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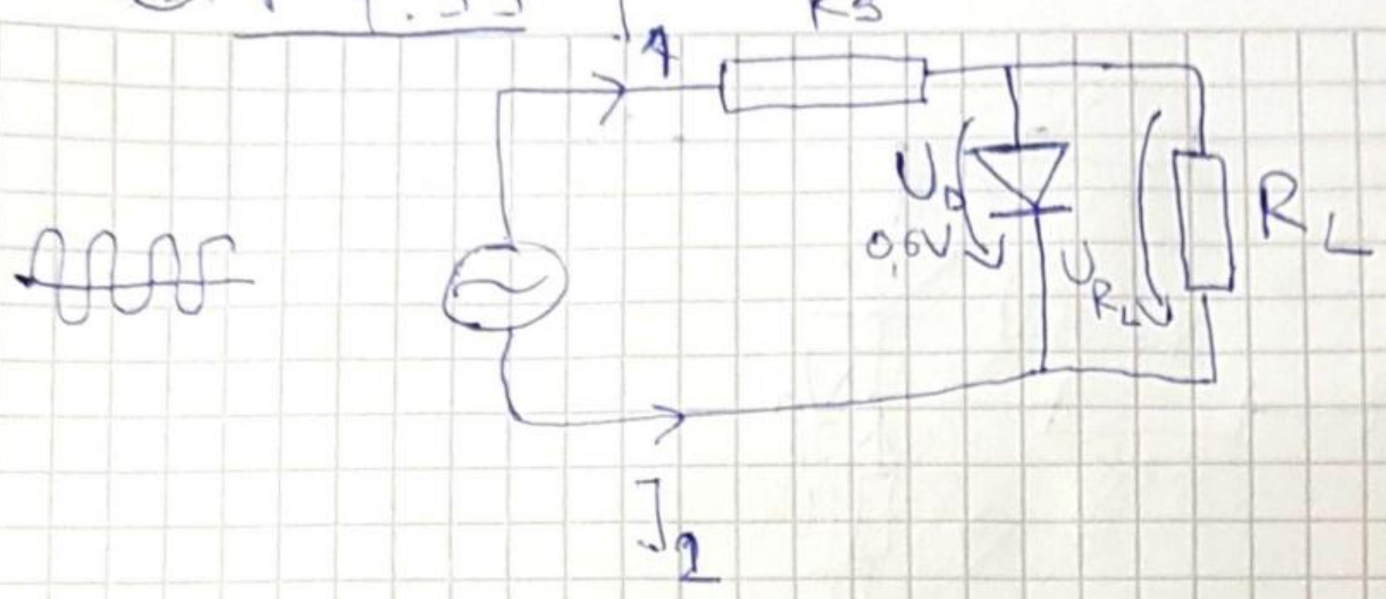
324CD

Colaboratori: Caraja Alexandru

Temă EEA

Subiect: ① P 4.33



Atunci când curentul circulă în sensul I_1 și $U_i > 0{,}6V$

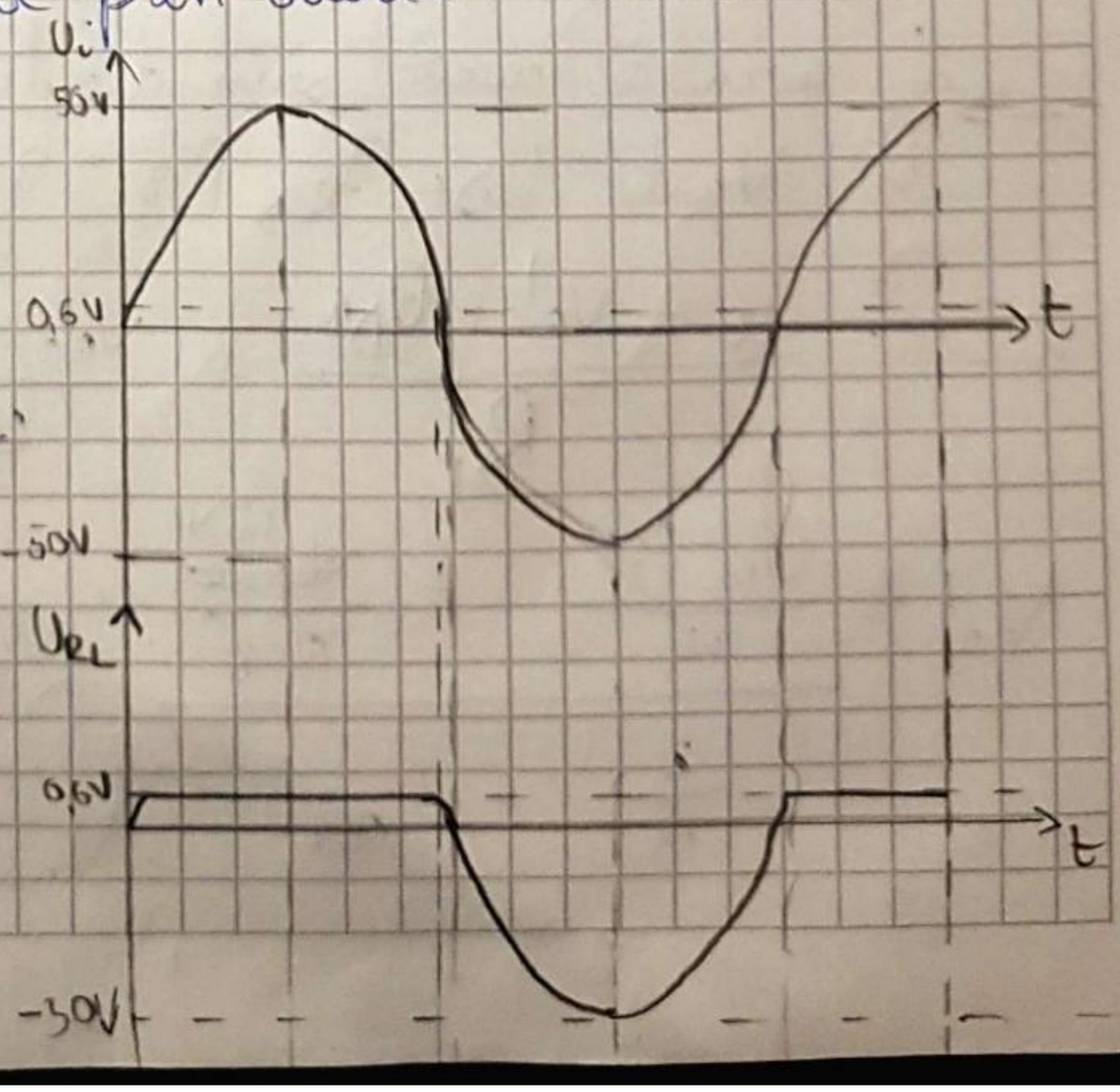
→ { curentul trece prin diodă, și nu prin R_L.
$U_{R_L} = U_D = 0{,}6V$.

Atunci când curentul circulă în sensul I_1 și $U_i < 0{,}6V$

→ { curentul nu trece prin diodă, ci prin R_L
$U_{R_L} = U_i \cdot \frac{R_L}{R_L + R_S}$

Atunci când curentul circulă în sensul I_2. →

→ { curentul nu trece deloc prin diodă
$U_{R_L} = U_i \cdot \frac{R_L}{R_L + R_S}$



Pentru ca circuitul să funcționeze corect, în realitate ar trebui să avem $R_L \gg 100 R_S$ ⇒

$U_{R_L\ minim} \simeq -50V$.

$U_{R_L\ maxim} = 0{,}6V$

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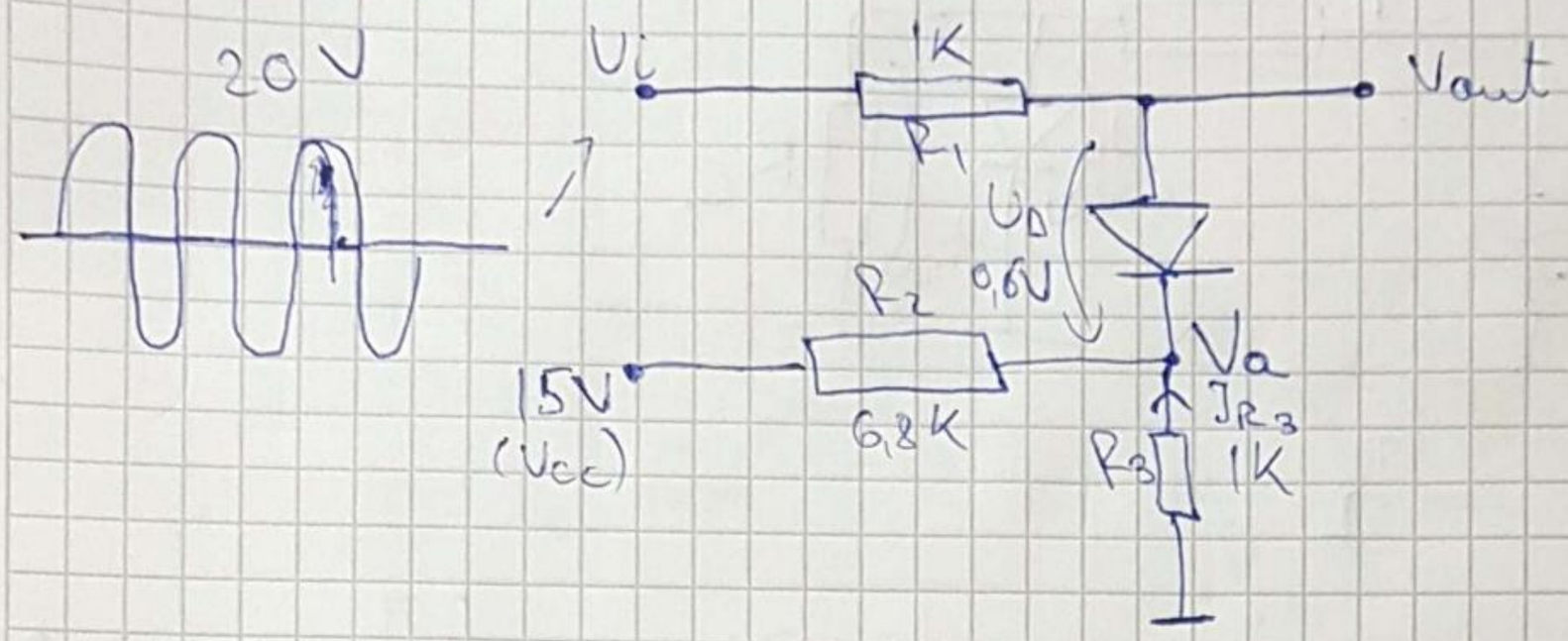

Atunci când prin diodă nu trece curent →

$$\rightarrow V_a = \frac{R_1}{R_1+R_2} \cdot V_{cc} = \frac{1K}{6K8+1K} \cdot 15V = 1,92V$$

Dacă $U_i < V_a + U_D = 1,92 + 0,6 = 2,52V$ →

→ { nu circulă curent prin diodă și nici prin R_1
$V_{out} = V_i$

Dacă $U_i > V_a + U_D = 2,52V$ →

→ { circulă curent prin diodă
$V_{out} = U_D + I_{R_3} R_3 = 0,6 + V_a'$

$$KI: \frac{U_i - V_a' - U_D}{R_1} + \frac{V_{cc} - V_a'}{R_2} + \frac{0 - V_a'}{R_3} = 0$$

$$V_a' = \frac{\frac{U_i - 0,6}{1k} + \frac{15V}{6k8}}{\frac{2}{1k} + \frac{1}{6k8}}$$ → V_a' depinde de U_i → $V_{out\,max}$

$V_{out\,max} = V_{a\,max}' + 0,6V$

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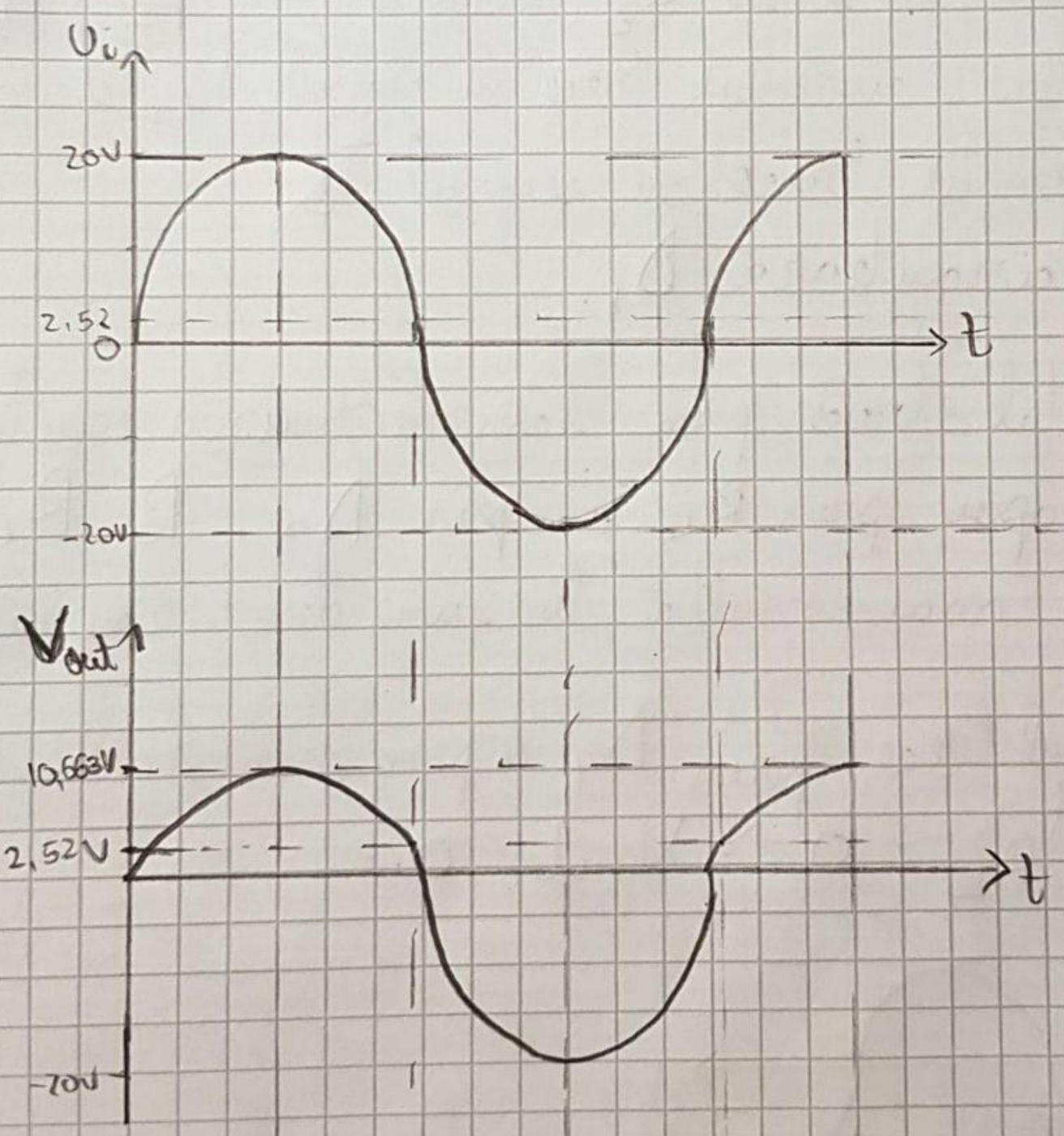
$$\Rightarrow V_{out\,max} = U_D + \frac{\frac{V_{i\,max} - U_D}{R_1} + \frac{V_{cc}}{R_2}}{\frac{2}{R_1+R_3} + \frac{1}{R_2}}$$

$$V_{out\,max} = 0{,}6 + \frac{\frac{20-0{,}6}{1k} + \frac{15}{6k8}}{\frac{2}{1k} + \frac{1}{6k8}} \simeq 10{,}663\ V$$

$$V_{out\,min} = U_{i\,min} = -20V$$



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Subiect: (G) P 4.44

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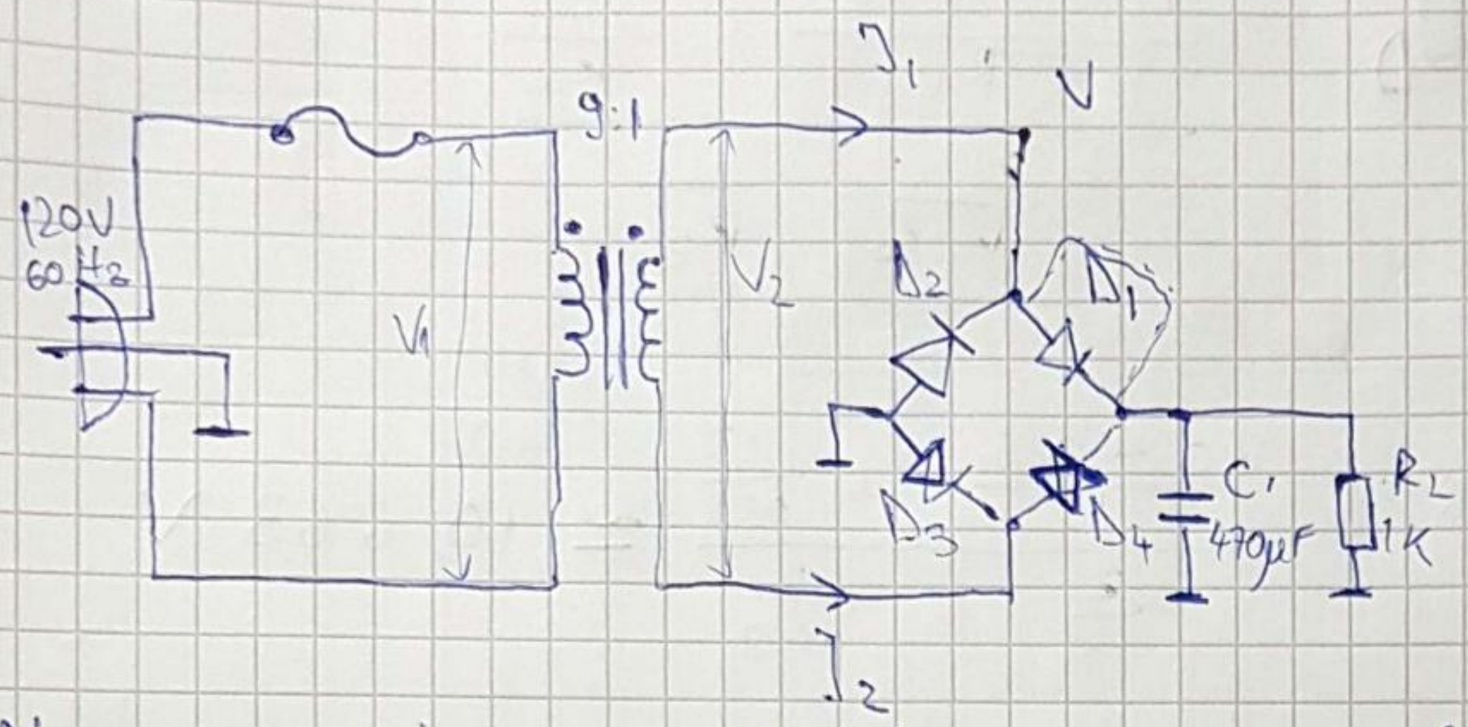


Atunci când curentul trece în sensul I_1, trece prin $D_1 \to R_L \to D_3$

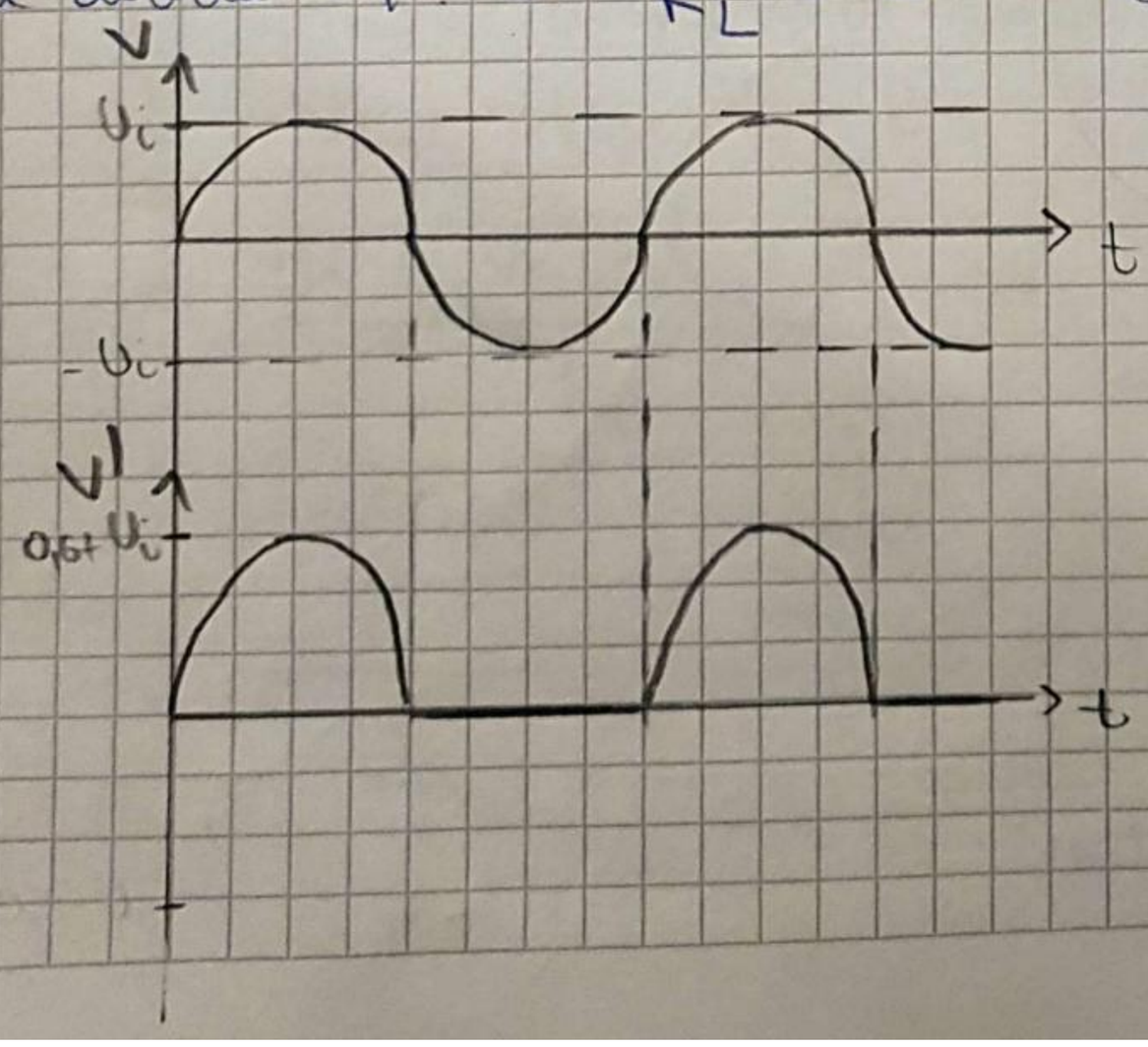
Atunci când curentul trece în sensul I_2, acesta trece prin $D_4 \to R_L \to D_2$.

Dacă V este pozitiv, curentul trece în sensul I_1; dacă V e negativ, curentul trece în sensul I_2.

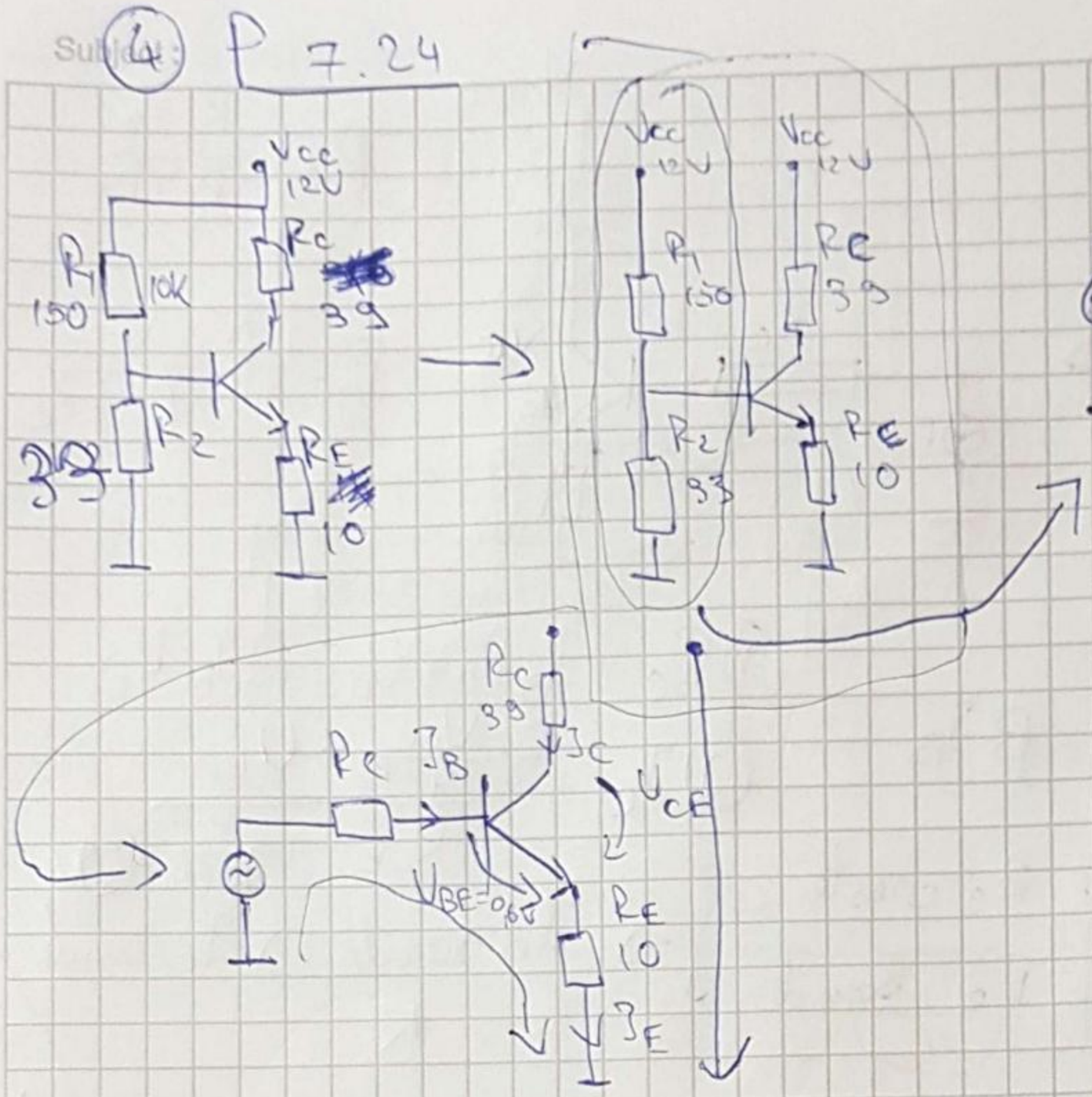
Pp că se scurtcircuitează D_1.

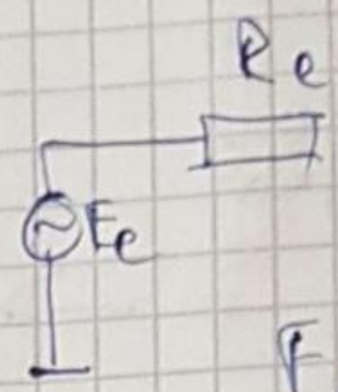
$V > 0 \Rightarrow$ curentul trece prin ramura scurtcircuitată a diodei D_1 și apoi prin R_L și prin D_3. Pe R_L va cădea cu 0,6V mai multă tensiune decât inițial.

$V < 0 \Rightarrow$ curentul trece prin D_4 și prin ramura scurtcircuitată a diodei D_1 $\Rightarrow I_{R_L} = 0 \Rightarrow V_{out} = 0$



Subject: 4 P 7.24





$$E_e = R_2 \cdot \frac{V_{cc}}{R_1+R_2} \simeq 2{,}10V$$

$$R_e = \frac{R_1 R_2}{R_1+R_2} \simeq 27\Omega$$

$$I_E \simeq I_C = \beta I_B \Rightarrow I_B = \frac{I_C}{\beta}$$

KII: $E_e = I_B R_e + I_E R_E + U_{BE}$

$$I_C\left(\frac{R_e}{\beta} + R_E\right) = E_e - U_{BE} \Rightarrow$$

$$\Rightarrow I_C = \frac{E_e - U_{BE}}{\frac{R_e}{\beta} + R_e} \simeq 151{,}9\,mA$$

KII: $I_C R_c + U_{CE} + I_E R_e = V_{cc}$

$$U_{CE} = V_{cc} - I_C R_E - I_E R_E$$

$$= 12 - 151{,}9mA \cdot 27 - 151{,}9mA \cdot 27$$

$$U_{CE} \simeq 5{,}46V > 0{,}6V$$

$U_{CE} > U_{BE} \Rightarrow$ RAN.

Sub. 5 P 7.30

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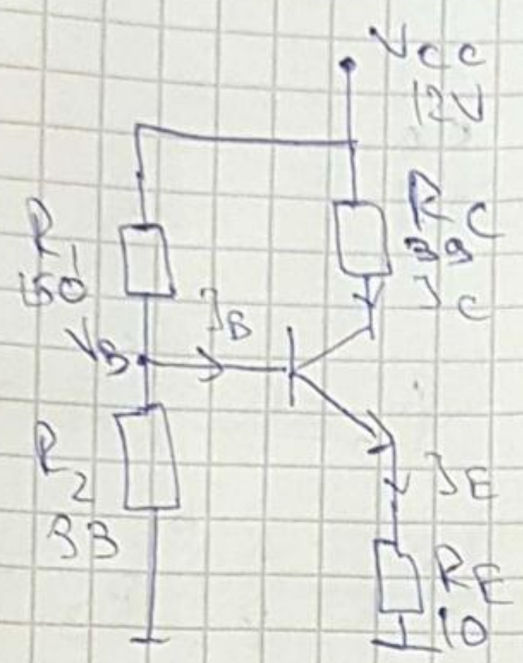

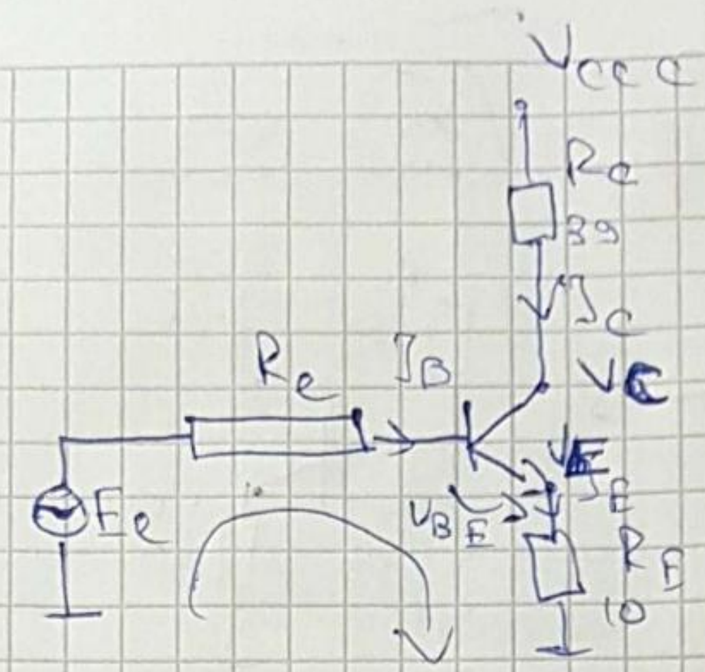

$$R_e = \frac{R_1 R_2}{R_1 + R_2}$$

$$E_e = R_2 \cdot \frac{V_{CC}}{R_1 + R_2}$$

$$I_C \simeq I_E \quad ; \quad I_C = \beta I_B$$

① $E_e = I_B R_e + U_{BE} + I_E R_E$

② $I_C = \dfrac{R_2 \cdot \frac{V_{CC}}{R_1+R_2} - U_{BE}}{R_E + \frac{R_1 R_2}{\beta(R_1+R_2)}}$

a) R_1 creste $\Rightarrow \left\{ \begin{array}{l} R_e \text{ creste} \\ E_e \text{ scade} \end{array} \right\} \Rightarrow I_B$ scade $\Rightarrow I_C$ scade $\Rightarrow$

$V_C = V_{CC} - I_C R_C$

$\Rightarrow V_C$ creste

b) R_2 scade $\Rightarrow V_B$ scade $\Rightarrow V_E$ scade $\Rightarrow I_E$ scade $\Rightarrow$

$\Rightarrow I_C$ scade $\Rightarrow V_C$ creste

c) R_E creste $\Rightarrow I_E$ scade $\Rightarrow I_C$ scade $\Rightarrow V_C$ creste

d) R_C scade $\Rightarrow U_{R_C}$ scade $\Rightarrow V_C$ creste

e) V_{CC} creste : $V_C = V_{CC} - I_C R_C \Big| \Rightarrow$

②

$$\Rightarrow V_C = V_{CC} - \frac{R_2 \frac{V_{CC}}{R_1+R_2} - U_{BE}}{R_E + \frac{R_1 R_2}{\beta(R_1+R_2)}} \cdot R_C$$

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$$\Rightarrow V_C = V_{CC} - V_{CC}\frac{\beta R_2 R_C}{\beta R_e(R_1+R_2)+R_1R_2} + \frac{U_{BE}}{R_E + \frac{R_1R_2}{R_1+R_2}}$$

$$\frac{U_{BE}}{R_E + \frac{R_1R_2}{R_1+R_2}} = ct$$

$$= \frac{1287\beta}{4950+1830\beta} < 1$$

$\Rightarrow V_C$ crește

g) β scade $\Rightarrow \dfrac{\cancel{\beta} R_2 R_C}{\cancel{\beta}\left(R_e(R_1+R_2) + \frac{R_1R_2}{\beta}\right)}$ $\Rightarrow$ raportul scade $\Rightarrow$ ~~crește~~ $\Rightarrow V_C$ crește

$\frac{R_1R_2}{\beta} \rightarrow$ crește

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Subiect: 6 P7.38

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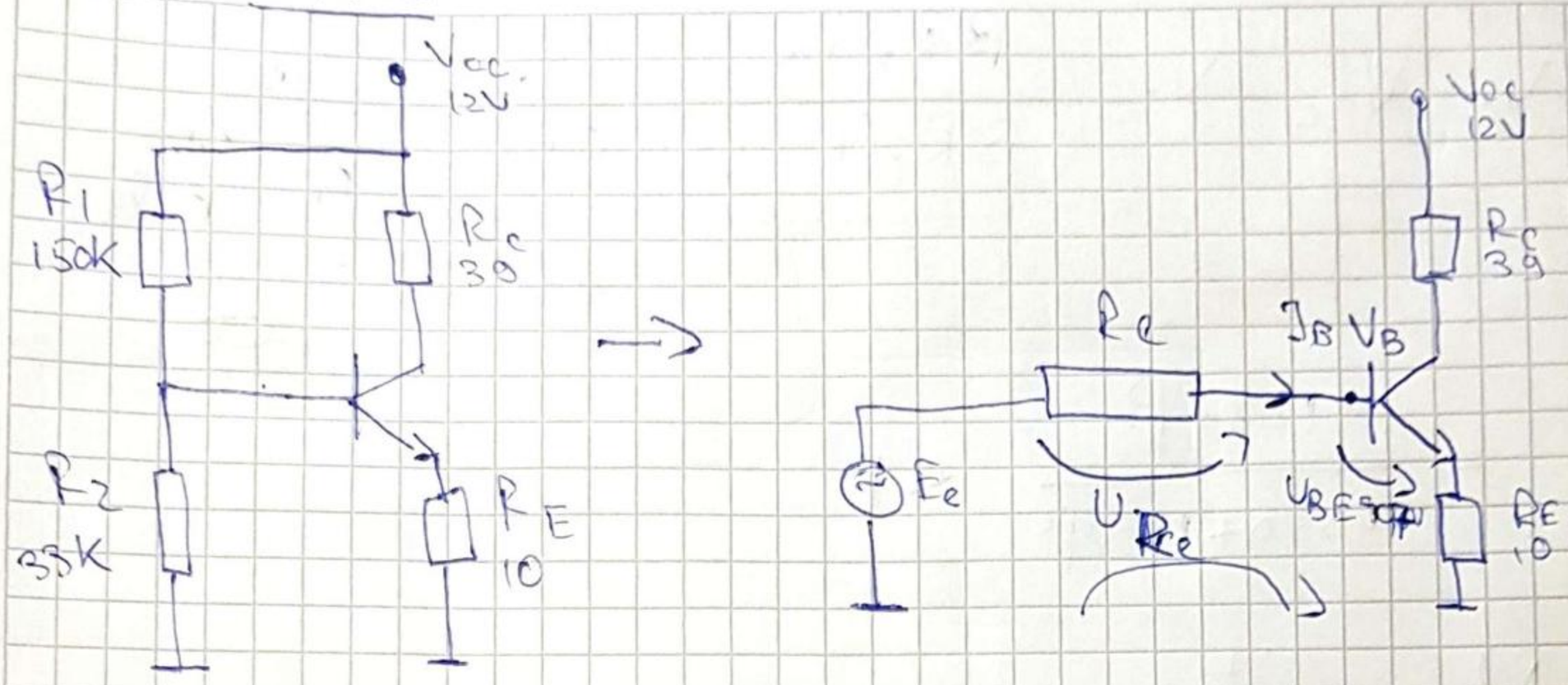

$$E_e = R_2 \frac{V_{cc}}{R_1 + R_2} = 33K \frac{12}{150K + 33K} = \frac{396K}{183K} \simeq 2,16V$$

$$R_e = \frac{R_1 R_2}{R_1 + R_2} = \frac{4950 \cdot 10^{\cancel{6}3}}{183 \cdot \cancel{10^3}} \simeq 27,05K$$

$R_e >> R_E \mid R_e \Rightarrow U_{R_e}$ nu mai e neglijabilă.

$$E_e = I_B R_e + U_{BE} + I_E R_E \Rightarrow$$

$$I_E \simeq I_C = \beta I_B$$

$$\Rightarrow I_B = \frac{E_E - U_{BE}}{R_e + \beta R_E} \Rightarrow I_B = \frac{2,16 - 0,7}{27,05K + 1K} = \frac{1,46}{28,05K}$$

Ei $\beta = 100$

$$I_B \simeq 0,05 mA$$

$$\cancel{U_{R_e} = \frac{1,46}{28,05K} \cdot 27,05K} =$$

$$U_{R_e} = R_e \cdot I_B = 1,35V$$

$$\Rightarrow V_B = 2,16 - 1,35 = 0,81V$$

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Problema apare deoarece atunci când există diferență de ordin între rezistențele din divizorul de tensiune de pe rețeua I_B și rezistențele R_C și R_E, căderea de tensiune pe R_E nu mai este neglijabilă, rezultând astfel în pierderi de tensiune de la V_{CC} la V_B.

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Subject: 7 8.35

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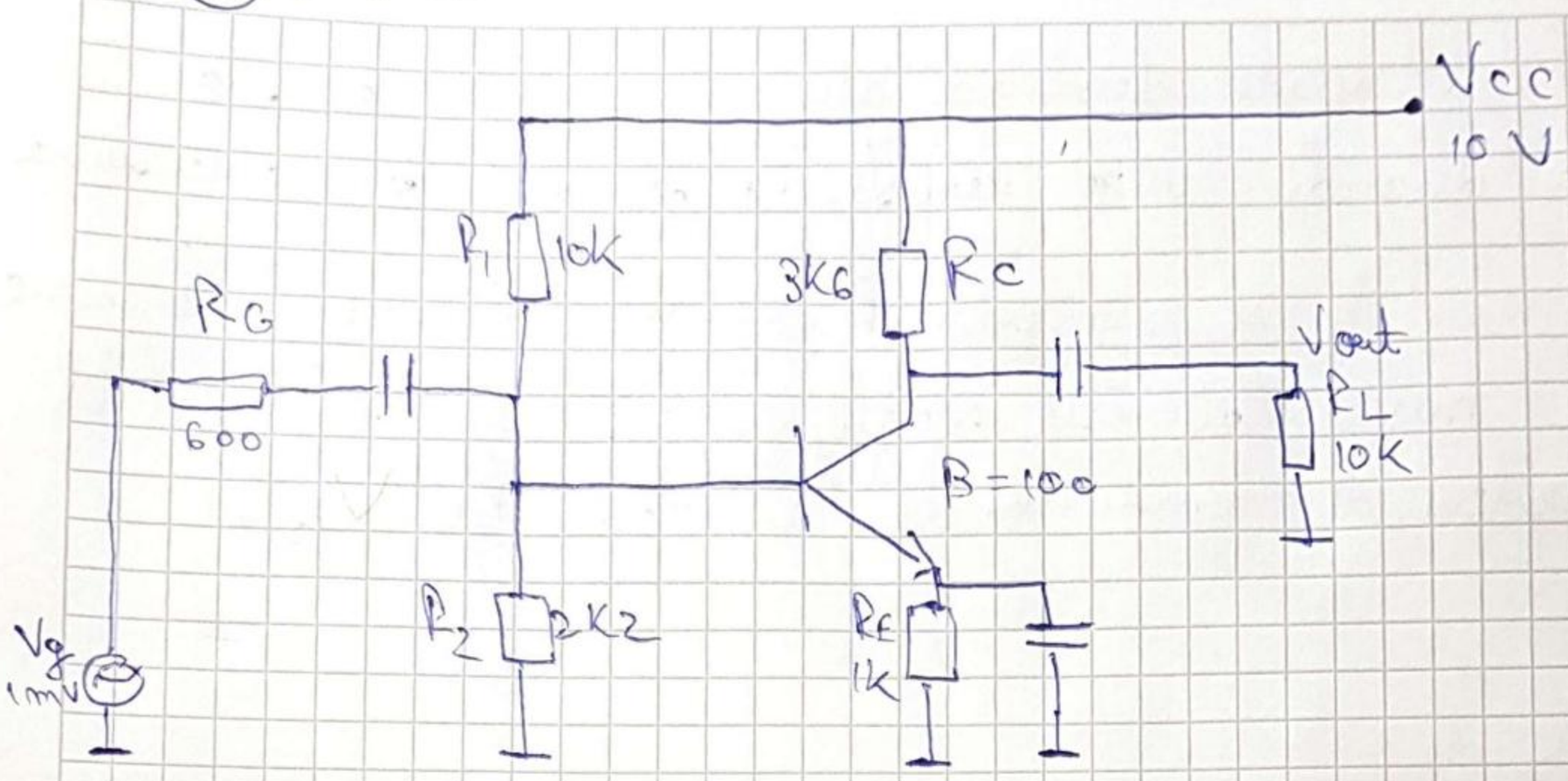
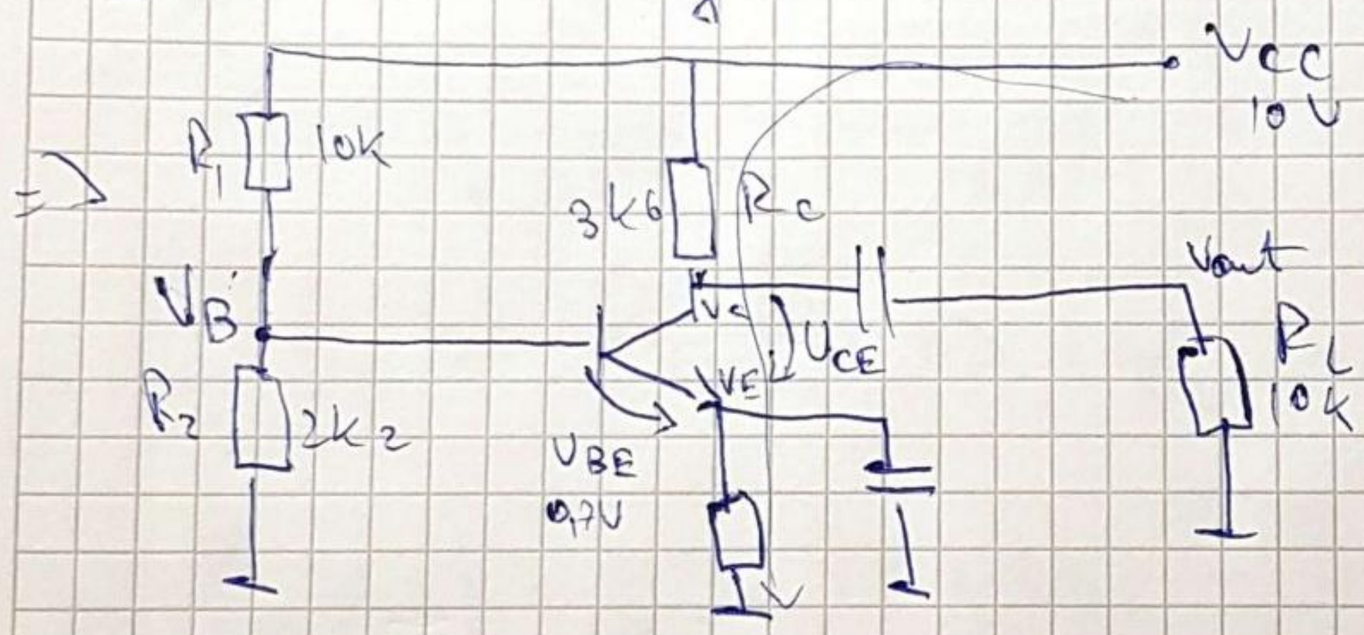


I. Pasivizăm Vg =>

=>



$$V_B = V_{CC} \cdot \frac{R_2}{R_1 + R_2} = 10 \cdot \frac{2{,}2 \cdot 10^3}{12{,}2 \cdot 10^3} = 1{,}8V$$

$$V_E = V_B - 0{,}7V = 1{,}1V \Rightarrow I_E = \frac{V_E}{R_E} = \frac{1{,}1V}{1K} = 1{,}1mV$$

$$I_C \simeq I_E \Rightarrow I_C \simeq 1{,}1mA$$

$$K_{II}: V_{CC} = I_C R_C + U_{CE} + I_E R_E$$

$$U_{CE} = 10V - 1{,}1mV(3K6 + 1K) \simeq 4{,}94V$$

$$U_{CE} > U_{BE} \Rightarrow RAN$$

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$r_i = \frac{25mV}{I_E} = \frac{25mV}{1,1mA} \simeq 22,7\Omega$ (ideal)

$r_i = \frac{h_i}{h_f}$

$R_D = r_i = \frac{1}{40 I_C} K$

$h_f = \beta$

$r_c = R_C \| R_L = \frac{R_C R_L}{R_C + R_L} = \frac{36 \cdot 10^3}{13,6 \cdot 10^3} \simeq 2,65 K\Omega$

$A_v = \frac{r_c}{r_i} = \frac{2650}{22,7} \simeq 117$

$Z_{in(base)} = \beta \cdot r_i = 100 \cdot 22,7 = 2,27 K\Omega \simeq 2,3 K\Omega$

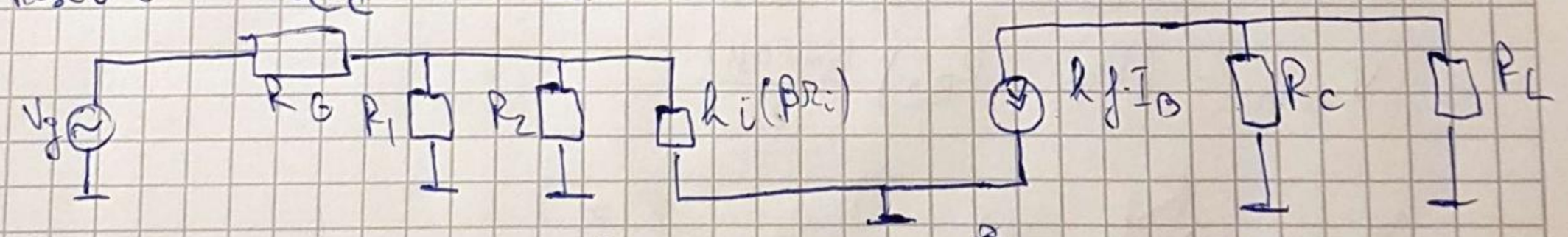
$Z_{in(stage)} = R_1 \| R_2 \| \beta r_i = 10K \| 2,2K\Omega \| 2,3K\Omega$

$= \frac{22 \cdot 10^6}{12,2 \cdot 10^3} \| 2,3K\Omega = 1,8K \| 2,3K\Omega = \frac{4,14 \cdot 10^6}{4,1 \cdot 10^3} = 1K\Omega$

$V_{in} = \frac{Z_{in(stage)}}{R_G + Z_{in(stage)}} \cdot V_g = \frac{1K}{600+1K} \cdot 1mV \simeq 0,625 mV$

$V_{out} = A_v V_{in} = 117 \cdot 0,625 mV = 73,125 mV$

Pasivizam V_{CC} => circuitul echivalent în AC (semnal mic)



Dacă $V_{CC} \to 15V \Rightarrow V_B' = 15 \cdot \frac{2,2 \cdot 10^3}{12,2 \cdot 10^3} \simeq 2,7 V$

$\Rightarrow V_E' = 2,7 - 0,7 = 2V \Rightarrow I_E' = \frac{V_E'}{R_E} = 2mV \simeq I_C'$

$\Rightarrow U_{CE}' = 15 - 2(3k6 + 1k) \simeq 5,8 V$

$r_e' = \frac{25mV}{I_E} = \frac{25mV}{2mA} = 12,5\Omega \Rightarrow Z_{in(base)}' \simeq 1,3K$

$Z_{in(stage)} = 1,8k \| 1,3k \simeq 0,74K\Omega$; $R_C' = 2,65K\Omega \Rightarrow A_v' = 212$

$V_{in}' = \frac{0,74K}{1,34K} \cdot 1mV \simeq 0,55mV$; $V_{out} = A_v' \cdot V_{in}' = 117mV$

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Subject: 8 P 17.27

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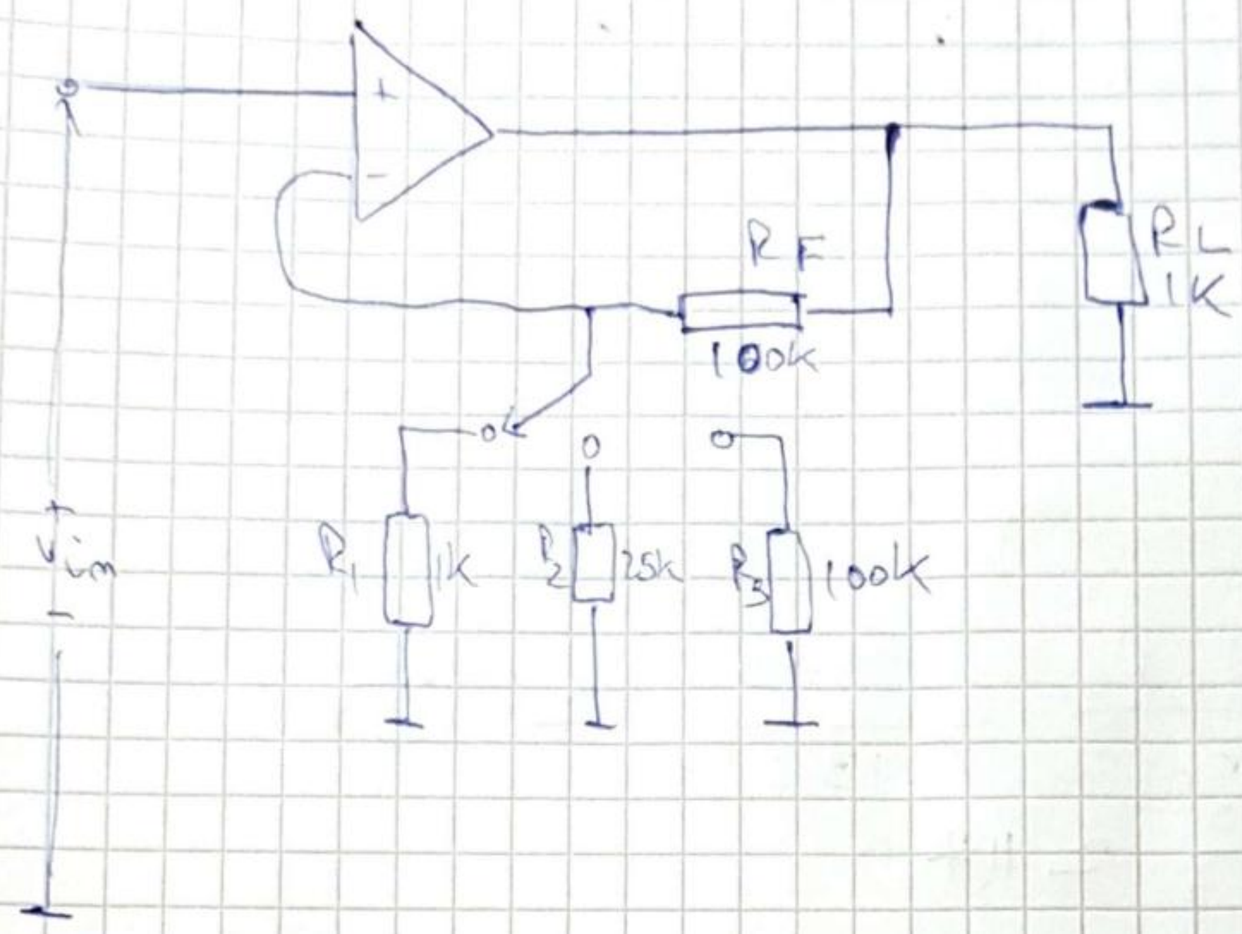

$A_{vol} = 100000.$

$I_{in(bias)} = 80nA$

$I_{in(offset)} = 20nA$

$V_{in(offset)} = 1mV$

Feedback negativ $\Rightarrow V_{error} = A_{v(OL)}(V_{1\,err} + V_{2\,err} + V_{3\,err})$

$V_{1err} = (R_{B1} - R_{B2}) I_{in(bias)}$

$V_{2err} = (R_{B1} + R_{B2}) \frac{I_{in(off)}}{2}$

$V_{3err} = V_{in(off)}$

$R_{B1} = 0$

$R_{B2} = R_1 \| R_f$

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$$A_{V(CL)} = \frac{R_F}{R_1} + 1 = 101$$

I. $R_{B2} = R_1 \parallel R_F = \frac{100 \cdot 10^6}{101 \cdot 10^3} = 990,1\ \Omega$

$V_{1err} = +990,1 \cdot 80 \cdot 10^{-9} = +79,208 \cdot 10^{-6}\ V$

$V_{2err} = 990,1 \cdot \frac{20}{2} \cdot 10^{-9} = \frac{19,908}{9,901} \cdot 10^{-6}\ V$

$V_{3err} = 10^{-3}\ V$

$V_{error} = 101 \left(+79,208 \cdot 10^{-6} + 19,908 \cdot 10^{-6} + 10^{-3} \right)$

$V_{error} = 101 \cdot 1089,109 \cdot 10^{-6} \simeq 110\ mV$

II. $R_{B2} = R_2 \parallel R_F = \frac{2500 \cdot 10^6}{125 \cdot 10^3} = 2 \cdot 10^4\ \Omega$

$V_{1err} = 2 \cdot 10^4 \cdot 80 \cdot 10^{-9} = 16 \cdot 10^{-4}\ V$

$V_{2err} = 2 \cdot 10^4 \cdot \frac{20}{2} \cdot 10^{-9} = 2 \cdot 10^{-4}\ V$

$V_{3err} = 10^{-3}\ V$; $A_{V(CL)} = \frac{R_F}{R_2} + 1 = 5$

$V_{error} = 5 \left(16 \cdot 10^{-4} + 2 \cdot 10^{-4} + 10 \cdot 10^{-4} \right)$

$V_{error} = 14\ mV$

III. $A_{V(CL)} = \frac{R_F}{R_3} + 1 = 2$

$R_{B2} = R_3 \parallel R_F = \frac{\cancel{100} \cdot \cancel{100} \cdot 10^{\cancel{6}\,3}}{\cancel{200} \cdot 10^{\cancel{3}}} = 50\ k\Omega$

$V_{1err} = 50 \cdot 10^3 \cdot 80 \cdot 10^{-9} = 40 \cdot 10^{-4}\ V$

$V_{2err} = 50 \cdot 10^3 \cdot 10 \cdot 10^{-9} = 50 \cdot 10^{-5}\ V$

$V_{3err} = 10^{-3}\ V$

$V_{error} = 2 \left(40 \cdot 10^{-4}\ V + 50 \cdot 10^{-5}\ V + 10 \cdot 10^{-4}\ V \right) = 11\ mV$

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Subject: 9 P 18.29

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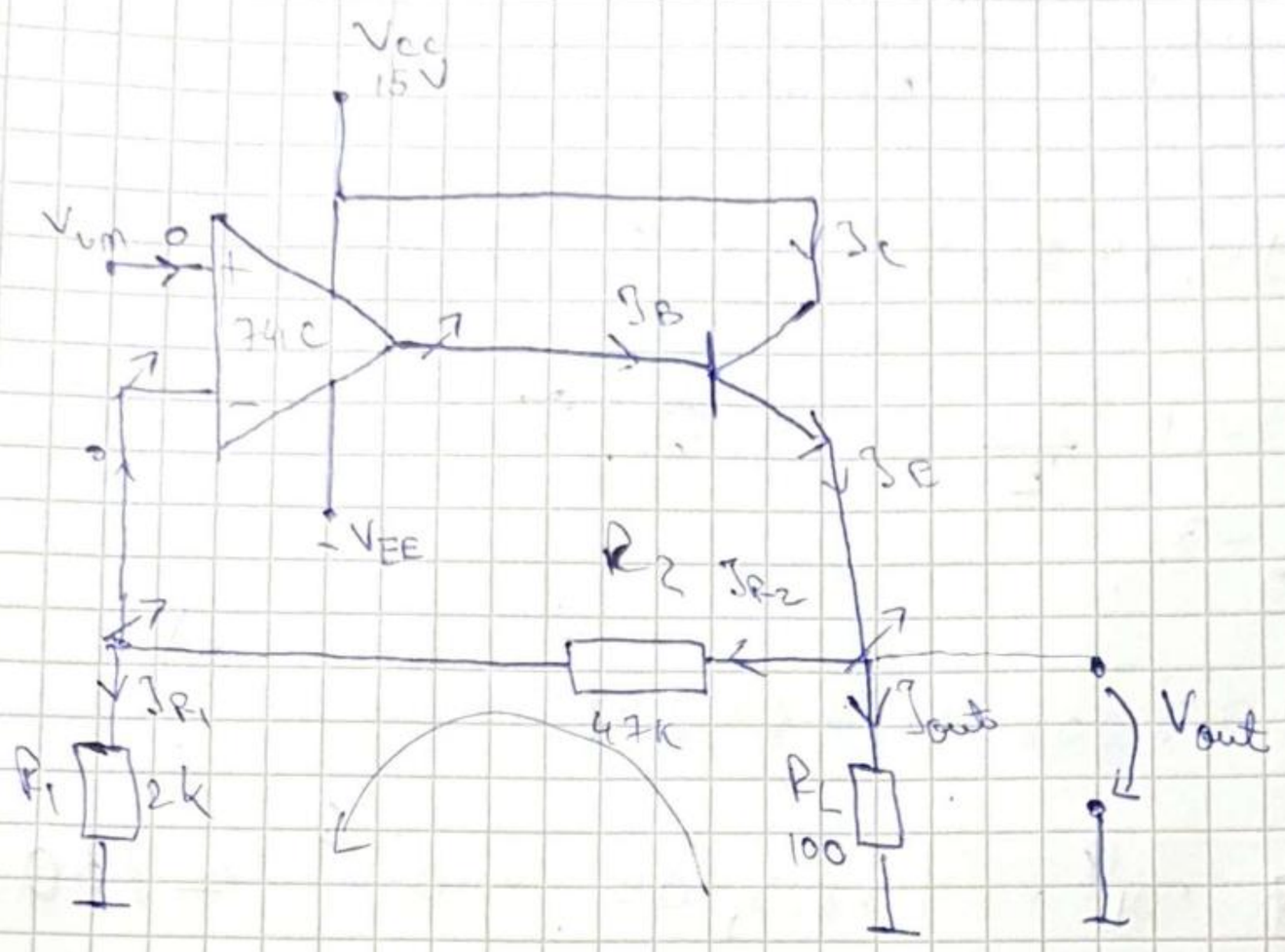

Reacción negativa $\Rightarrow V^+ = V^- = V_{in}$

$$KI: \quad \frac{V_{out} - V_{in}}{R_2} + \frac{0 - V_{in}}{R_1} = 0$$

$$\Rightarrow V_{in}\left(\frac{1}{R_2} + \frac{1}{R_1}\right) = \frac{V_{out}}{R_2}$$

$$V_{gain} = \frac{V_{out}}{V_{in}} = R_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = 1 + \frac{R_2}{R_1} = 24{,}5$$

$$I_E = \frac{V_{out}}{R_L} + \frac{V_{out} - V_{in}}{R_2}$$

$$I_C \simeq I_E \quad \Big| \Rightarrow I_E \simeq \beta I_B \qquad V_{out} = 24{,}5\, V_{in}$$
$$I_C = \beta I_B$$

$$I_B = \frac{\frac{V_{out}}{R_L} + \frac{V_{out} - V_{in}}{R_2}}{\beta} = \frac{\frac{24{,}5\, V_{in}}{100} + \frac{23{,}5\, V_{in}}{17k}}{100}$$

$$I_B \simeq 24{,}5 \cdot 10^{-4} V_{in} \Rightarrow I_C = \beta I_B = \cancel{24{,}5 V_{in}}\ 0{,}245\, V_{in}$$

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Fie $I_B = 25\,mA \Rightarrow I_C = \beta I_B = 2{,}5A \Rightarrow I_E = 2{,}5A$

$RN \Rightarrow \cancel{I_{R_1} = I_{R_2}}$ $\quad I_- = 0 \Rightarrow I_{R_1} = I_{R_2}$

$$\Rightarrow \left.\begin{array}{l} I_{out} R_L = (R_1 + R_2) I_{R_2} \\ I_E = I_{out} + I_{R_2} \end{array}\right| \Rightarrow$$

$$\Rightarrow I_{out} R_L = (R_1 + R_2)(I_E - I_{out})$$

$$I_{out}(R_L + R_1 + R_2) = I_E (R_1 + R_2)$$

$$I_{out} = \frac{I_E (R_1 + R_2)}{R_L + R_1 + R_2} = \frac{2{,}5 \cdot 49k}{49{,}1k} \simeq 2{,}49A$$

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