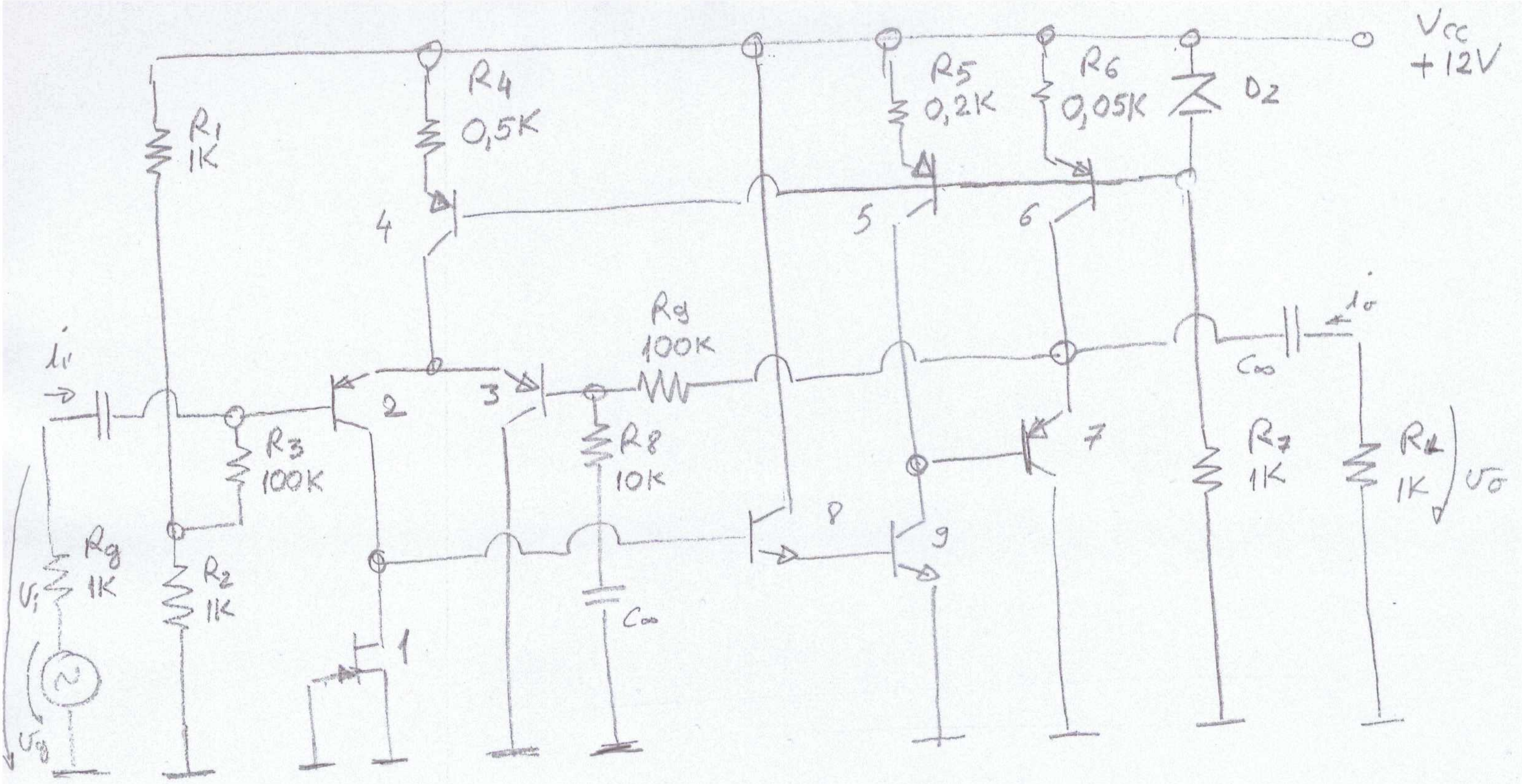


Fig 1

Ptr. circuitul din Fig 1 se cunosc :

Q_1 : $I_{DSS} = 1mA$; $V_T = -1\,V$; $r_{ds} = \infty$

$Q_{2\div 7}$: $V_{EB}\big|_{RAN} \cong 0,6V$; $\beta_F = \beta_0 = 500$; $r_{ce} = \infty$

$Q_{8,9}$: $V_{BE}\big|_{RAN} \cong 0,6V$; ———— " ; ———— "

D_Z : $V_Z = 4,6\,V$; $I_{Z\,min} = 1mA$; $R_Z = 0$

Se cer :
- PSF
- $A_{vg} = \dfrac{v_o}{v_g}$
- $R_i = \dfrac{v_i}{i_i}$
- $R_o = \dfrac{v_o}{i_o}$
- $A_i = \dfrac{i_o}{i_i}$
- $A_z = \dfrac{v_o}{i_i}$

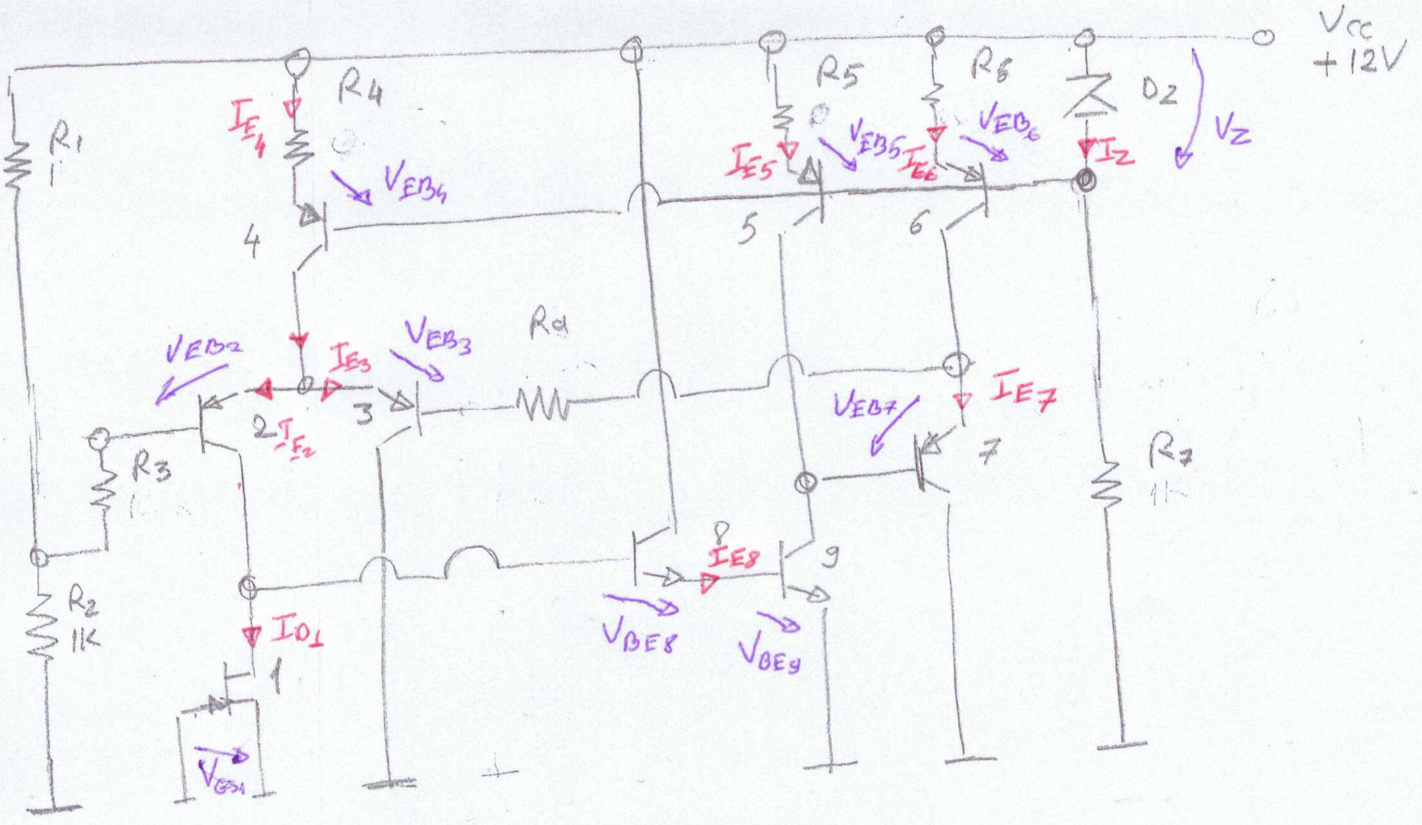


Fig 2.a Schema de C.C.

$V_{GS_1} = 0 \Rightarrow I_{D_1} = I_{DSS_1} = 1mA$

$pp\ (I_{B_8} << I_{D_1}) \Rightarrow I_{C_2} \simeq I_{D_1} = 1mA$

$pp\ I_Z > I_{Z\,min}$, dioda în reg de străpungere

$V_Z - V_{EB_2} - I_{E_6} R_6 = 0 \Rightarrow I_{E_6} \simeq I_{C_6} = \dfrac{V_Z - V_{EB_6}}{R_6} = 20mA$

$pp\ (I_{B_3} << I_{C_6}) \Rightarrow I_{C_6} \cong I_{E_7}$

$V_Z - V_{EB_5} - I_{E_5} R_5 = 0 \Rightarrow I_{E_5} \simeq I_{C_5} = \dfrac{V_Z - V_{EB5}}{R_5} = 5mA$

$pp\ (I_{B_7} << I_{C_5}) \Rightarrow I_{C_5} \cong I_{C_9} = 5mA$

$V_Z - V_{EB_4} - I_{E_4} R_4 = 0 \Rightarrow I_{E_4} \simeq I_{C_4} = \dfrac{V_Z - V_{EB_4}}{R_4} = 2mA$

$I_{C_4} = I_{E_2} + I_{E_3} \Rightarrow I_{C_3} \simeq I_{C_4} - I_{E_2} = 1mA$

$I_{E_8} = I_{B_9} \cong \dfrac{I_{C_9}}{\beta_F} = 10\mu A$

2 $pp\ (I_{B_6} + I_{B_5} + I_{B_4}) << I_Z \Rightarrow V_{CC} = V_Z + I_Z R_7 \Rightarrow I_Z = \dfrac{V_{CC} - V_Z}{R_Z} = \underline{10{,}4mA}$

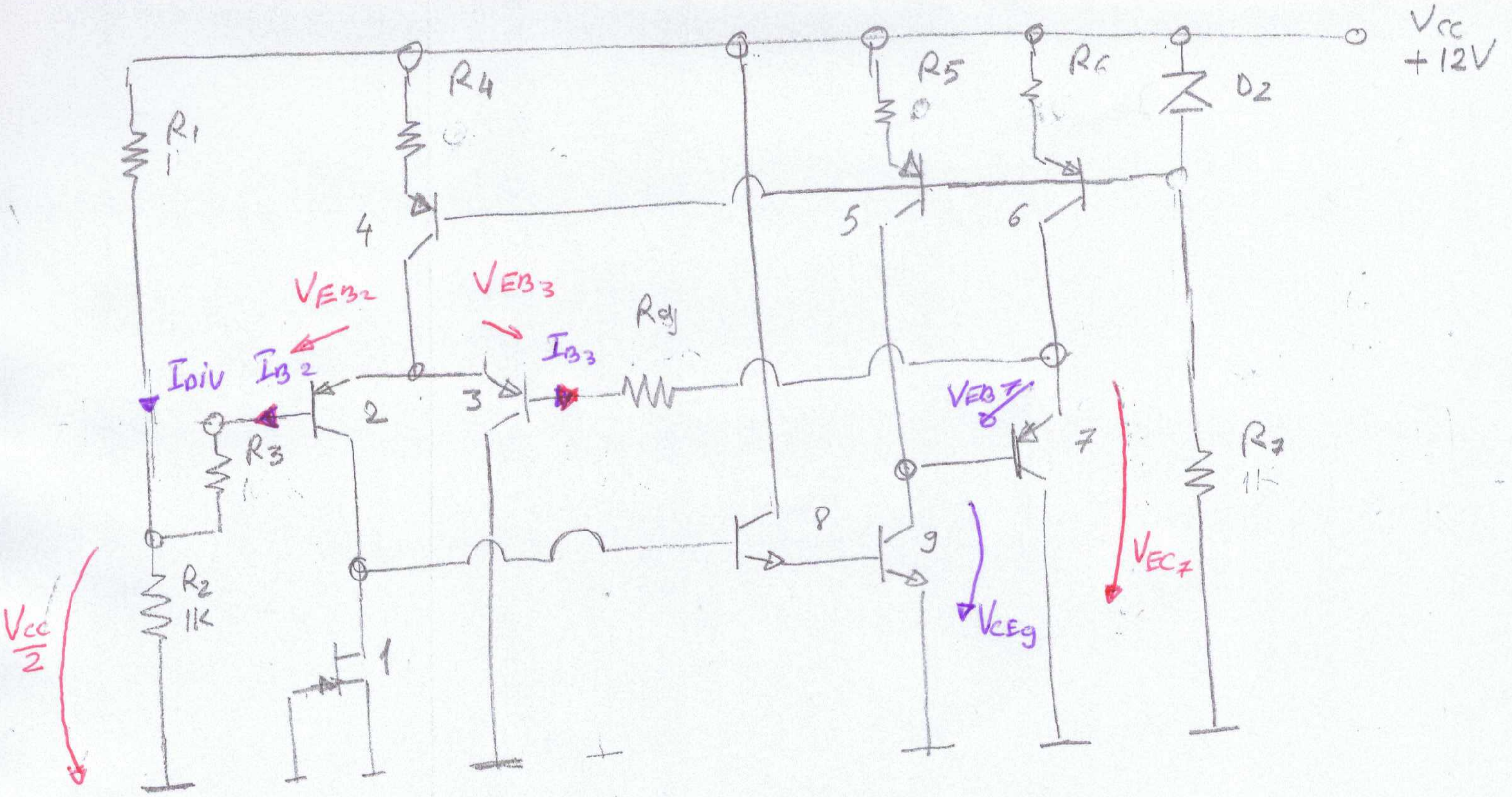


Fig 2.6 Schema de C.C.

pp ($I_{DIV} >> I_{B3}$)

notatie: $V_{cc} \cdot \frac{R_2}{R_2+R_1} = \frac{V_{cc}}{2}$

V_{EC_7}

$$-\frac{V_{cc}}{2} - I_{B_2} R_3 - V_{EB_2} + V_{EB_3} + I_{B_3} R_g + V_{EC_7} = 0$$

$$V_{EC_7} \simeq \frac{V_{cc}}{2} = 6V$$

$$-\frac{V_{cc}}{2} - I_{B_2} R_3 - V_{EB_2} + V_{EB_3} + I_{B_3} R_g + V_{EB_7} + V_{CE_9} = 0$$

V_{CE_9}

$$V_{CE_9} = \frac{V_{cc}}{2} - V_{EB} = 5,4V$$

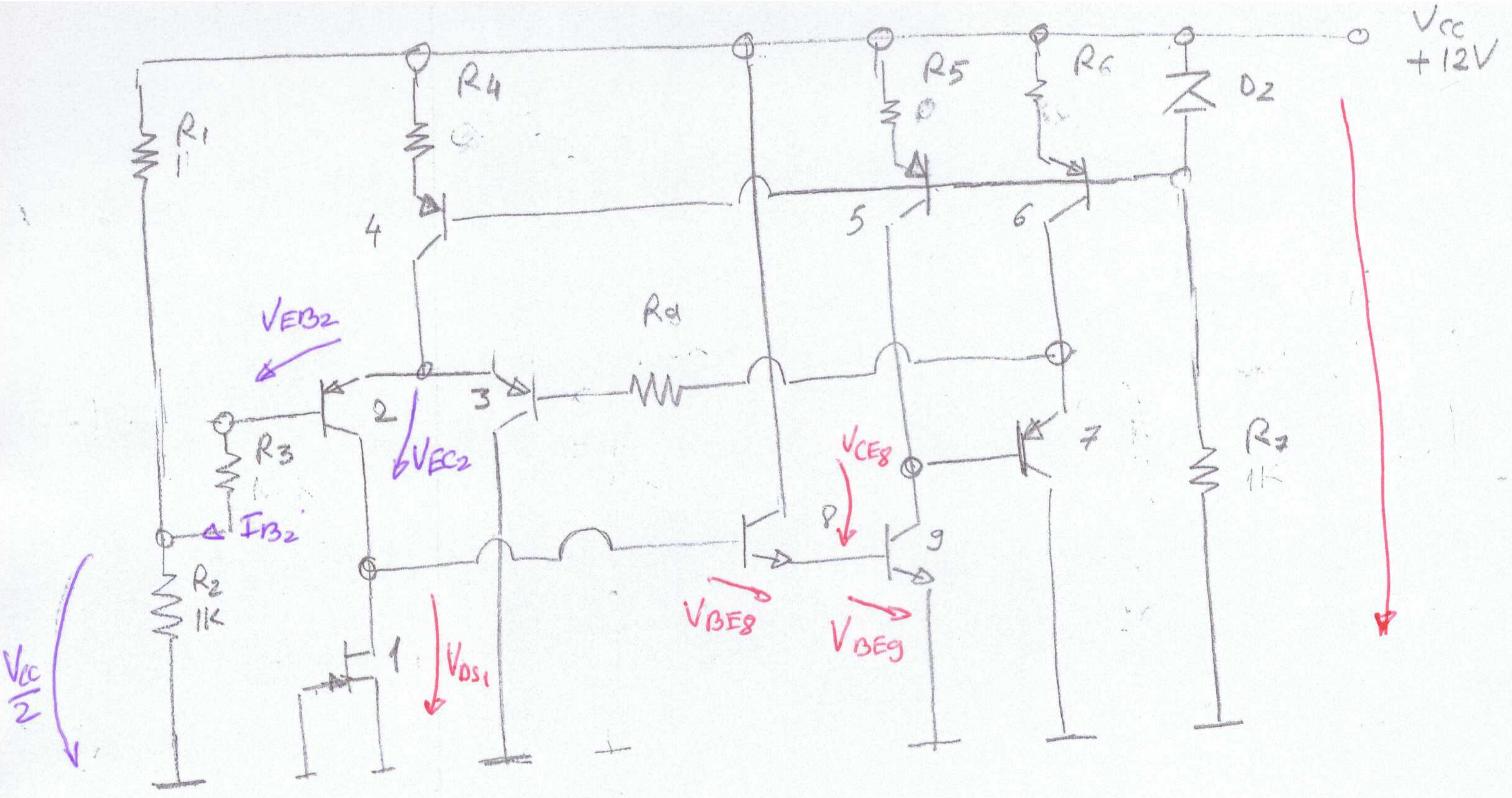


Fig 2.C Schema de C.C.

$$-V_{CC} + V_{CE8} + V_{BE9} = 0$$

V_{CE8}

$$V_{CE8} = V_{CC} - V_{BE} = 11{,}4\,V$$

$$-V_{DS1} + V_{BE8} + V_{BE9} = 0$$

V_{DS1}

$$V_{DS1} = 2V_{BE} = 1{,}2\,V$$

$$-\frac{V_{CC}}{2} - I_{B2}R_3 - V_{EB2} + V_{EC2} + V_{BE8} + V_{BE9} = 0$$

V_{EC2}

$$V_{EC2} = \frac{V_{CC}}{2} + I_{B2}R_3 - V_{BE} \simeq 5{,}4\,V$$

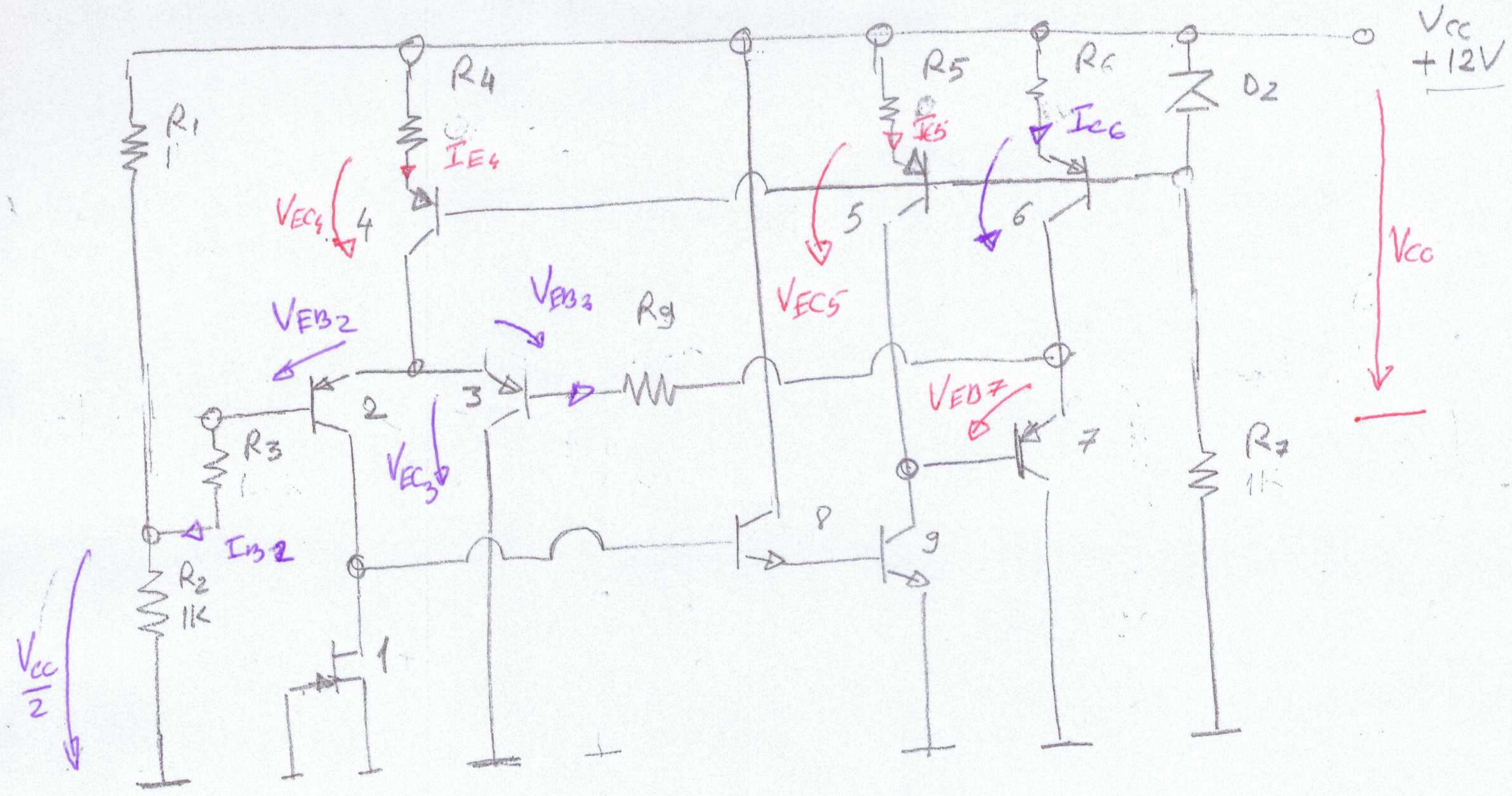


Fig 2.d Schema de C.C.

$$-\frac{V_{cc}}{2} - I_{B3} R_3 - V_{EB2} + V_{EC3} = 0$$

V_{EC3}

$$V_{EC3} = V_{CC}/2 + I_{B2} R_3 + V_{EB} \simeq 6{,}6\,V$$

$$-V_{CC} + I_{E4} R_4 + V_{EC4} + V_{EB2} + I_{B2} R_3 + \frac{V_{CC}}{2} = 0$$

V_{EC4}

$$V_{EC4} = V_{CC} - \frac{V_{CC}}{2} - I_{E4} R_4 - I_{B2} R_3 - V_{EB2} \simeq 4{,}4\,V$$

$$-V_{CC} + I_{C6} R_6 + V_{EC6} - I_{B3} R_9 - V_{EB3} + V_{EB2} + R_3 I_{B2} + \frac{V_{CC}}{2} = 0$$

V_{EC6}

$$V_{EC6} \simeq V_{CC}/2 - R_6 I_{C6} \simeq 5\,V$$

$$-V_{CC} + I_{C5} R_5 + V_{EC5} - V_{EB7} - I_{B3} R_9 - V_{EB6} + V_{EB2} + I_{B2} R_3 + \frac{V_{CC}}{2} = 0$$

V_{EC5}

$$V_{EC5} \simeq \frac{V_{CC}}{2} - R_5 I_{C5} + V_{BE} = 5{,}6\,V$$

Centralizare rezultate

	I	V	
D_Z	$\frac{V_{CC}-V_Z}{R_7}$	V_Z	strapungere
1	I_{DSS}	$2V_{BE}$	saturatie
2	I_{DSS}	$\frac{V_{CC}}{2}+V_{BE}$	RAN
3	I_{DSS}	$\frac{V_{CC}}{2}+V_{BE}$	RAN
4	$\frac{V_Z-V_{EB}}{R_4}$	$\frac{V_{CC}}{2}-V_{EB}-1V$	RAN
5	$\frac{V_Z-V_{EB}}{R_5}$	$\frac{V_{CC}}{2}+V_{EB}-1V$	RAN
6	$\frac{V_Z-V_{EB}}{R_6}$	$\frac{V_{CC}}{2}-1V$	RAN
7	$\frac{V_Z-V_{EB}}{R_6}$	$V_{CC}/2$	RAN
8	$\frac{V_Z-V_{EB}}{\beta_F R_5}$	$V_{CC}-V_{BE}$	RAN
9	$\frac{V_Z-V_{EB}}{R_5}$	$\frac{V_{CC}}{2}-V_{EB}$	RAN

Verif ip:

$$I_{B8}=\frac{I_{C8}}{\beta_F}=\frac{I_{C9}}{\beta_F^2}\le\frac{5}{(500)^2} \ll 1mA$$

$$I_{B2}\le\frac{I_{C2}}{\beta_F}=\frac{1}{500}mA \ll \frac{V_{CC}}{R_1+R_2}=6mA$$

$$I_{B6}+I_{B5}+I_{B4}=\frac{I_{C6}+I_{C5}+I_{C4}}{\beta_F}=\frac{27}{500}mA \ll I_Z=10mA$$

$$I_{B7}=\frac{I_{C7}}{\beta_F}\le\frac{20}{500}mA \ll I_{C5}=5mA$$

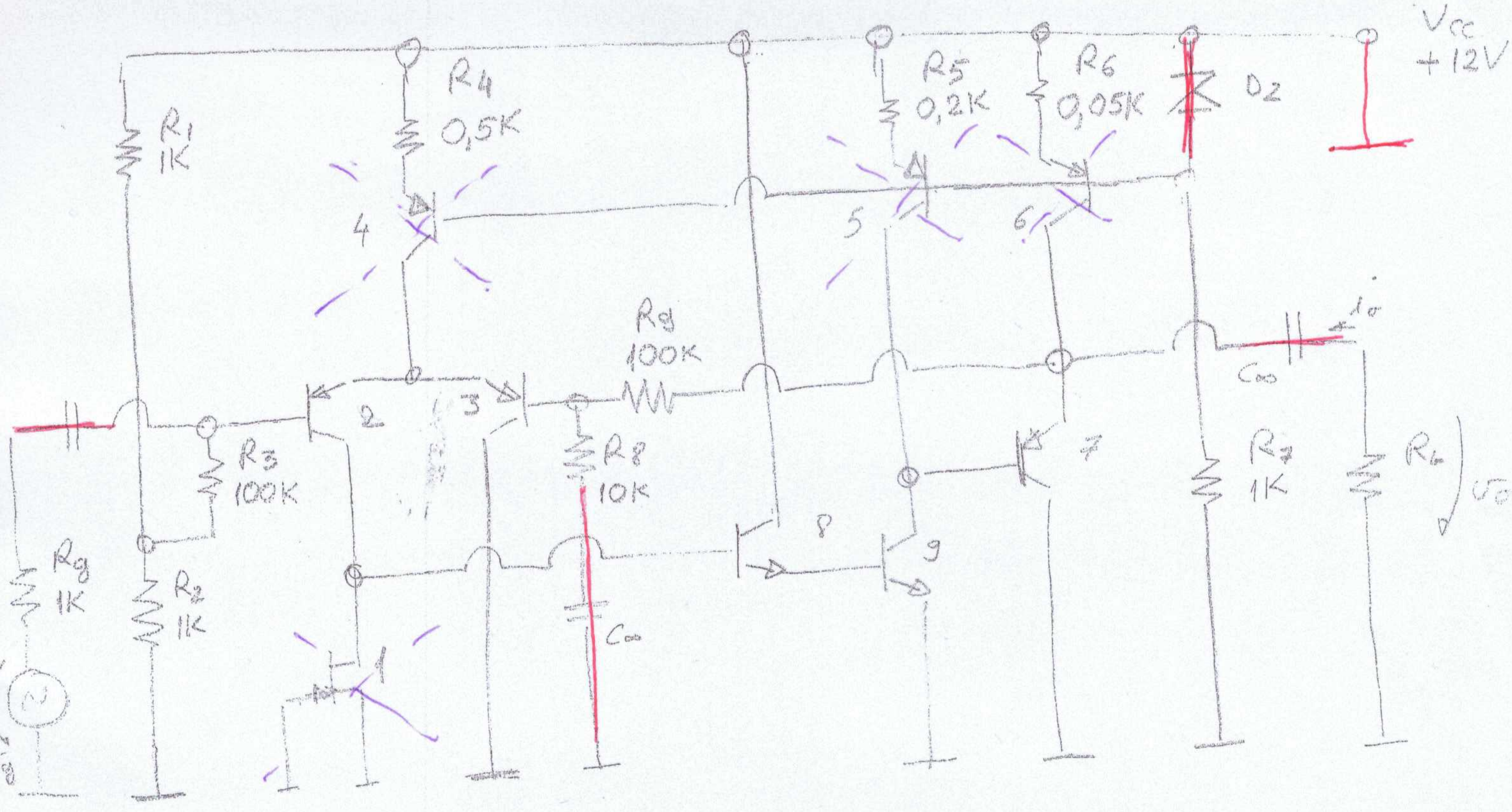


fig 3 a schema de ca

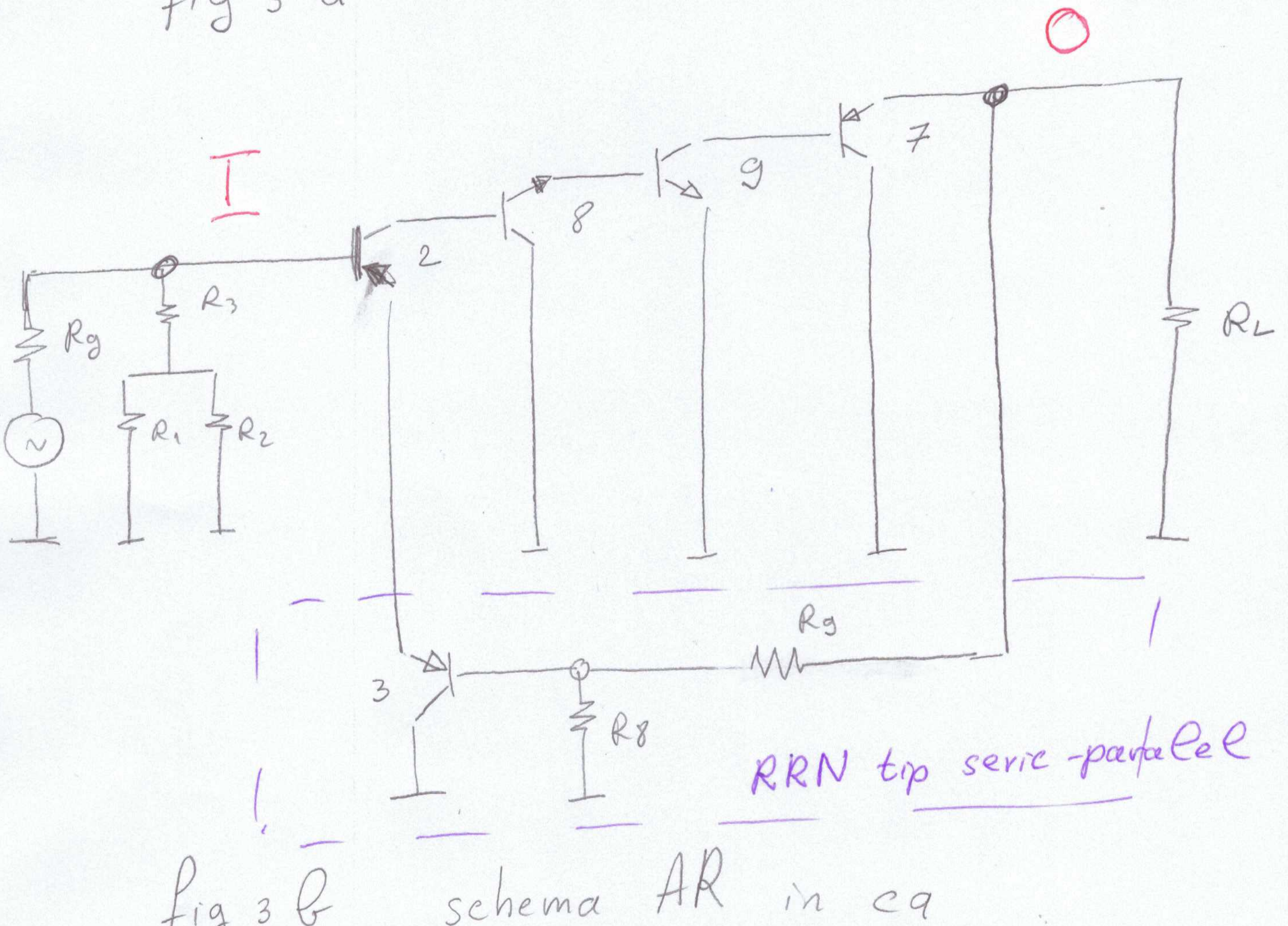


fig 3 b schema AR in ca

Circuitul "f", detm. parametrii echivalenti.

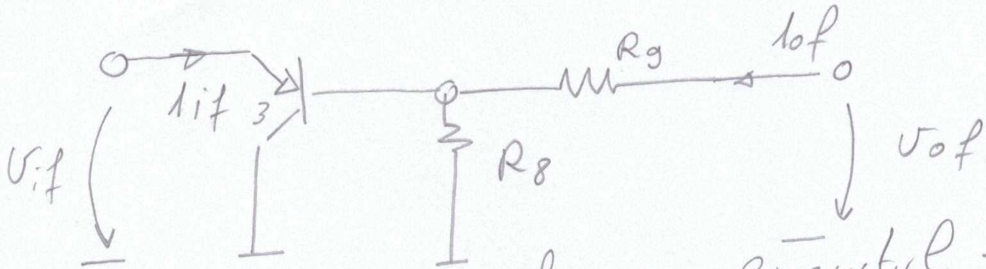


fig.4. Circuitul f

$$f = \frac{v_{if}}{v_{of}}\Big|_{i_{if}=0} \iff$$

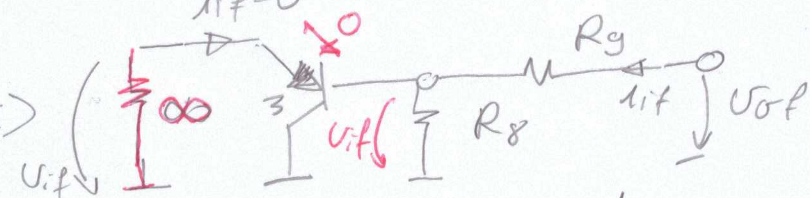
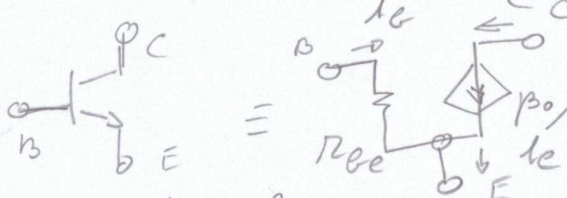


fig 4.a



Restrictia pt. factorul de reactie f (conditia) este echivalentă cu $i_e = 0$; => $i_b = 0$ => în acest mod de functionare baza (B) si emitorul (E) au acelasi potential, v_{if} se poate determina la bornele lui R_8. Conf teoremei divizorului de tensiune:

$$v_{if} = v_{of} \cdot \frac{R_8}{R_8+R_9}\ ; \quad \boxed{f = \frac{R_8}{R_8+R_9}}$$

$$r_{if} = \frac{v_{if}}{i_{if}}\Big|_{v_{of}=0} \iff$$

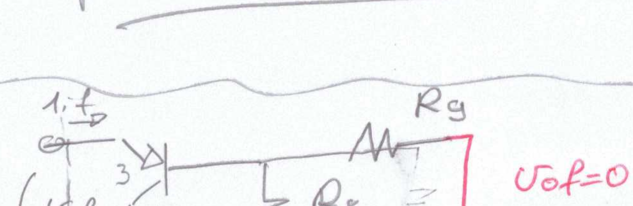


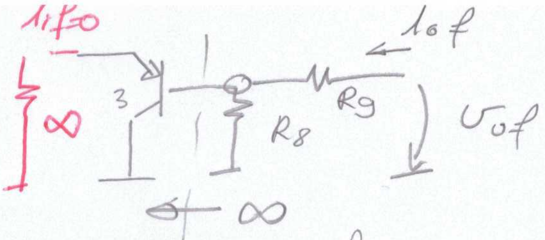
fig 4b

(schema 2)

$$r_{if} = \frac{\overset{12{,}5K}{r_{be}} + \overset{10K}{R_8 \| R_9}}{\beta_0+1} \simeq \simeq \frac{22}{500}k$$

$$R_{of} = \left.\frac{V_{of}}{I_{if}}\right|_{i_{if}=0}$$

$\Longleftrightarrow$



$$R_{of} = R_9 + R_8 \| \infty \simeq 110K$$

fig 4c

Circuitul "a"

Echivalez generatorul + R_3, R_1, R_2 cu o schemă serie

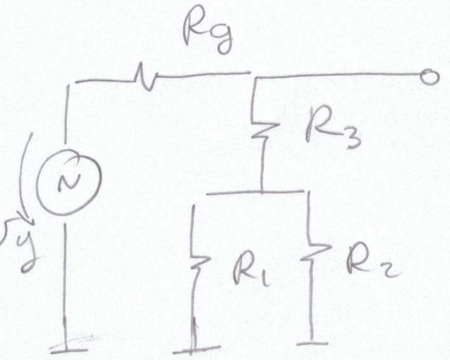
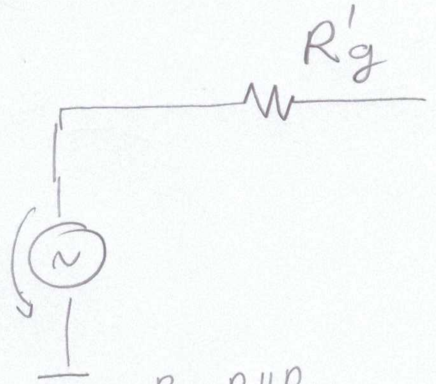


fig 5
Echivalarea generatorului

$\Longleftrightarrow$



$$V'_g = \frac{R_3 + R_1 \| R_2}{R_3 + R_1 \| R_2 + R_g}$$

$$R'_g = R_g \| (R_3 + R_1 \| R_2)$$

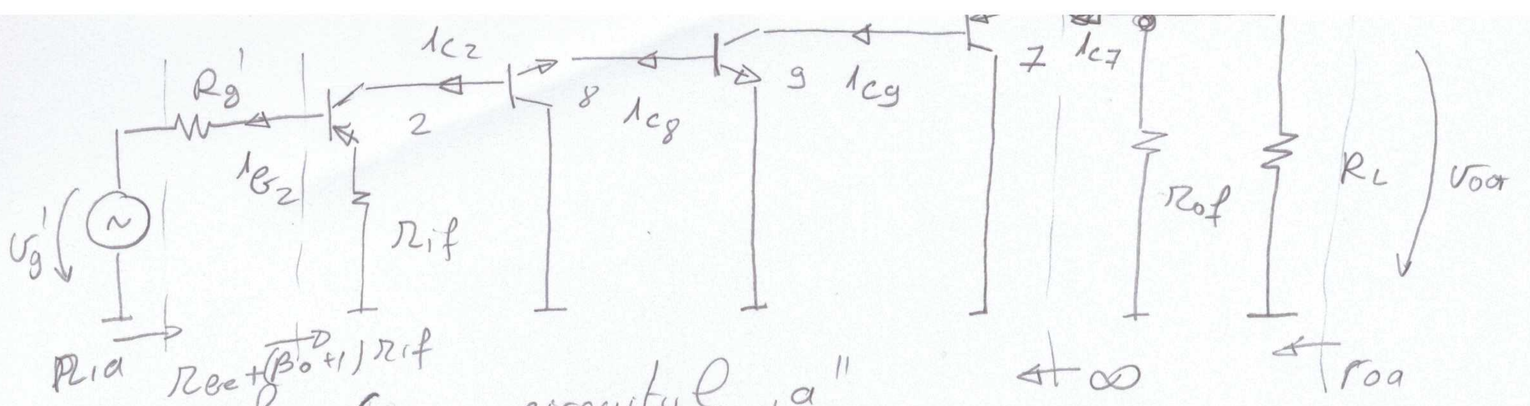
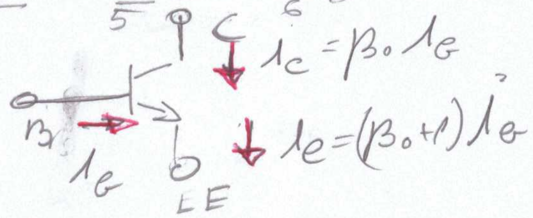


fig 6 circuitul „a"

$$a_v = \frac{v_{oa}}{v_g'} = \underbrace{\frac{v_{oa}}{i_{c7}}}_{1} \cdot \underbrace{\frac{i_{c7}}{i_{c9}}}_{2} \cdot \underbrace{\frac{i_{c9}}{i_{c8}}}_{3} \cdot \underbrace{\frac{i_{c8}}{i_{c2}}}_{4} \cdot \underbrace{\frac{i_{c2}}{i_{b2}}}_{5} \cdot \underbrace{\frac{i_{b2}}{v_g'}}_{6}$$



(1) $= -r_{of} \| R_L \simeq -1K$

(2) $= (\beta_0+1)_7 \simeq 500$

(3) $= -\beta_{0\,9} \simeq -500$

(4) $-(\beta_0+1)_8 \simeq -500$

(5) $\beta_{0\,2}$

$$v_g' - i_{b2}\left(R_g' + r_{be_2} + (\beta_{02}+1) r_{if}\right) = 0$$

(6) $$= -\frac{1}{R_g' + r_{be_2} + (\beta_0+1) r_{if}} \simeq -\frac{1}{22 \cdot 500}$$

$a \simeq +11 \cdot 10^3$

$r_{ia} = r_g' + r_{be} + (\beta_0+1)\, r_{if} \simeq 30K$

$r_{oa} = R_L \| r_{of} \simeq 1K$

$a \cdot f \simeq (+11 \cdot 10^3) \cdot \left(\frac{1}{11}\right) \simeq 10^3$

pentru amplificatorul cu reacție:

$$A_v = \frac{v_o}{v_i} = \frac{a}{1+af} \simeq \frac{1}{f} = 1 + \frac{R_9}{R_8} = 11$$

$$R_i = \frac{v_i}{i_i} = r_{ia}(1+af) - R'_g \simeq 30\ M\Omega$$

$$R_o^{-1} = \frac{v_o}{i_o}\Big|_{v_i=0} = r_{oa}^{-1}(1+af) - R_L^{-1} \simeq 1\ \Omega^{-1}$$

$R_o \simeq 1\Omega$

Schema echivalentă a AR

fig. 7

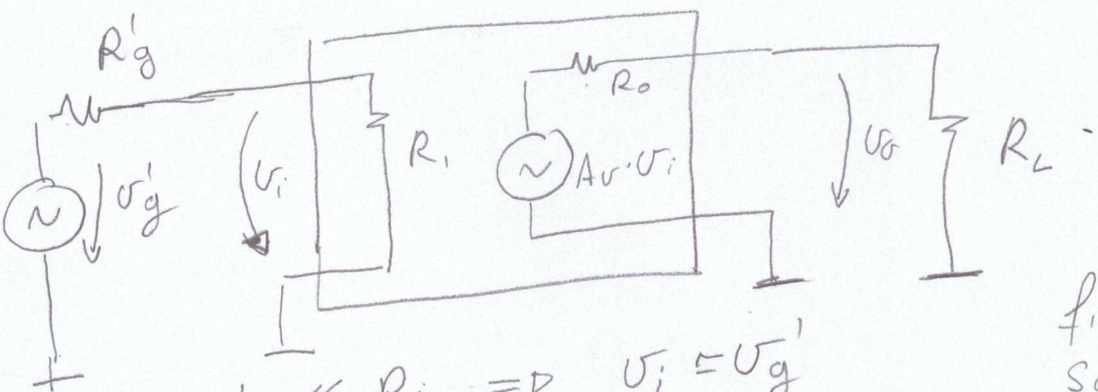


fig. 11.
Schema echivalenta a circuitului cu reactie

$R'_g \ll R_i \Rightarrow v_i \simeq v'_g$

$R_o \ll R_L \Rightarrow v_o \simeq A_v \cdot v_i$

Schema echivalentă a AR relativ la generatorul real

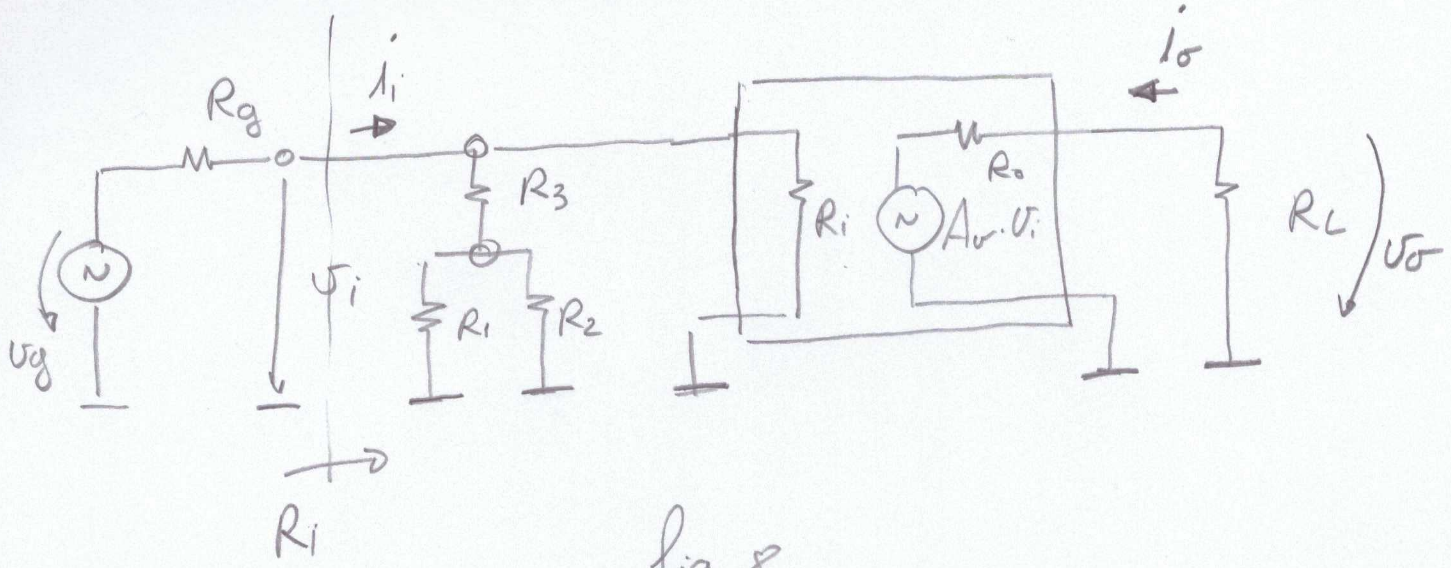


fig 8

Rez de intrare în circuitul real
(generatorul real)

$$R_i = \frac{v_i}{i_i} = (R_3 + R_1 \| R_2) \| R_i \simeq R_3$$

$$A_i = \frac{i_o}{i_i} = \frac{i_o}{v_o} \cdot \frac{v_o}{v_i} \cdot \frac{v_i}{i_i} = -\frac{1}{R_L} \cdot A_v \cdot R_i$$

$$A_z = \frac{v_o}{i_i} = \frac{v_o}{v_i} \cdot \frac{v_i}{i_i} = A_v \cdot R_i$$