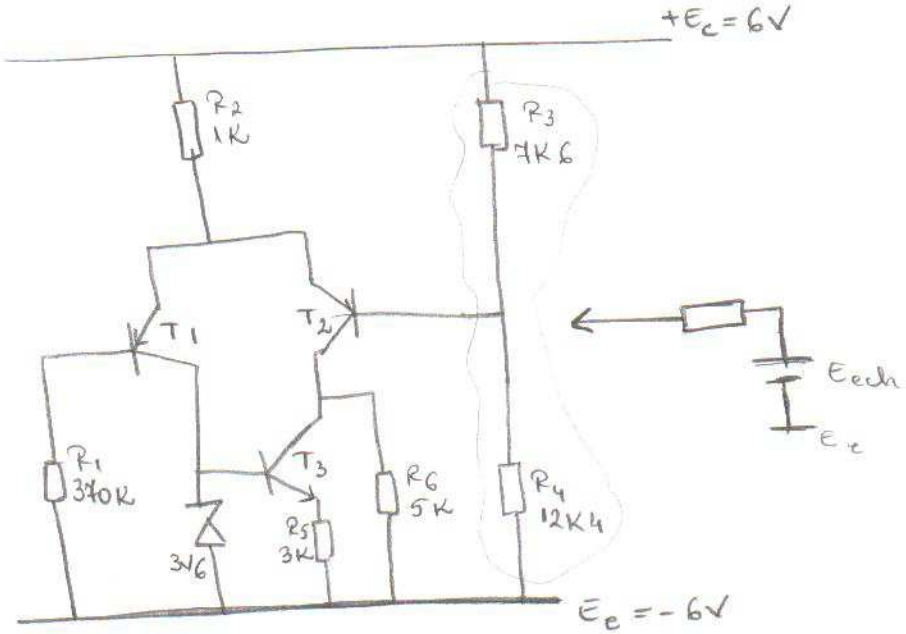
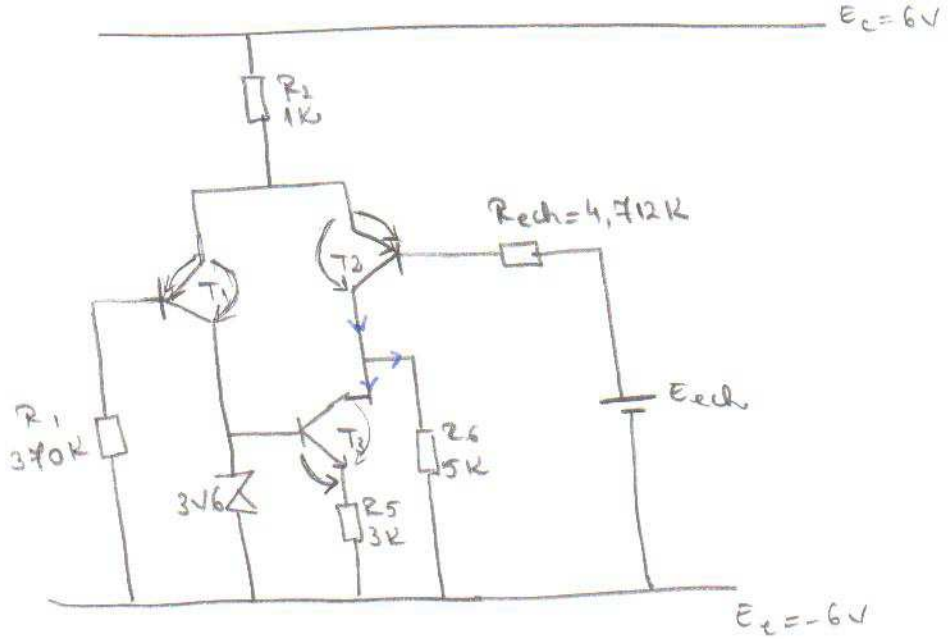
P1/E



$$R_{ech} = \frac{R_4 R_3}{R_4 + R_3} = \frac{12,4 \cdot 7,6}{20_{10}} = \frac{62.476}{1000} = 4,712\ K$$

$$E_{ech} = E_c \cdot \frac{R_4}{R_3 + R_4} = 12 \cdot \frac{12,4}{20_{10}} = \frac{6 \cdot 124}{100} = 7,44\ V$$



i_{c1}:

$$E_c - E_e = R_2(i_{c_1} + i_{c_2}) + R_1 \cdot \frac{i_{c_1}}{\beta_0} + 0,6 \Rightarrow 12 = i_{c_1} + i_{c_2} + 3,7 i_{c_1} + 0,6$$

$$12 = 4,7 i_{c_1} + i_{c_2} + 0,6$$

$$0,6 = 3,6 - R_5 i_{c_3} \Rightarrow 3 = 3 i_{c_3} \Rightarrow \boxed{i_{c_3} = 1\,mA}$$

$$E_c - E_e = R_2(i_{c_1} + i_{c_2}) + 0,6 + R_{ech} \frac{i_{c_2}}{\beta_0 + 1} + E_{ech} \Rightarrow$$

$12 = i_{C_1} + i_{C_2} + 0,6 + 7,44 \Rightarrow i_{C_1} + i_{C_2} = 3,96$

$4,7 i_{C_1} + i_{C_2} = 11,4$

$3,7 i_{C_1} = 7,44 \Rightarrow \boxed{i_{C_1} = 2\,mA}$

$\boxed{i_{C_2} = 2\,mA}$

U_{CE}:

$E_C - E_e = R_2(i_{C_1} + i_{C_2}) + U_{CE_1} + U_{bt} \Rightarrow 12 = 4 + U_{CE_1} + 3,6 \Rightarrow \boxed{U_{CE_1} = 4,}$

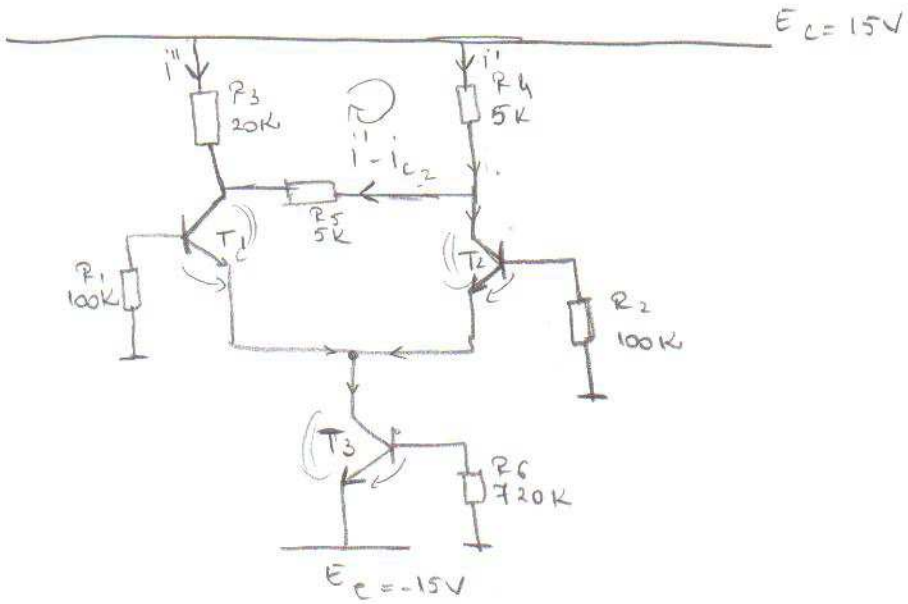
$E_C - E_e = R_2(i_{C_1} + i_{C_2}) + U_{CE_2} + R_6(i_{C_2} - i_{C_3}) \Rightarrow$

$12 = 4 + U_{CE_2} + 5 \Rightarrow \boxed{U_{CE_2} = 3V}$

$E_C - E_e = R_2(i_{C_1} + i_{C_2}) + U_{CE_2} + U_{CE_3} + R_5 \cdot i_{C_3} \Rightarrow$

$12 = 4 + 3 + U_{CE_3} + 3 \Rightarrow \boxed{U_{CE_3} = 2V}$

P1 A)



i_C:

$0 - E_e = R_6 \cdot \frac{i_{C_3}}{\beta_0} + 0,6 \Rightarrow 15 = 4,2\, i_{C_3} + 0,6 \Rightarrow \boxed{i_{C_3} = 2\,mA}$

$i_{C_1} + i_{C_2} = i_{C_3}$

$0 = R_1 \frac{i_{C_1}}{\beta_0} + 0,6 - 0,6 - R_2 \frac{i_{C_2}}{\beta_0} \Rightarrow 0 = i_{C_1} - i_{C_2} \Rightarrow i_{C_1} = i_{C_2}$ (2)

$\boxed{i_{C_1} = i_{C_2} = 1\,mA}$

$$\begin{cases} i'' + i' - i_{C_2} = i_{C_1} \Rightarrow i' + i'' = 2 \\ 5i' - 5 - 20i'' + 5i' = 0 \Rightarrow 2i' - 4i'' = 1 \Rightarrow \cancel{3i'' = 2 \Rightarrow i'' = 0,6\,mA} \\ \qquad \cancel{i' = 1,4\,mA} \end{cases}$$

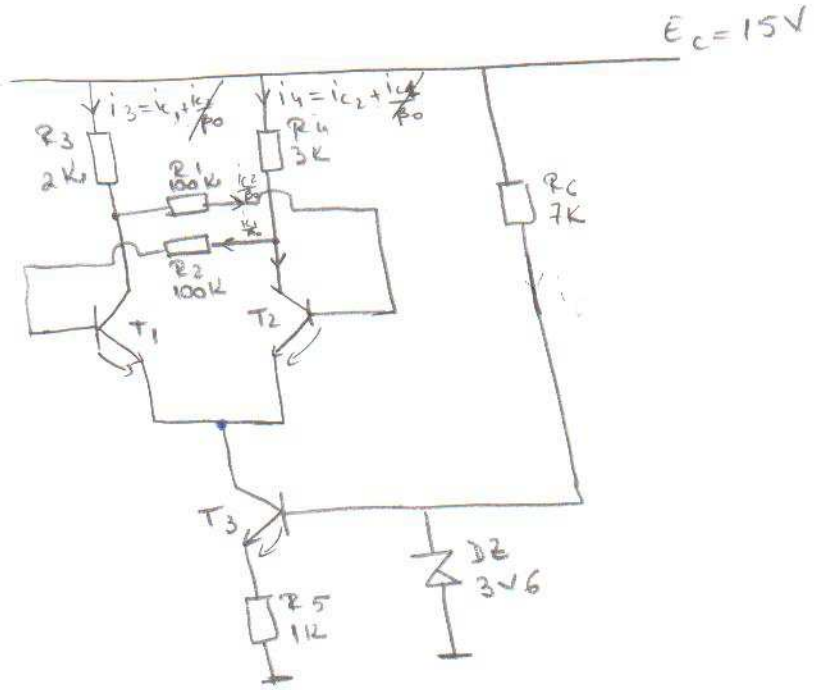
$$\Rightarrow \begin{array}{l} 2i' + 2i'' = 2 \\ 2i' - 4i'' = 1 \\ \hline 6i'' = 3 \Rightarrow i'' = 0,5\,mA \end{array} \quad ; i' = 1,5\,mA .$$

U_{CE}:
$$\begin{cases} E_c - E_e = R_3 \cdot i'' + U_{CE_1} + U_{CE_3} \Rightarrow 30 = 10 + U_{CE_1} + U_{CE_3} \Rightarrow U_{CE_1} + U_{CE_3} = 2 \\ E_c - E_e = R_4 \cdot i' + U_{CE_2} + U_{CE_3} \Rightarrow 30 = 7,5 + U_{CE_2} + U_{CE_3} \Rightarrow U_{CE_2} + U_{CE_3} = \\ 0 - E_e = R_1 \cdot \frac{i_{C_1}}{\beta_0} + 0,6 + U_{CE_3} \Rightarrow 15 = 1,6 + U_{CE_3} \Rightarrow \boxed{U_{CE_3} = 13,4\,V} \end{cases}$$

$\boxed{U_{CE_2} = 9,1\,V}$

$\boxed{U_{CE_1} = 6,6\,V}$

P1/B



i_C:
$$\begin{cases} i_{C_1} + i_{C_2} = i_{C_3} . \\ 0 - 0 = -3,6 + 0,6 + R_5 i_{C_3} \Rightarrow 3 = i_{C_3} \Rightarrow \boxed{i_{C_3} = 3mA} \\ 15 - 15 = R_3 i_{C_1} + R_1 \frac{i_{C_2}}{\beta_0} + \cancel{0,6} - \cancel{0,6} - R_2 \frac{i_{C_1}}{\beta_0} - R_4 i_{C_2} \end{cases}$$

$$0 = 2i_{C_1} + i_{C_2} - i_{C_1} - 3i_{C_2} \Rightarrow i_{C_1} - 2i_{C_2} = 0 \Rightarrow i_{C_1} = 2i_{C_2}$$

$$\Rightarrow 3i_{C_2} = 3 \Rightarrow \boxed{i_{C_2} = 1mA} \; ; \boxed{i_{C_1} = 2mA}$$

U_{CE}:

$E_c - 0 = R_3 i_{C_1} + R_1 \frac{i_{C_2}}{\beta_0} + 0,6 + U_{CE_3} + R_5 i_{C_3} \Rightarrow 15 = 4 + 1 + 0,6 + U_{CE_3} \overset{+3}{\Rightarrow}$

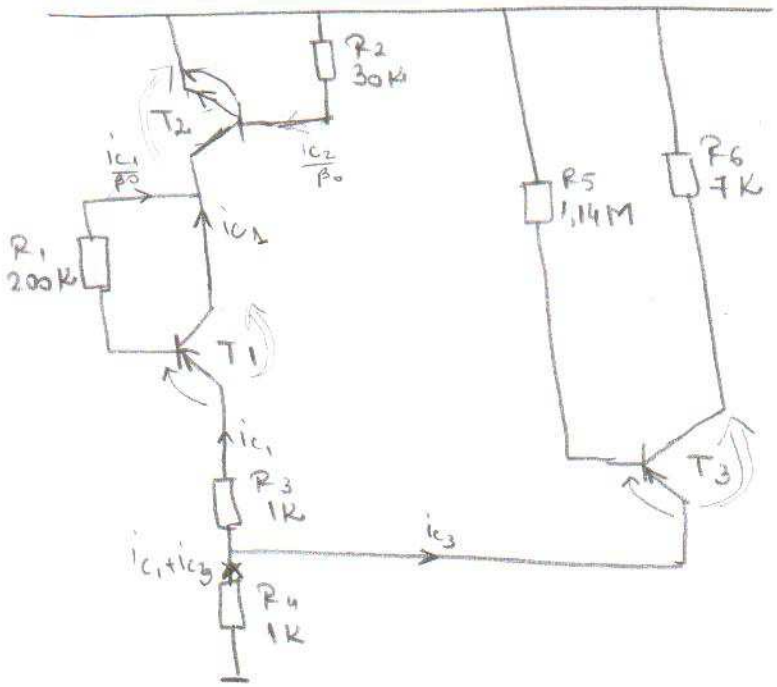
$\boxed{U_{CE_3} = 6,4\,V}$

$E_c - 0 = R_3 i_{C_1} + U_{CE_1} + U_{CE_3} + R_5 i_{C_3} \Rightarrow 15 = 4 + U_{CE_1} + 6,4 + 3 \Rightarrow \boxed{U_{CE_1} = 1,6}$

$E_c - 0 = R_4 i_{C_2} + U_{CE_2} + U_{CE_3} + R_5 i_{C_3} \Rightarrow 15 = 3 + U_{CE_2} + 6,4 + 3 \Rightarrow \boxed{U_{CE_2} = 2,6}$

P1 (c)

$E_E = -15\,V$



1140

i_C:

$0 - E_c = R_4(i_{C_1} + i_{C_2}) + 0,6 + R_5 \cdot \frac{i_{C_3}}{\beta_0} \Rightarrow 15 = i_{C_1} + i_{C_2} + 0,6 + 11,4 i_{C_3}$

$14,4 = 12,4 i_{C_3} + i_{C_2}$

$i_{C_1} = i_{C_2}$

$0,6 = R_2 \cdot \frac{i_{C_2}}{\beta_0} \Rightarrow 0,6 = 0,3 i_{C_2} \Rightarrow \boxed{i_{C_2} = 2\,mA}$

$\boxed{i_{C_1} = 2\,mA}$; $\boxed{i_{C_3} = 1\,mA}$

U_{CE}:

$0 - E_c = R_4(i_{C_1} + i_{C_2}) + U_{CE_3} + R_6 i_{C_3} \Rightarrow 15 = 3 + U_{CE_3} + 7 \Rightarrow \boxed{U_{CE_3} = 5\,V}$

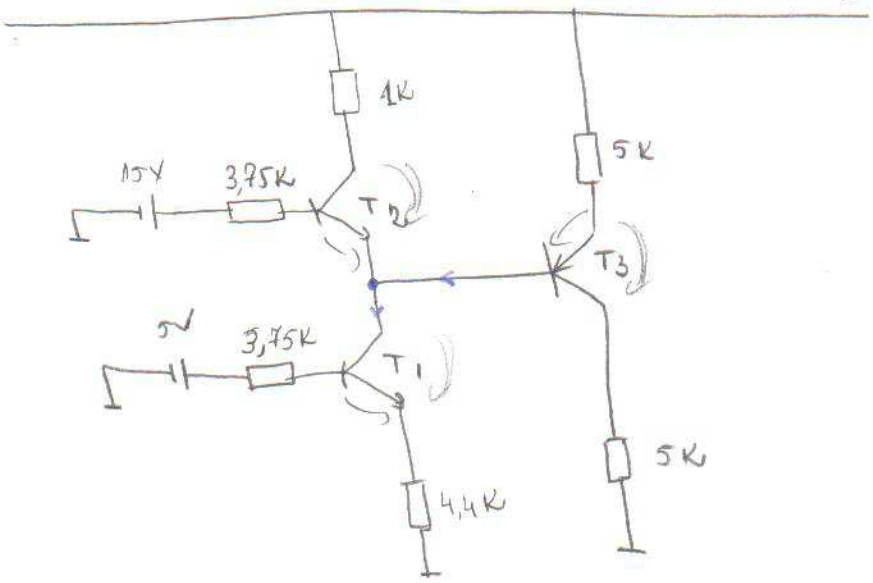
$0 - E_c = R_4(i_{C_1} + i_{C_2}) + R_3 i_{C_1} + 0,6 + R_1 \cdot \frac{i_{C_1}}{\beta_0} + U_{CE_2} \Rightarrow$

$15 = 3 + 2 + 0,6 + 4 + U_{CE_2} \Rightarrow \boxed{U_{CE_2} = 5,4\,V}$

$0 - E_c = R_4(i_{C_1} + i_{C_2}) + R_3 i_{C_1} + U_{CE_1} + U_{CE_2} \Rightarrow 15 = 3 + 2 + 5,4 + U_{CE_1}$

$\boxed{U_{CE_1} = 4,6\,V}$

(1)



i_c:

$5 = 3,75 \cdot \frac{i_{c_1}}{\beta_0} + 0,6 + i_{c_1} \cdot 4,4 \Rightarrow \boxed{i_{c_1} = 1\,mA}$

$20 - 15 = 5 i_{c_3} + 0,6 - 0,6 - 3,75 \cdot \frac{i_{c_2}}{\beta_0} \Rightarrow \boxed{i_{c_3} = 1\,mA}$

$i_{c_2} = i_{c_1} \Rightarrow \boxed{i_{c_1} = 1\,mA}$

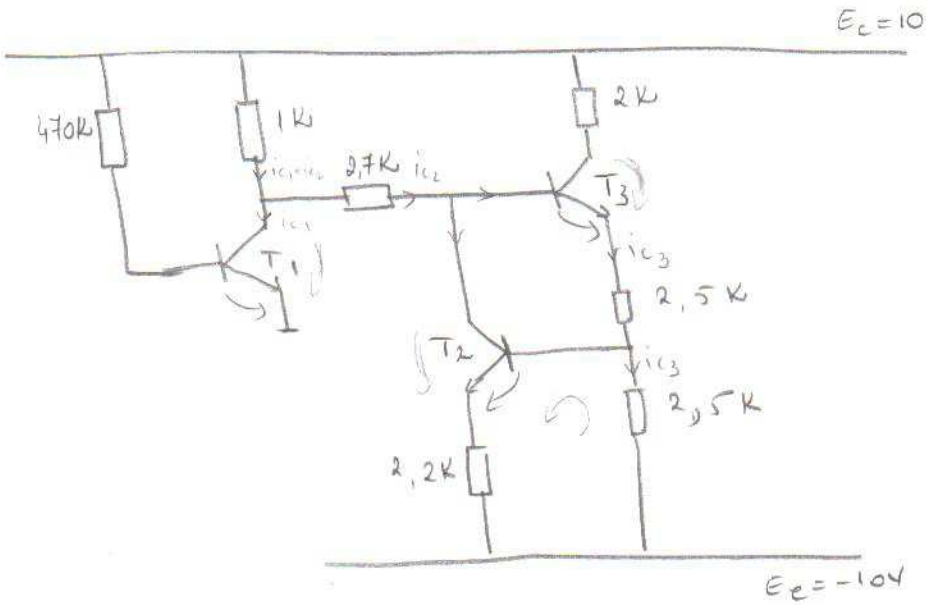
U_{CE}:

$20 - 0 = 5 i_{c_3} + U_{CE_3} + 5 i_{c_3} \Rightarrow 20 = 10 + U_{CE_3} \Rightarrow \boxed{U_{CE_3} = 10V}$

$0 = 5 i_{c_3} + 0,6 - U_{CE_2} - i_{c_2} \Rightarrow \boxed{U_{CE_2} = 4,6V}$

$20 = 1 + 4,6 + U_{CE_1} + 4,4 \Rightarrow \boxed{U_{CE_1} = 10V}$

(3)



$$i_C: \begin{cases} e_C = 4{,}7\Omega \cdot \frac{i_{C_1}}{\beta_0} + 0{,}6 \Rightarrow 10 = 4{,}7\, i_{C_1} + 0{,}6 \Rightarrow \boxed{i_{C_1} = 2\,mA} \\ 0{,}6 = 2{,}5\, i_{C_3} - 2{,}2\, i_{C_2} \\ 20 = i_{C_1} + i_{C_2} + 2{,}7\, i_{C_2} + 0{,}6 + 5\, i_{C_3} \Rightarrow 17{,}4 = 3{,}7\, i_{C_2} + 5\, i_{C_3} \end{cases}$$

$$-1{,}2 = +4{,}4\, i_{C_2} - 5\, i_{C_3}$$

$$16{,}2 = 8{,}1\, i_{C_2} \rightsquigarrow \boxed{i_{C_2} = 2\,mA}$$

$$0{,}6 = 2{,}5\, i_{C_3} - 4{,}4 \Rightarrow \boxed{i_{C_3} = 2\,mA}$$

$$U_{CE}: \begin{cases} 10 = 4 + U_{CE_1} \Rightarrow \boxed{U_{CE_1} = 6\,V} \\ 20 = 14 + U_{CE_3} \rightsquigarrow \boxed{U_{CE_3} = 6\,V} \\ 20 = 4 + 5{,}4 + 4{,}4 + U_{CE_2} \rightsquigarrow \boxed{U_{CE_2} = 6{,}2\,V} \end{cases}$$