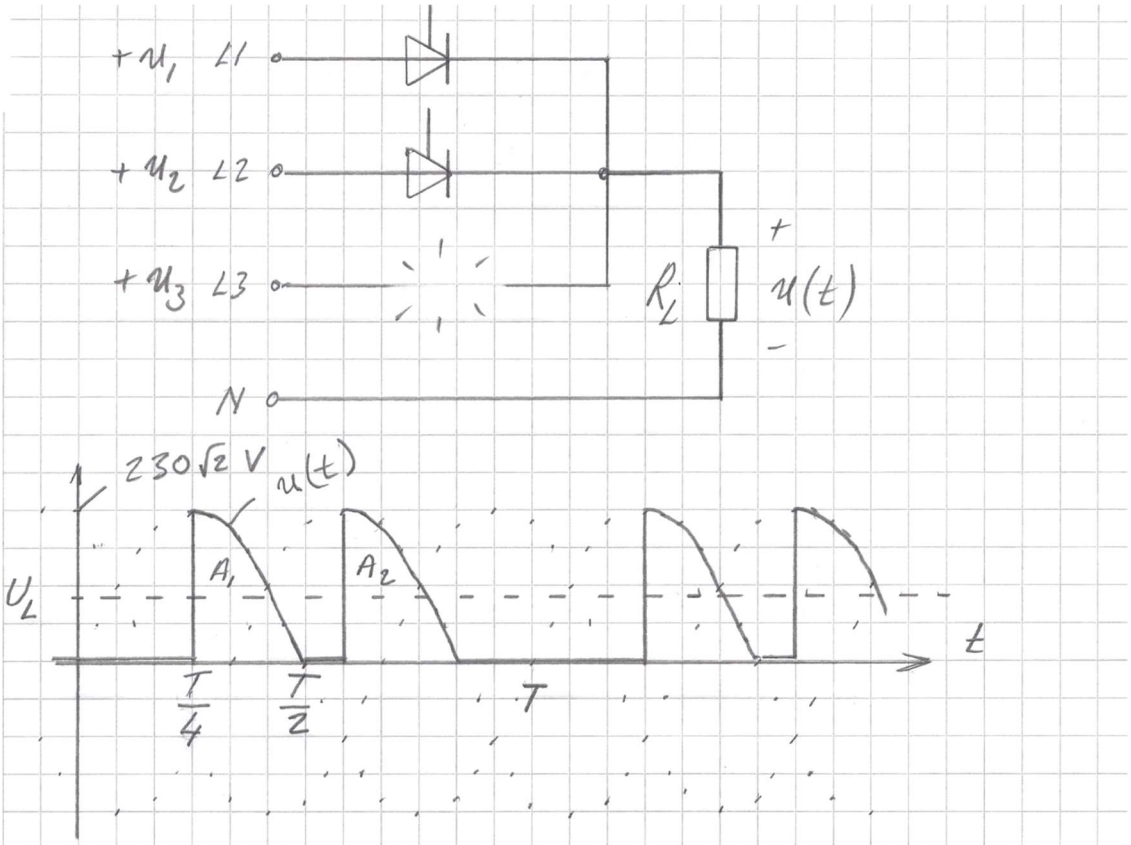
$$\underline{U_L} = \frac{1}{T}\int_0^T u(t)\,dt = \left| A_1 = A_2 = A_3 \right| =$$

$$= \frac{3}{T}\int_{T/4}^{T/2} u(t)\,dt = \frac{3}{T}\int_{T/4}^{T/2} 230\sqrt{2}\sin(\omega t)\,dt =$$

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

$$= 155{,}3\left[-\cos\pi + \cos\frac{\pi}{2}\right] = \underline{155\ V}\ (155{,}3)$$

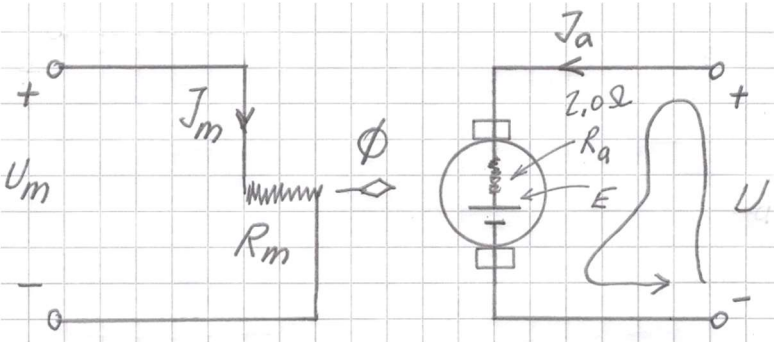
4b)



$$\underline{U_L} = \frac{1}{T}\int_0^T u(t)\,dt = \left| A_1 = A_2 \right| = \frac{2}{T}\int_{T/4}^{T/2} u(t)\,dt =$$

$$= \ldots\ldots \approx \underline{104\ \text{V}} \quad (103{,}5)$$

5. Separatmagnetiserad likströmsmotor



FALL I

$U_I = 200\ V$

$J_{aI} = 10\ A$

$E_I = ?$

$n_I = 1000\ RPM$

FALL II

$U_{II} = 170\ V$

$J_{aII} = ?$

$E_{II} = ?$

$n_{II} = ?$

SAMMA MOMENT OCH MAGNETISKT FLÖDE I DE TVÅ FALLEN.

a) $M = k_2 \Phi J_{aI}$ } $\Rightarrow J_{aII} = J_{aI} = \underline{10A}$
$M = k_2 \Phi J_{aII}$ }

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