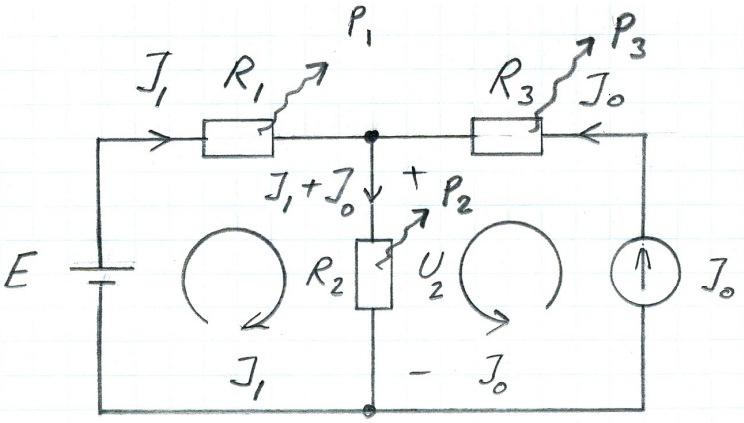
Lösningsförslag till tentamen TMMI04 Elektroteknik 2019-01-11

Lösning med slinganalys

1.



a) $+E - R_1 J_1 - R_2 (J_1 + J_0) = 0 \rightarrow$

$+15 - 3{,}0 J_1 - 3{,}0 (J_1 + 1{,}0) = 0 \rightarrow J_1 = 2{,}0\ A$

$U_2 = R_2 (J_1 + J_0) \rightarrow \underline{\underline{U_2 = 9{,}0\ V}}$

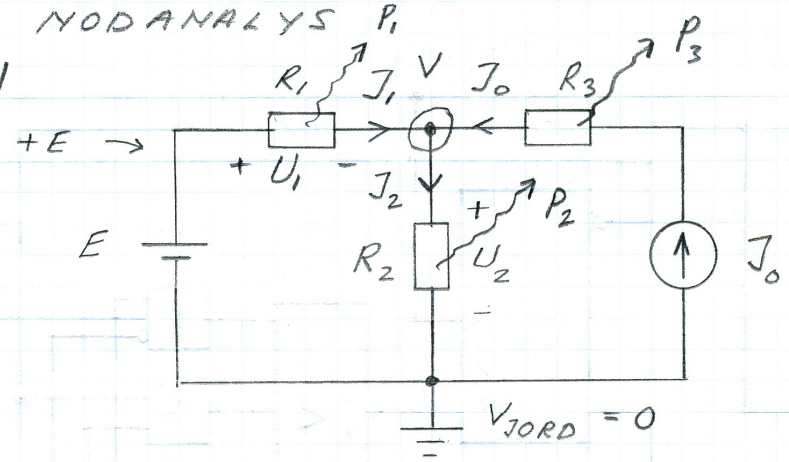
b) $P_1 = R_1 \cdot J_1^{\,2} \rightarrow \underline{\underline{P_1 = 12\ W}}$

$P_2 = R_2 \cdot (J_1 + J_0)^2 \rightarrow \underline{\underline{P_2 = 27\ W}}$

$P_3 = R_3 J_0^{\,2} \rightarrow \underline{\underline{P_3 = 3{,}0\ W}}$

ALTERNATIV LÖSNING MED NODANALYS

a)



$$J_1 + J_0 = J_2 \Rightarrow J_1 + J_0 - J_2 = 0$$

$$\Rightarrow \frac{E - V}{R_1} + J_0 - \frac{V - 0}{R_2} = 0$$

$$\rightarrow \frac{1.5 - V}{3,0} + 1,0 - \frac{V - 0}{3,0} = 0$$

$$\Rightarrow V = +9,0\,V$$

$$U_2 = V - V_{JORD} \rightarrow \underline{\underline{U_2 = 9,0\,V}}$$

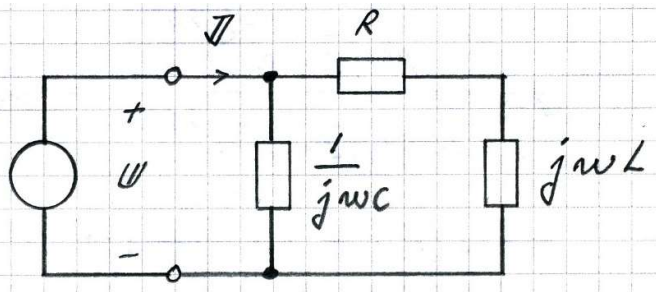
b)

$$P_1 = \frac{U_1^2}{R_1} = \frac{(E - V)^2}{R_1} \rightarrow \underline{\underline{P_1 = 12\,W}}$$

$$P_2 = \frac{U_2^2}{R_2} \Rightarrow \underline{\underline{P_2 = 27\,W}}$$

$$P_3 = R_3 J_0^2 \Rightarrow \underline{\underline{P_3 = 3,0\,W}}$$

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) $\Rightarrow$

$$\underline{J} = \frac{10\sqrt{2}\cdot e^{+j90^\circ}}{1000\sqrt{2}\cdot e^{-j45^\circ}} = 0{,}010\, e^{+j135^\circ}\ A$$

$$\Rightarrow \underline{i(t) = 10 \sin(1000t + 135^\circ)\ mA}$$

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

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

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

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

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

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

$\varphi = 90^\circ - 135^\circ = -45^\circ$

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)

$$\frac{\hat{U}_1}{\hat{U}_2} = \frac{N_1}{N_2}$$

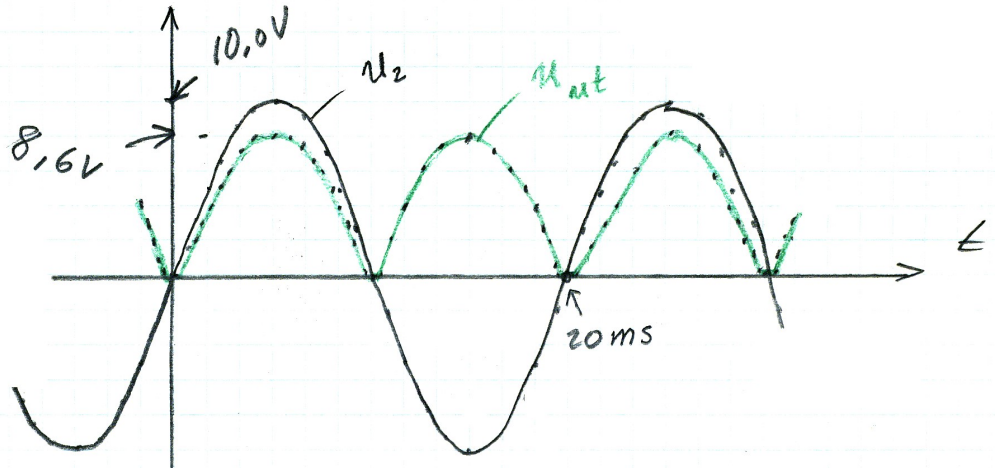
$$\frac{230\sqrt{2}}{\hat{U}_2} = 32{,}5 \rightarrow \hat{U}_2 \approx 10{,}0\ \text{V}$$

TVÅ DIODER LEDER

$$\hat{U}_{ut} = \hat{U}_2 - 2 \cdot 0{,}70 = 8{,}6\ \text{V}$$

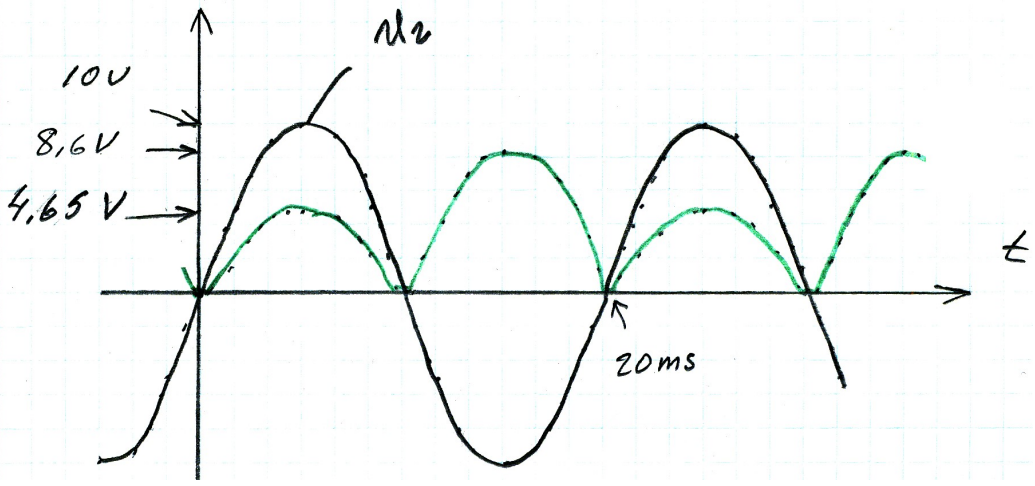
$$\omega = 100\pi\ \frac{\text{RAD}}{\text{S}}$$

$$\omega = \frac{2\pi}{T} \Rightarrow T = 20\,\text{ms}$$



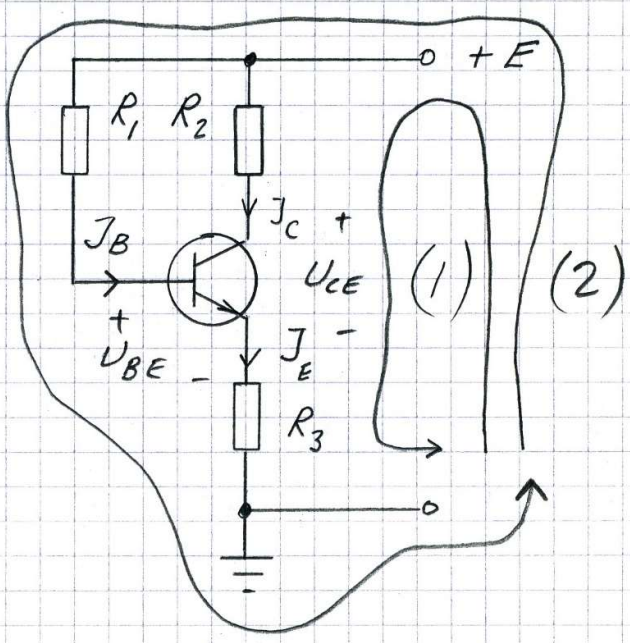
3b) NÄR D_2 BYTS UT MOT EN RESISTOR $R = 1{,}0\ k\Omega$ LEDER ENDAST EN DIOD (D_3) DÅ $u_2(t)$ ÄR POSITIV. 0,70 V FÖRSVINNER FRÅN $\hat{U}_2$. ÅTERSTODEN 9,3 V FÖRDELAR SIG JÄMT ÖVER R_L OCH R EFTERSOM DE ÄR LIKA STORA.

DÅ $u_2(t)$ ÄR NEGATIV LEDER D_4 OCH D_1. 1,4 V FÖRSVINNER FRÅN $\hat{U}_2$ OCH LIKRIKTAREN FUNGERAR SOM VANLIGT.



3c) Om D_2 ersätts med en kortslutning blir D_1 direktansluten till u_2 på transformatorns sekundärsida. Dioden D_1 går alltså sönder eftersom den bara tål 0,70 V i framriktningen.

4a) LIKSTROMSSCHEMA



$$h_{FE} = \frac{J_C}{J_B} \Rightarrow J_B = \frac{0{,}0040}{200} = 20\,\mu A$$

$$J_E = J_B + J_C \Rightarrow J_E = 4{,}020\ mA$$

$$+E - R_2 J_C - U_{CE} - R_3 J_E = 0 \ldots (1)$$

$$\Rightarrow 12 - 1000 \cdot 0{,}0040 - 4{,}0 - R_3 \cdot 0{,}004020 = 0$$

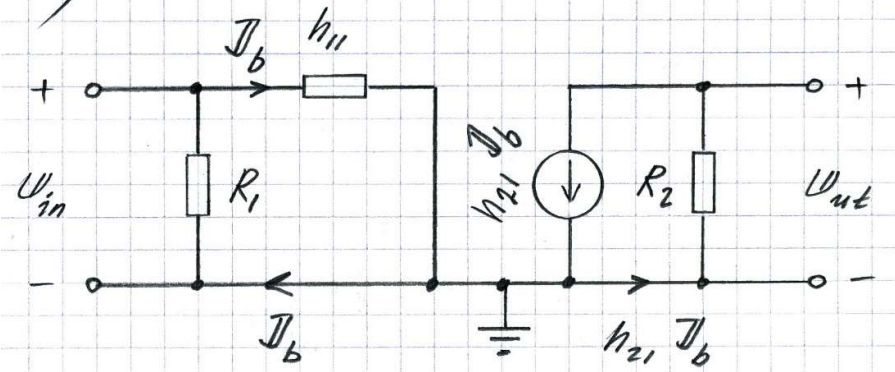
$$\Rightarrow \underline{R_3 \approx 1{,}0\,k\Omega}$$

$$+E - R_1 J_B - U_{BE} - R_3 \cdot J_E = 0 \ldots (2)$$

$$\Rightarrow 12 - R_1 \cdot 0{,}000020 - 0{,}70 - 4{,}0 = 0$$

$$\Rightarrow \underline{R_1 \approx 0{,}36\,M\Omega}$$

4b)



$$U_{ut} = - h_{21} I_b R_2$$

$$U_{in} = h_{11} I_b$$

$$\rightarrow \frac{U_{ut}}{U_{in}} = - \frac{h_{21} R_2}{h_{11}} \Rightarrow$$

$$\frac{U_{ut}}{U_{in}} = -100$$

$$Z_{ut} \approx R_2 \rightarrow Z_{ut} = 1{,}0\ k\Omega$$

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

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

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

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

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

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

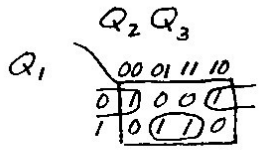
6a) $Y = \overline{A B}\,(A + B)$

6b) $Y = (\bar{A} + \bar{B})(A + B) = \bar{A}A + \bar{A}B +$

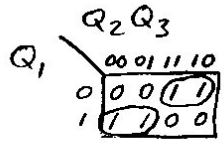
$+ \bar{B}A + \bar{B}B = \bar{A}B + A\bar{B} = A \oplus B$

6c)

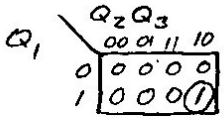
Q_1	Q_2	Q_3	D_1	D_2	D_3	Q_1^+	Q_2^+	Q_3^+
0	0	0	1	0	0	1	0	0
0	0	1	0	0	0	0	0	0
0	1	0	1	1	0	1	1	0
0	1	1	0	1	0	0	1	0
1	0	0	0	1	0	0	1	0
1	0	1	1	1	0	1	1	0
1	1	0	0	0	1	0	0	1
1	1	1	1	0	0	1	0	0



$D_1 = \bar{Q}_1 \bar{Q}_3 + Q_1 Q_3 = \overline{Q_1 \oplus Q_3}$



$D_2 = \bar{Q}_1 Q_2 + Q_1 \bar{Q}_2 = Q_1 \oplus Q_2$



$D_3 = Q_1 Q_2 \bar{Q}_3$