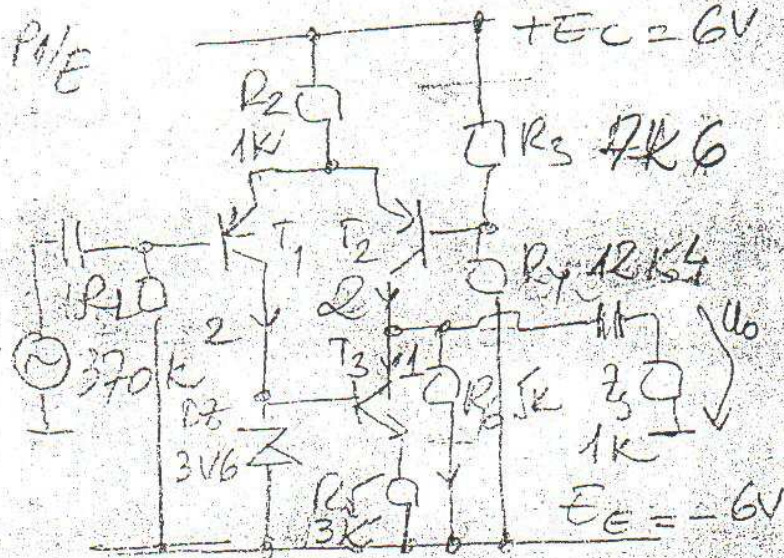


# EA/EEA - PSF (example)

P1/E

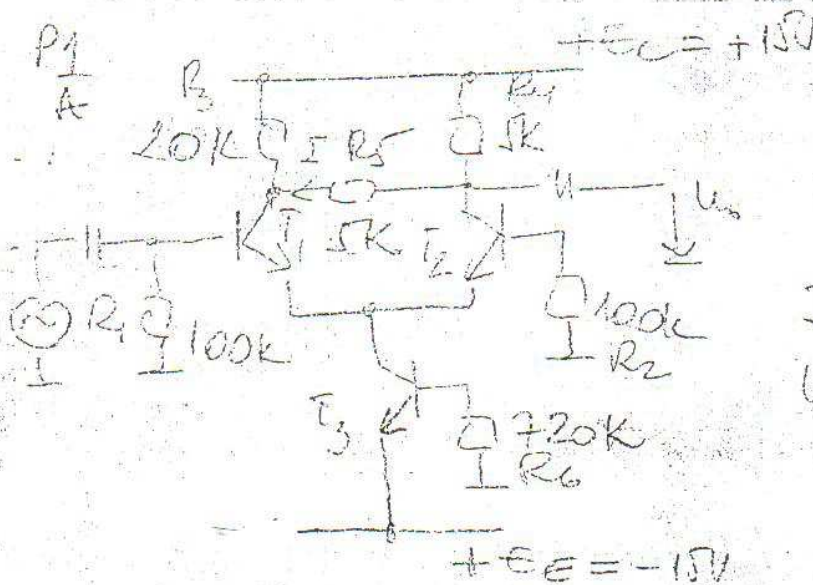


$$U_{BE} = 0,6V$$

$$\beta_0 = 100$$

	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
I <sub>C</sub>	2	2	1 mA
U <sub>CE</sub>	4,4	3V	2V

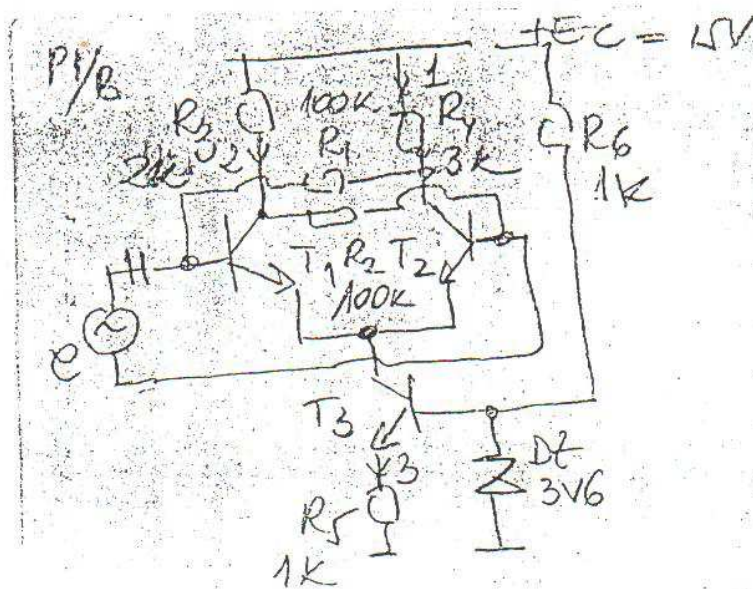
P1/A



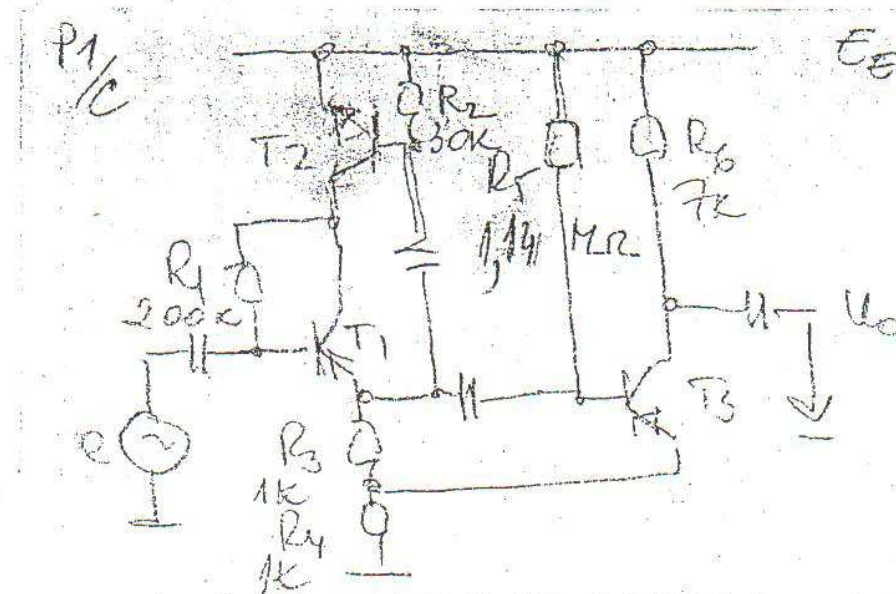
$$\beta_0 = 100$$

$$U_{BE} = 0,6$$

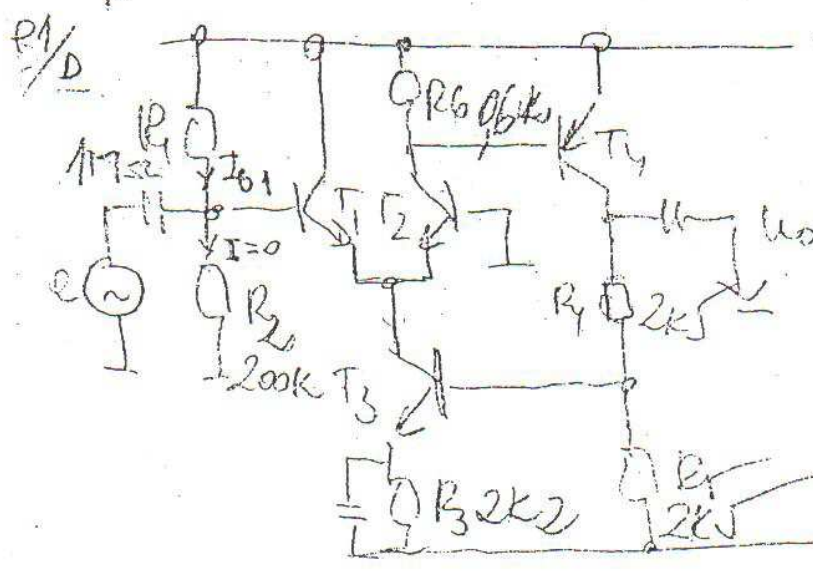
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
I <sub>C</sub>	1	1	2 mA
U <sub>CE</sub>	6,6	9,1	13,4 V



	T1	T2	T3	mA
$I_C$	2	1	3	
$U_{CE}$	1,6	2,6	6,4	V



	T1	T2	T3
$I_C$	2	2	1
$U_{CE}$	4,6	5,4	5V



	T1	T2	T3	T4
$I_C$	1	1	2	2
$U_{CE}$	10,6	10	2,8	4,0



$$\checkmark - \bar{E}_E = U_{BE} + R_6 \frac{I_{C3}}{\beta_0}$$

$P_1 / A$

$$15 = 0,6 + \frac{720}{100} I_{C3} \Rightarrow \boxed{I_{C3} = 2 \mu A}$$

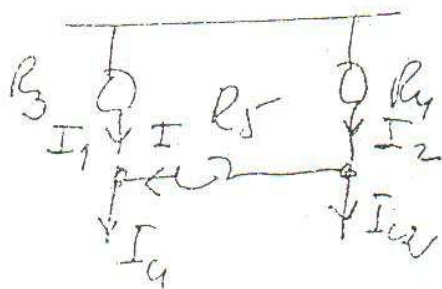
$$\checkmark I_{C1} + I_{C2} = I_{C3}$$

$$\checkmark R_1 \frac{I_{C1}}{\beta_0} + \cancel{U_{BE}} = \cancel{U_{BE}} + R_2 \frac{I_{C2}}{\beta_0}$$

$$\Rightarrow \boxed{I_{C1} = I_{C2} = 1 \mu A}$$

$$\checkmark - \bar{E}_E = R_1 \frac{I_{C1}}{\beta_0} + U_{BE} + U_{CE3}$$

$$15 = 100 \cdot \frac{1}{100} + 0,6 + U_{CE3} \Rightarrow \boxed{U_{CE3} = 13,4 V}$$



$$\left\{ \begin{array}{l} I_{C1} = I_1 + I \\ I_{C2} = I_2 - I \\ R_3 I_1 = R_5 I + R_4 I_2 \end{array} \right.$$

$$\Rightarrow I_2 = \frac{I_1 - I_2}{2} ; I_1 + I_2 = I_{C1} + I_{C2} = 2$$

$$\cancel{2/6} \cdot I_1 = \cancel{8} \cdot \frac{I_1 - I_2}{2} + 8 I_2$$

$$-8 I_1 + I_1 + I_2 + 2 I_2 = 0$$

$$I_2 = 3 I_1 \Rightarrow \boxed{I_1 = 0,5 \mu A} \quad \boxed{I_2 = 1,5 \mu A}$$

$$\checkmark E_C - E_E = U_{CE1} + U_{CE3} + R_3 I_1$$

$$30 = 13,4 + U_{CE1} + 20 \cdot 0,5$$

$$\boxed{U_{CE1} = 6,6 \text{ V}}$$

$$\checkmark R_3 I_1 + U_{CE1} = R_4 I_2 + U_{CE2}$$

$$10 + 6,6 = 5 \cdot 1,5 + U_{CE2}$$

$$\boxed{U_{CE2} = 9,1 \text{ V}}$$

Pb  $V_{CE}$

$$5.1 = V_{CE3} + 3.1 \Rightarrow V_{CE3} = 2V$$

$$12 = 1(2+2) + \cancel{0.6} + V_{CE1} + 3.6$$

$$V_{CE1} = \cancel{3.8}V$$

4/4

$$\cancel{3.8} + 0.6 = 2 + V_{CE2}$$

4/4

$$V_{CE2} = 3V$$

$$\checkmark R_3 I_{C1} + R_2 \frac{I_{C2}}{\beta_0} + \cancel{U_{BE}} = \cancel{U_{BE}} + R_1 \frac{I_{C1}}{\beta_0} + R_4 I_{C2} \quad \left( \frac{P_{1/B}}{B} \right)$$

$$\checkmark I_{C1} + I_{C2} = I_{C3}$$

$$\checkmark U_{D2} = U_{BE} + R_5 I_{C3}$$

$$3,6 = 0,6 + 1 \cdot I_{C3} \Rightarrow \boxed{I_{C3} = 3 \text{ mA}}$$

$$\rightarrow 2 I_{C1} + \frac{100}{100} I_{C2} = \frac{100}{100} + 3 I_{C2}$$

$$I_{C1} = 2 I_{C2} \Rightarrow \boxed{\begin{array}{l} I_{C2} = 1 \text{ mA} \\ I_{C1} = 2 \text{ mA} \end{array}}$$

$$\checkmark U_C = R_3 I_{C1} + R_2 \frac{I_{C2}}{\beta_0} + U_{BE} + U_{CE3} + R_4 I_{C3}$$

$$15 = 2 \cdot 2 + \frac{100}{100} \cdot 1 + 0,6 + U_{CE3} + 1 \cdot 3$$

$$\boxed{U_{CE3} = 15 - 8,6 = 6,4 \text{ V}}$$

$$\checkmark \text{At } U_{CE1} = R_2 \frac{I_{C2}}{\beta_0} + U_{BE} = 1 + 0,6 = \boxed{1,6 \text{ V}}$$

$$\checkmark U_{CE2} = R_1 \frac{I_{C1}}{R_1} + U_{BE} = \frac{100}{100} \cdot 2 + 0,6 = \underline{\underline{2,6}}$$



(P1/c)

$$La \bar{I}_2 \quad \checkmark \quad V_{BE} = R_2 \frac{\bar{I}_{C2}}{\beta_{D0}}$$

$$0,6 = \frac{30}{100} \bar{I}_{C2} \Rightarrow \boxed{\bar{I}_{C2} = 2 \mu A}$$

$$\checkmark \left( \frac{\cancel{R_1}}{\beta_{D0}} + 1 \right) \bar{I}_{C1} = \bar{I}_{C2} \Rightarrow \boxed{\bar{I}_{C2} = 2 \mu A}$$

$$\checkmark -E_E = R_5 \frac{\bar{I}_{C3}}{\beta_{D0}} + \underline{V_{BE}} + R_4 (\bar{I}_Q + \bar{I}_{C3})$$

$$15 = 0,6 + 1 \cdot 2 + \bar{I}_{C3} \left( 1 + \frac{R_5}{100} \right)$$

$$12,4 = \bar{I}_{C3} \left( 1 + \frac{1,4 \text{ M}\Omega}{100} \right) \Rightarrow \boxed{\bar{I}_{C3} = 1 \mu A}$$

$$\checkmark V_{CE1} = V_{BE} + R_1 \frac{\bar{I}_Q}{\beta_{D0}} = 0,6 + \frac{200}{100} \cdot 2 = \boxed{4,6 \text{ V}}$$

$$\checkmark -E_E = V_{CE1} + V_{CE2} + R_3 \bar{I}_{C1} + R_4 (\bar{I}_Q + \bar{I}_{C3})$$

$$15 = 4,6 + V_{CE2} + 2 + 3$$

$$V_{CE2} = \boxed{5,4 \text{ V}}$$

$$\checkmark -E_E = R_4 (\bar{I}_Q + \bar{I}_{C3}) + V_{CE3} + R_6 \bar{I}_{C3} \Rightarrow \boxed{V_{CE3} = 5 \text{ V}}$$

$$\checkmark \quad \frac{I_{C1}}{\beta} \cdot R_1 + \cancel{V_{BE}} - \cancel{V_{BE}} = E_C \quad \text{(P1/D)}$$

$$I_{C1} = \frac{10 \cdot 100}{1000} = \underline{\underline{1 \text{ mA}}}$$

$$\checkmark \quad I_{C2} R_6 = V_{BE}$$

$$I_{C2} \cdot 0,6 \text{ k} = 0,6 \Rightarrow \underline{\underline{I_{C2} = 1 \text{ mA}}}$$

$$\checkmark \quad I_{C3} = I_{C1} + I_{C2} = \underline{\underline{2 \text{ mA}}}$$

$$V_{BE} + R_3 (I_{C1} + I_{C2}) = R_5 I_{C4}$$

$$0,6 + 2 \cdot 2 \text{ k} = 2,5 \text{ k} I_{C4}$$

$$I_{C4} = \underline{\underline{2 \text{ mA}}}$$

$$\checkmark \quad V_{CE1} = R_1 \frac{I_{C1}}{\beta_0} + V_{BE} = 1000 \cdot \frac{1}{100} + 0,6 = \underline{\underline{10,6}}$$

$$\checkmark \quad V_{CE2} = V_{CE1} - R_6 I_{C2} = 10,6 - 0,6 \cdot 1 = \underline{\underline{10}}$$

$$E_C + E_E = V_{CE1} + V_{CE3} + R_3 I_{C3}$$

$$20 = 10,6 + V_{CE3} + 2 \cdot 3$$

$$\checkmark \quad V_{CE3} = 20 - \frac{17,2}{1} = \underline{\underline{2,8 \text{ V}}}$$

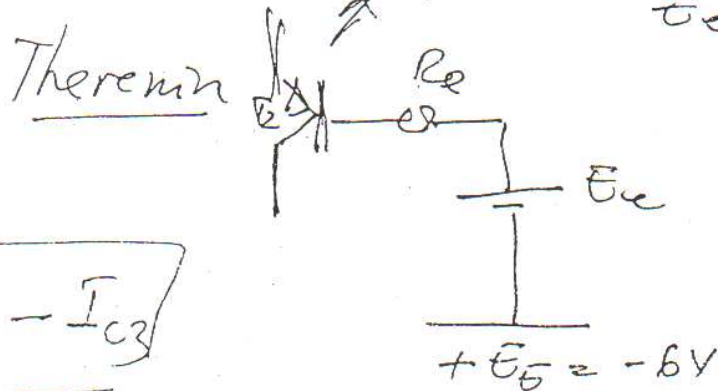


P1/C

$$V_{D2} = V_{BE} + R_5 I_{C3}$$

$$V_{EC} - E_E = R_2 (I_G + I_{C2}) + V_{BE} + R_1 \frac{I_G}{\beta_0}$$

$$R_1 \frac{I_G}{\beta_0} + V_{BE} = V_{BE} + \underbrace{(R_3 || R_4)}_{R_E} \frac{I_{C2}}{\beta_0} \rightarrow E_E \frac{R_4}{R_3 + R_4}$$



$$I_{R_E} = I_{C2} - I_{C3}$$

$$R_E I_{R_E} = V_{CE3} + R_5 I_{C3}$$

$$V_{CE1} + V_{BE} = V_{CE2} + V_{CE3}$$

$$V_{EC} - E_E = R_2 (I_G + I_{C2}) + V_{CE1} + V_{D2}$$

Calculate (1)  $3.6 = 0.6 + 3 I_{C3} \Rightarrow I_{C3} = 1 \mu A$

$R_E < 7K\Omega \rightarrow$  Neglijer  $I_{B2}$  in (3)

$$370 \cdot \frac{I_G}{100} = 12 \cdot \frac{12.4}{200}$$

$$I_G = \frac{12.4 \cdot 12 \cdot 5}{370} = 2.01 = 2 \mu A$$

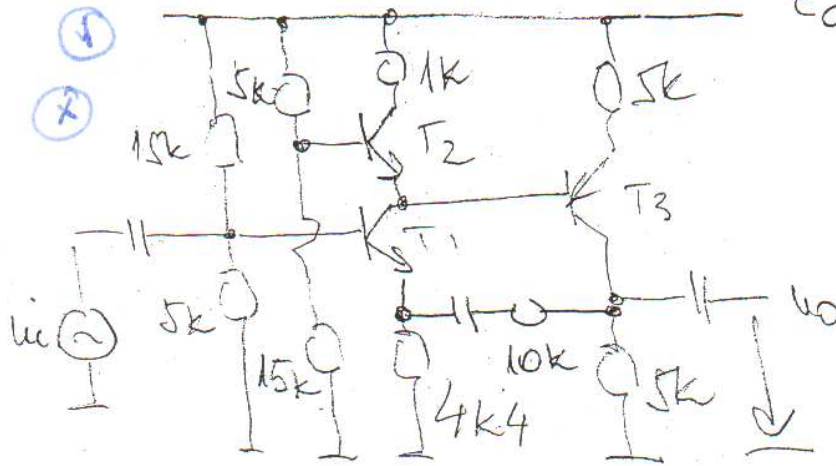
$$12 = (2 + I_{C2}) + 0.6 + \frac{370}{100} \cdot 2 \Rightarrow I_{C2} = 2 \mu A$$

# EA / ECA (examen) 1/4

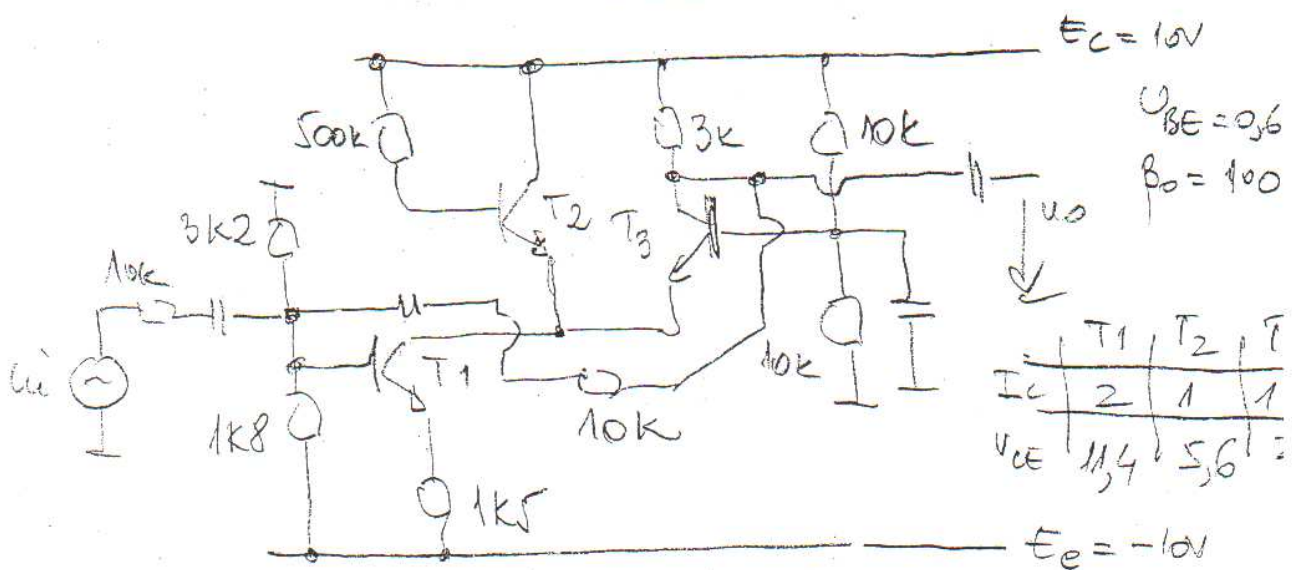
$$E_C = 20V$$

$$U_{BE} = 0.6V$$

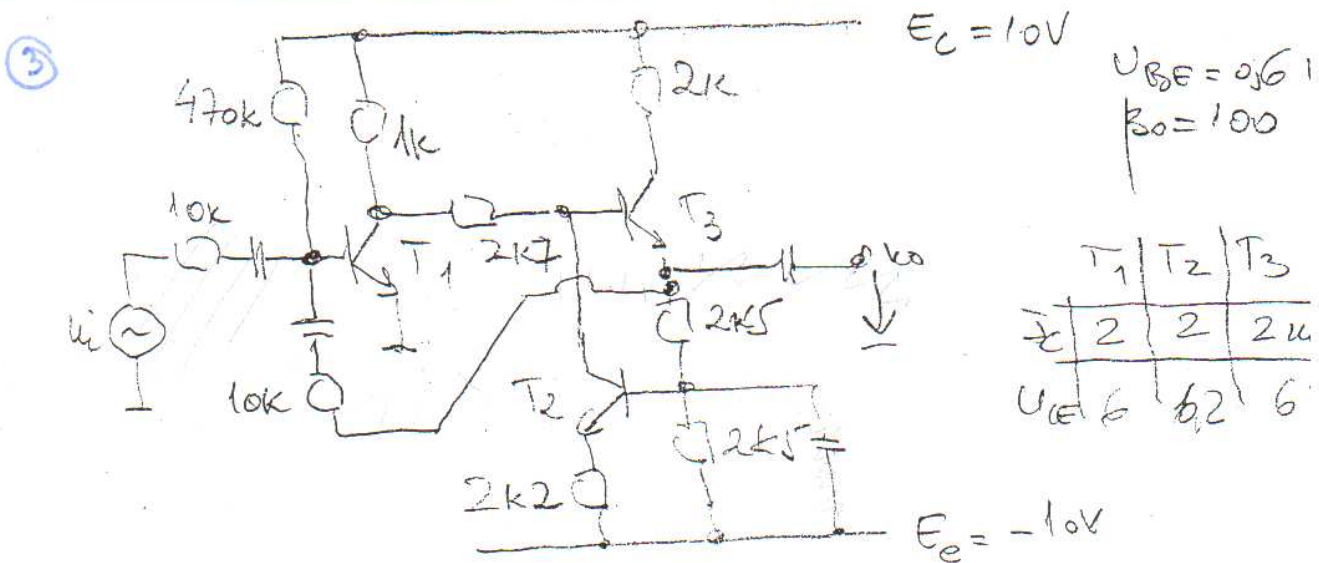
$$\beta_0 = 100$$



	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
$I_C$	1	1	1
$U_{CE}$	10	4,6	10



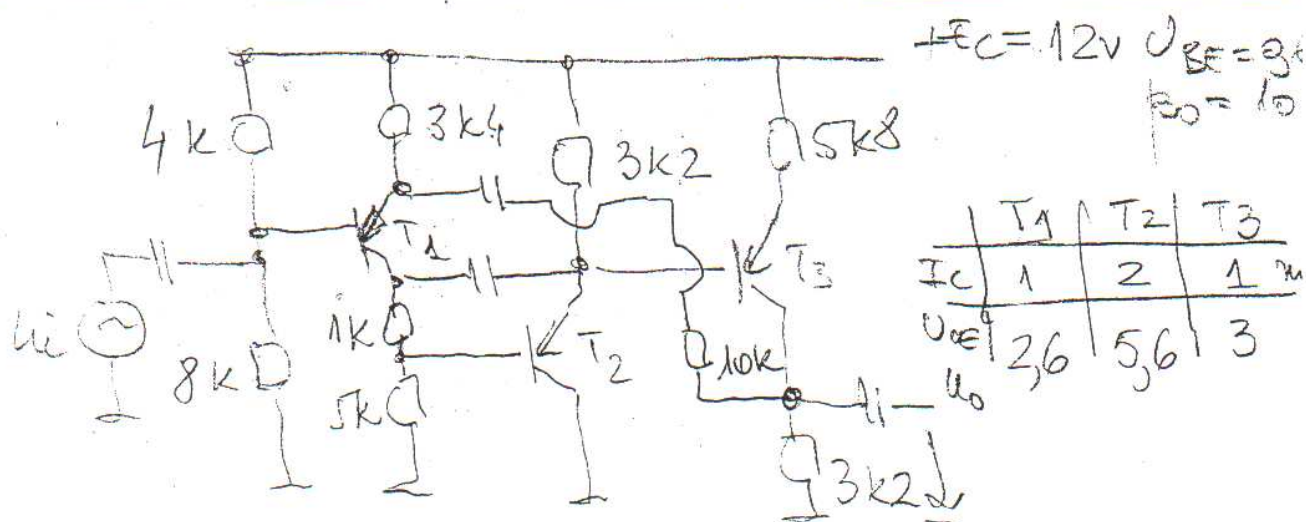
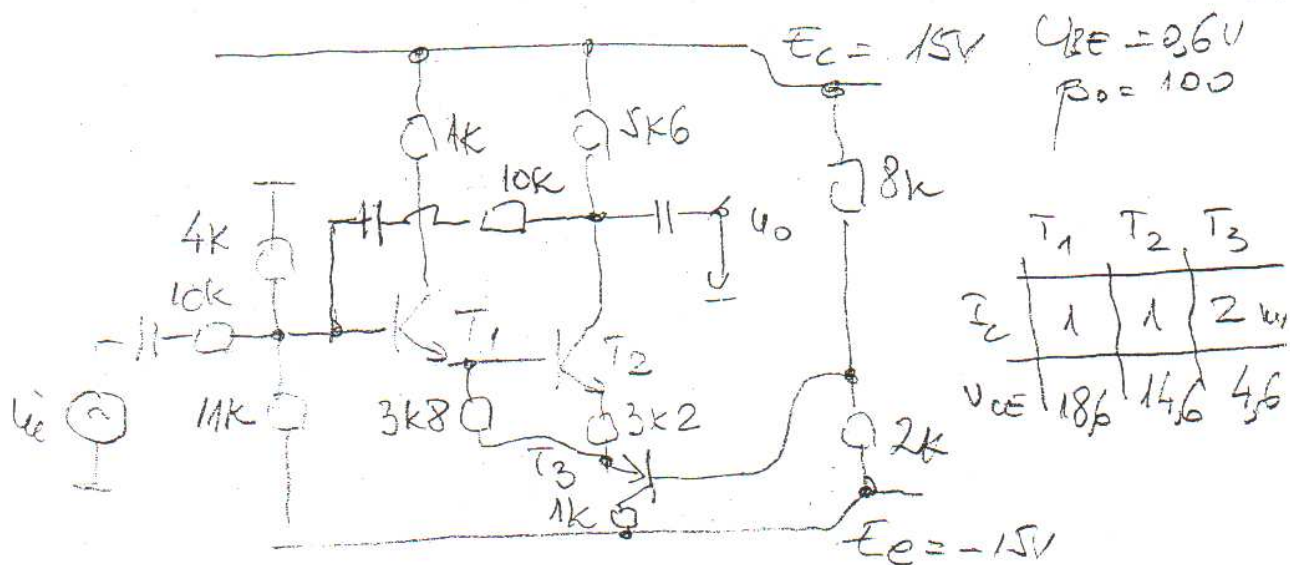
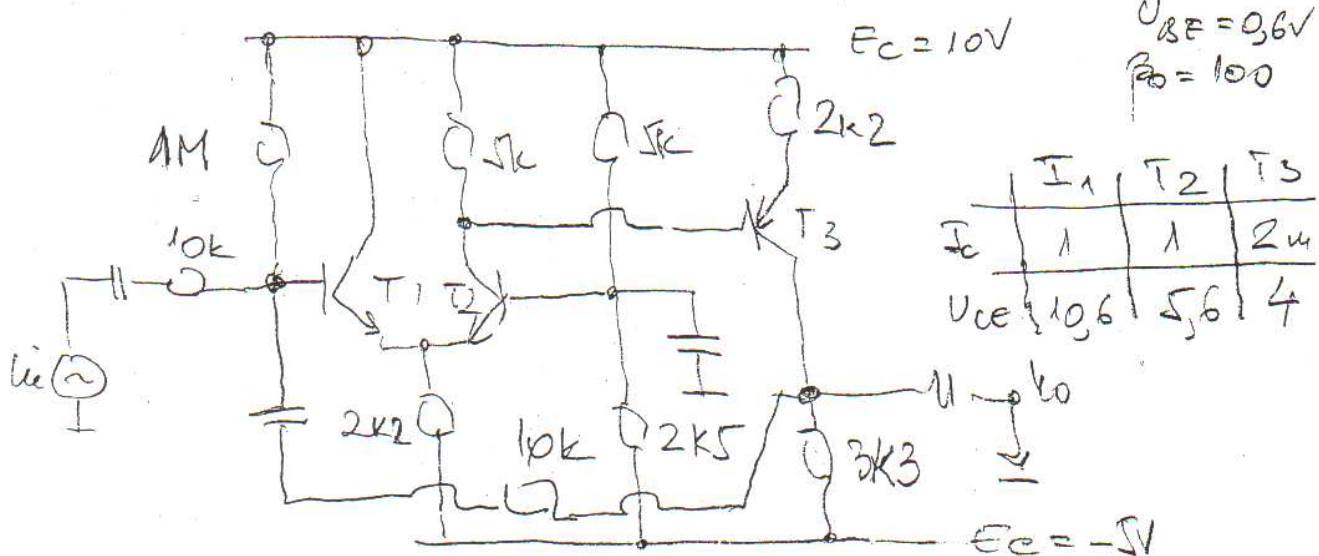
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
$I_C$	2	1	1
$U_{CE}$	11,4	5,6	5,6



	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
$I_C$	2	2	2
$U_{CE}$	6	6,2	6

ЕК / ЕЕА

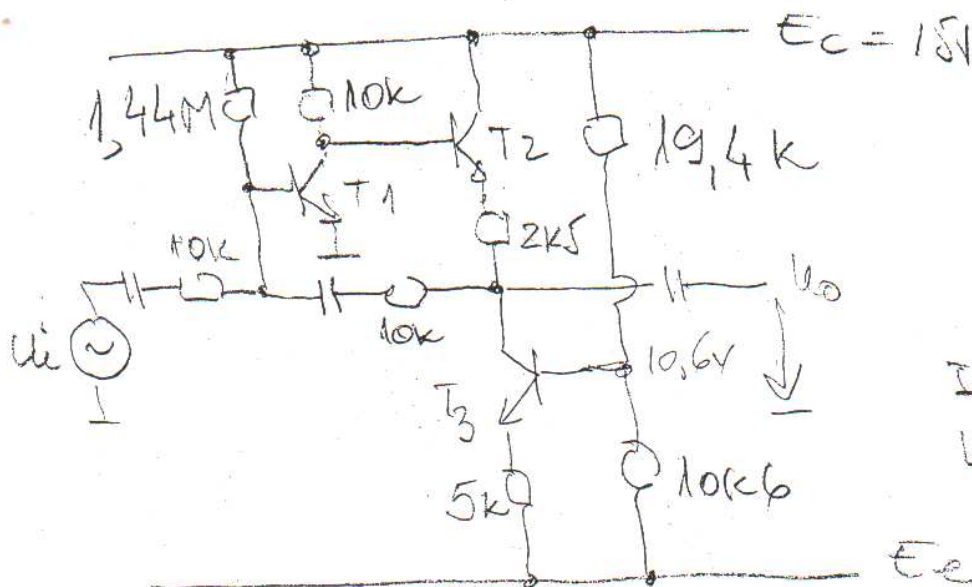
2/4



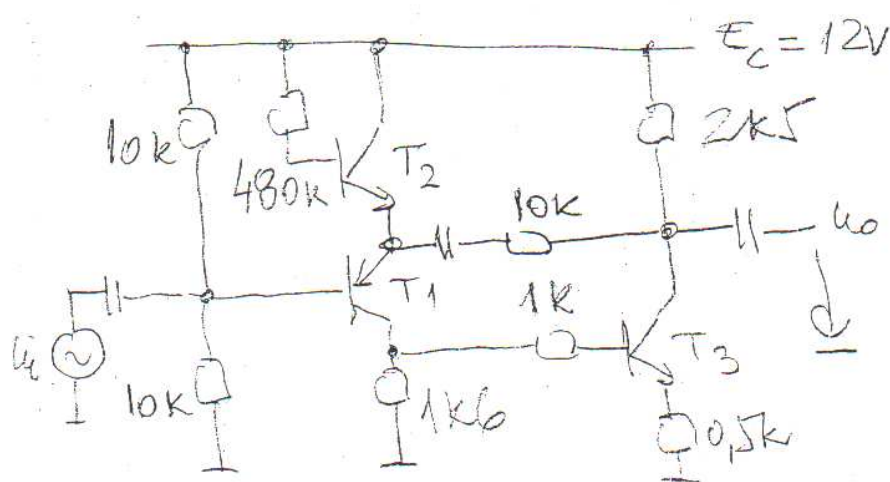


EA/EEN

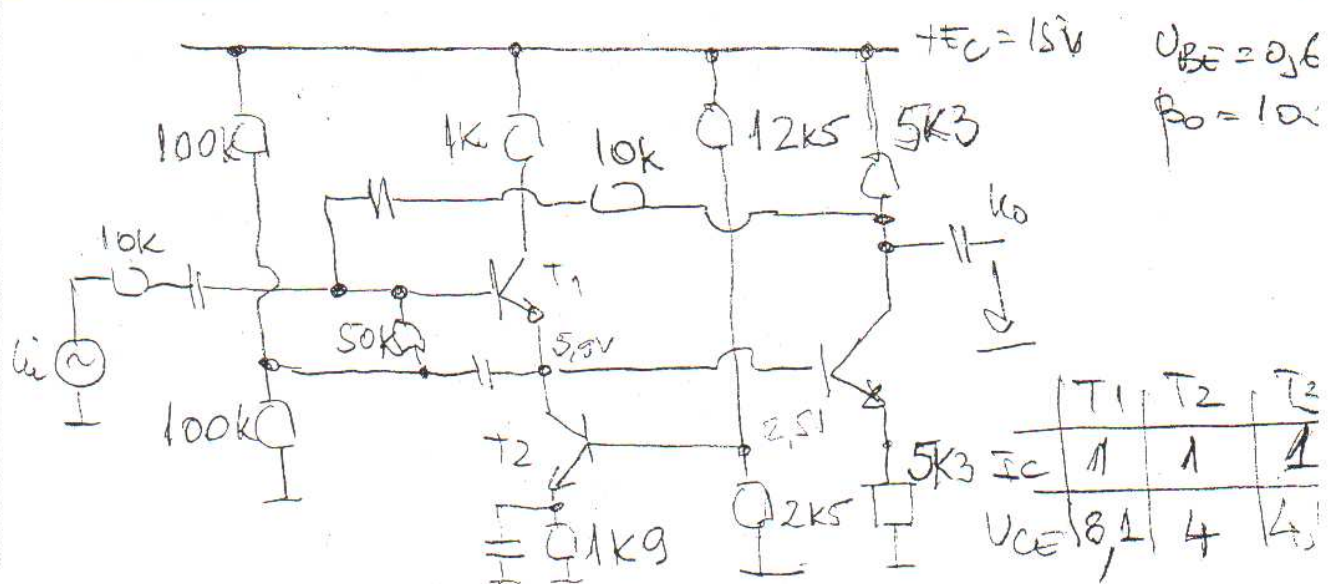
3/4



	T1	T2	T3
$I_C$	1	2	2
$U_{CE}$	5	10.6	4.1



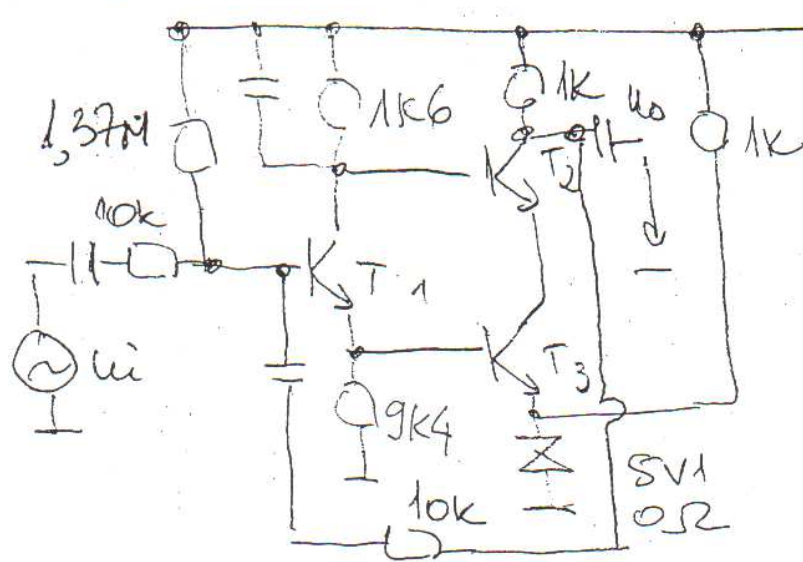
	T1	T2	T3
$I_C$	1	1	2
$U_{CE}$	5	5.4	6



	T1	T2	T3
$I_C$	1	1	1
$U_{CE}$	8.1	4	4

CA / CCA

4/4

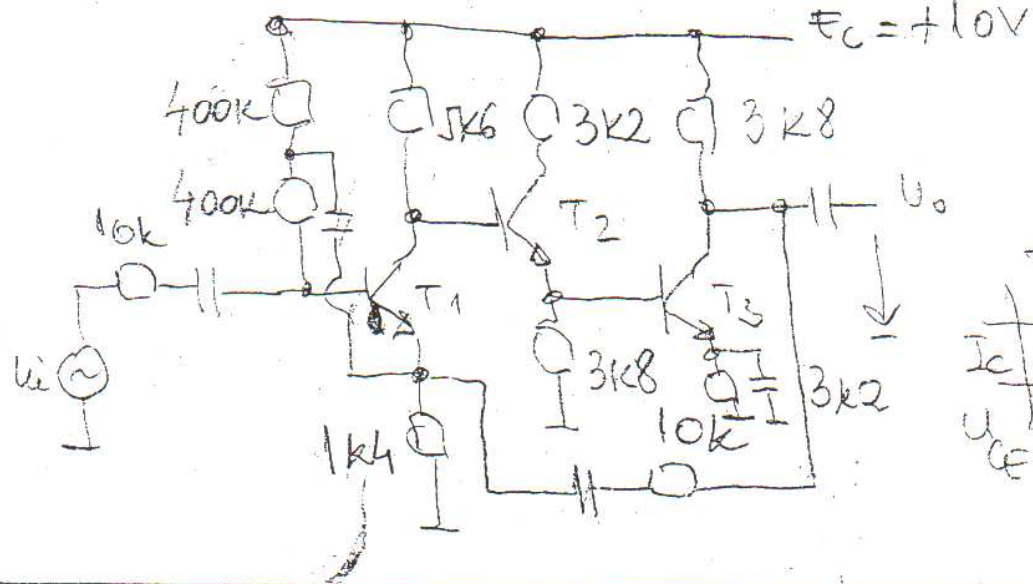


$E_C = 20V$

$U_{BE} = 0.6V$

$\beta_0 = 100$

	T1	T2	T3
$I_C$	1	1	1 mA
$U_{CE}$	9	4	9V

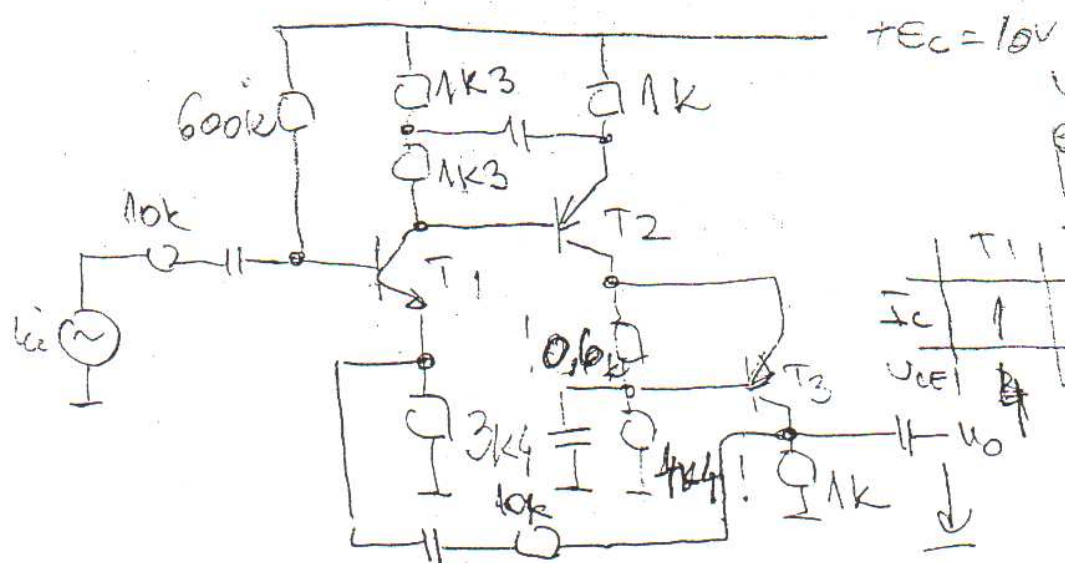


$E_C = +10V$

$U_{BE} = 0.6V$

$\beta_0 = 100$

	T1	T2	T3
$I_C$	1	1	1 mA
$U_{CE}$	3	3	3



$E_C = 10V$

$U_{BE} = 0.6V$

$\beta_0 = 100$

	T1	T2	T3
$I_C$	1	2	1 mA
$U_{CE}$	4	3	4