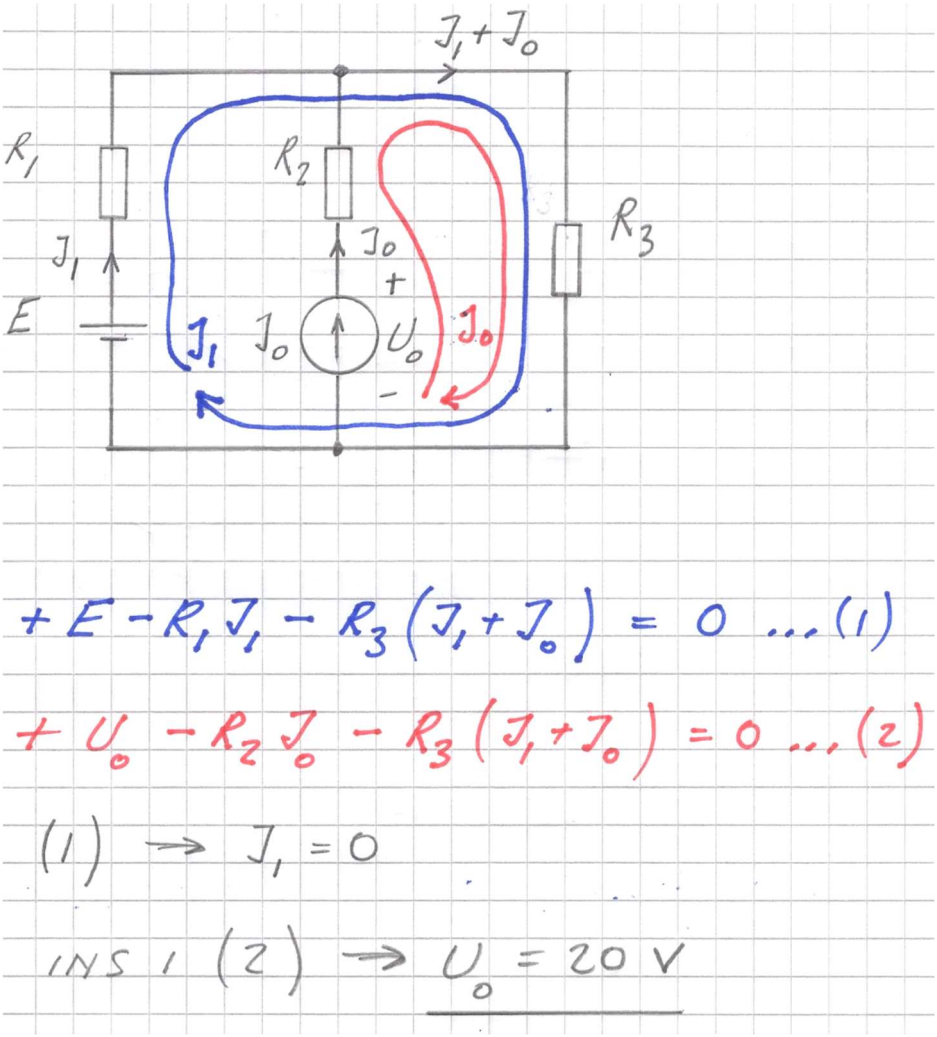
Lösningsförslag till tentamen TSFS13 Elektroteknik 2022-10-20

1.



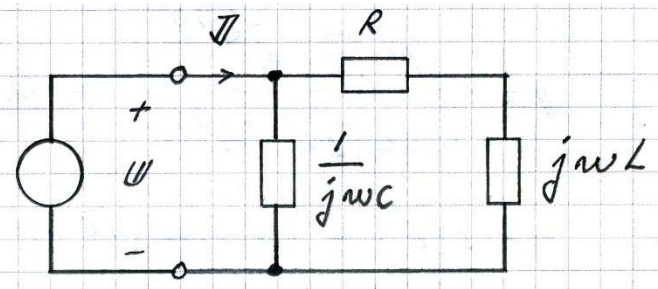
$$+E - R_1 I_1 - R_3 (I_1 + I_0) = 0 \quad \ldots (1)$$

$$+U_0 - R_2 I_0 - R_3 (I_1 + I_0) = 0 \quad \ldots (2)$$

$(1) \rightarrow I_1 = 0$

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

2a)



$$I = \frac{U}{Z} \quad \ldots (1)$$

$$u(t) = 10\sqrt{2} \cdot \sin(1000t - 90°)\ V$$

$$\rightarrow U = 10\sqrt{2}\, e^{-j90°}\ V$$

$$Z = \frac{\frac{1}{j\omega C} \cdot (R + j\omega L)}{\frac{1}{j\omega C} + (R + j\omega L)} =$$

$$= \frac{R + j\omega L}{1 + j\omega CR - \omega^2 CL} \rightarrow$$

$$Z = \frac{1000 + j1000}{1 + j - 1} =$$

$$= 1000 - j1000 = 1000\sqrt{2} \cdot e^{-j45°}\ \Omega$$

INSÄTTNING i (1) $\Rightarrow$

$$\underline{J} = \frac{10\sqrt{2}\cdot e^{-j90^\circ}}{1000\sqrt{2}\cdot e^{-j45^\circ}} = 0{,}010\, e^{-j45^\circ}\ A$$

$$\Rightarrow \underline{i(t) = 10\sin(1000t - 45^\circ)\ mA}$$

b)

$S = U \cdot J \quad \ldots (2)$

$P = S \cdot \cos\varphi \quad \ldots (3)$

$Q = S \cdot \sin\varphi \quad \ldots (4)$

$\hat{U} = 10\sqrt{2}\ V \rightarrow U = 10\ V$

$\hat{J} = 10\ mA \rightarrow J = \frac{10}{\sqrt{2}}\ mA$

$\varphi = \arg U - \arg J \rightarrow$

$\varphi = -90^\circ - (-45^\circ) = -45^\circ$

EFFEKTFAKTORN

$\cos\varphi = \cos(-45^\circ) \approx \underline{0{,}71}$

$(2) \rightarrow S = 10 \cdot \frac{10}{\sqrt{2}}\ mVA \approx \underline{71\ mVA}$

$(3) \rightarrow P = 71 \cdot 0{,}71\ mW = \underline{50\ mW}$

$(4) \rightarrow Q = 71 \cdot (-0{,}71)\ mVAr = \underline{-50\ mVAr}$

3a)

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

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

b)

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

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

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

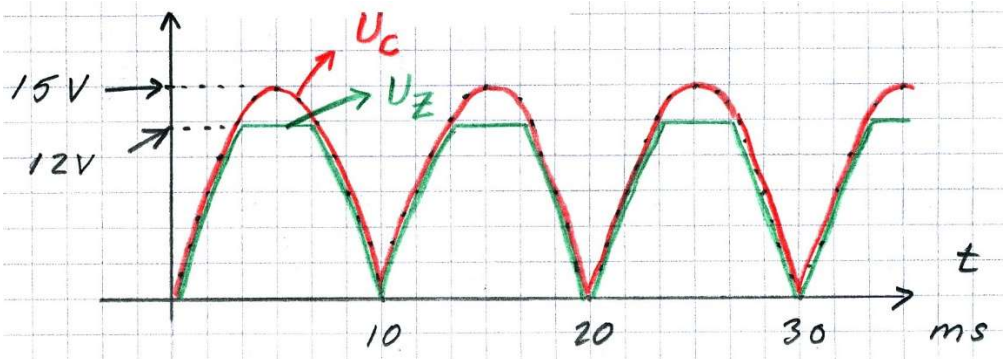
"NÄR LAST SAKNAS BLIR J_Z MAXIMAL OCH LIKA MED J_R."

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

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

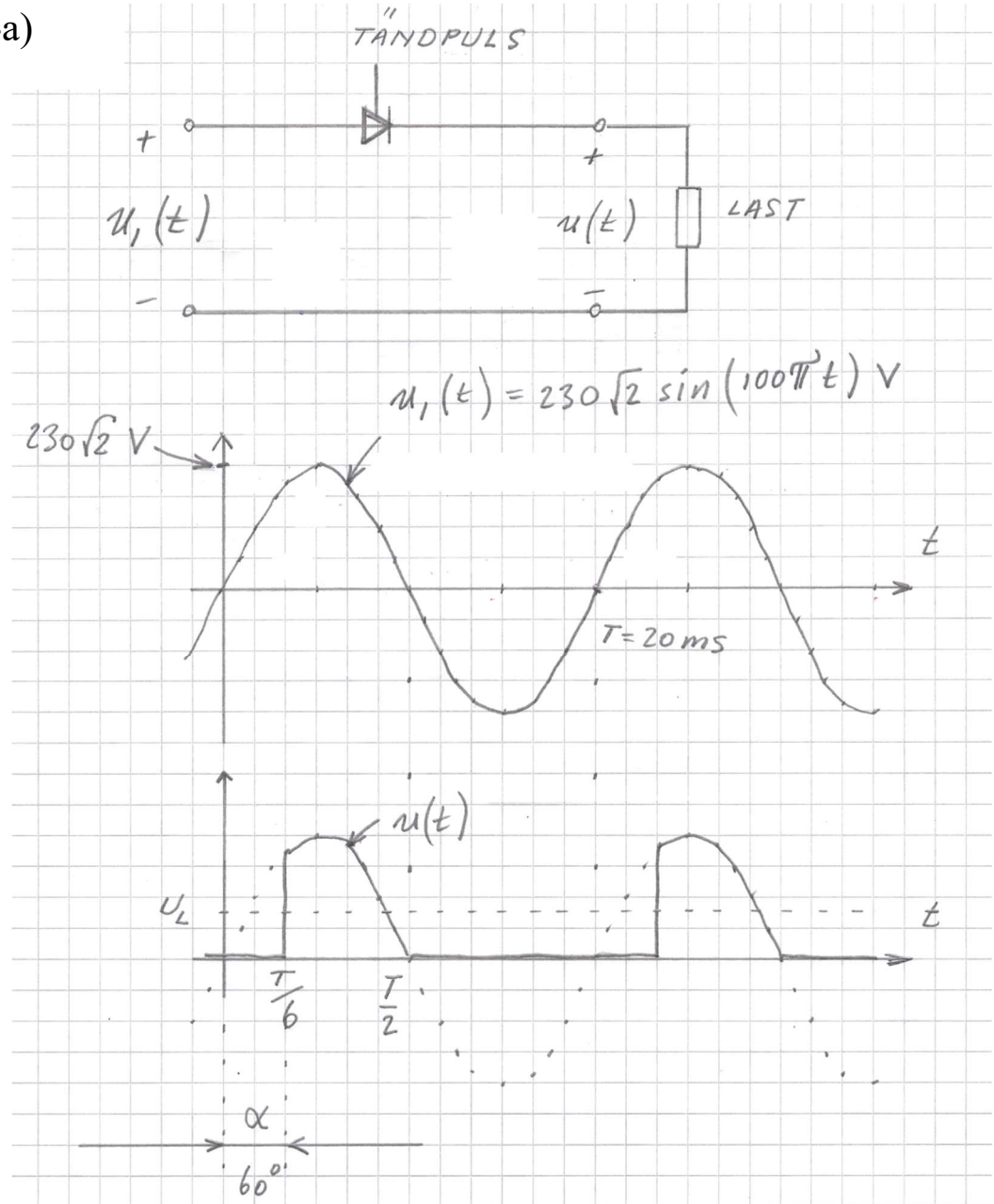
c)

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)



$$U_L = \frac{1}{T}\int_0^T u(t)\,dt = \frac{1}{T}\int_{T/6}^{T/2} u_1(t)\,dt = \frac{2\pi}{T} =$$

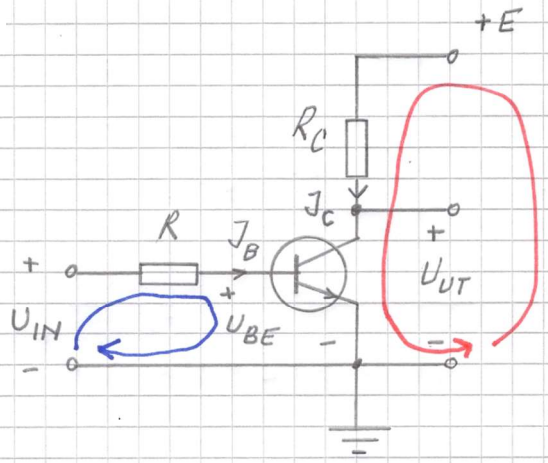
$$= \frac{1}{T}\int_{T/6}^{T/2} 230\sqrt{2}\sin(100\pi t)\,dt = \omega = 2\pi f =$$

$$= \frac{\omega}{2\pi} \int_{\frac{\pi}{3\omega}}^{\pi/\omega} 230\sqrt{2}\sin(\underbrace{100\pi}_{\omega} t)\,dt =$$

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

$$= \frac{230\sqrt{2}}{2\pi}\left[-\cos(\pi) + \cos\left(\frac{\pi}{3}\right)\right] \approx \underline{78\,V}$$

4b)



$+E - R_C J_C - U_{UT} = 0 \quad \ldots (1)$

$+U_{IN} - R J_B - U_{BE} = 0 \quad \ldots (2)$

$U_{IN} = 5{,}0\,V \Rightarrow U_{UT} = 0$ OCH $U_{BE} = 0{,}70\,V$

$(1) \rightarrow J_C = 8{,}0\,mA$

$h_{FE} = \frac{J_C}{J_B} \rightarrow J_B = 160\,\mu A$ VÄLJ $J_B = 320\,\mu A$

INS I (2) $\rightarrow \underline{R \approx 13\,k\Omega}$ (13437,5)

4c) Summatorkoppling med operationsförstärkare

$$u_c(t) = -\frac{R_A^{\circ}}{R_{F1}}(-E) - \frac{R_A^{\circ}}{R_{F2}} \cdot u_F(t)$$

$$4{,}0 + 4{,}0\sin(1000t) = 2E - 5u_F(t)$$

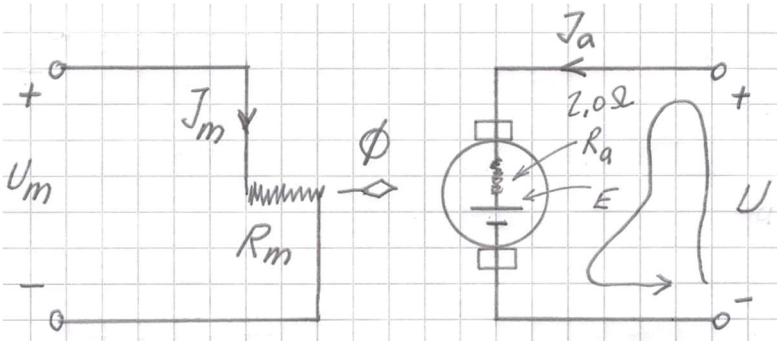
ALLTSÅ°: $4{,}0 = 2E \rightarrow \underline{E = 2{,}0\,V}$

$$4{,}0\sin(1000t) = -5u_F(t)$$

$$\Rightarrow \underline{u_F(t) = -0{,}80\sin(1000t)\,V}$$

(ELLER $u_F(t) = 0{,}80\sin(1000t - 180°)\,V$)

5. Separatmagnetiserad likströmsmotor



FALL I

$U_I = 200\ V$

$J_{aI} = 10\ A$

$E_I = ?$

$n_I = 1000\ RPM$

FALL II

$U_{II} = 170\ V$

$J_{aII} = ?$

$E_{II} = ?$

$n_{II} = ?$

SAMMA MOMENT OCH MAGNETISKT FLÖDE I DE TVÅ FALLEN.

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

b) KIRCHHOFFS SPÄNNINGSLAG $\rightarrow$

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

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

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