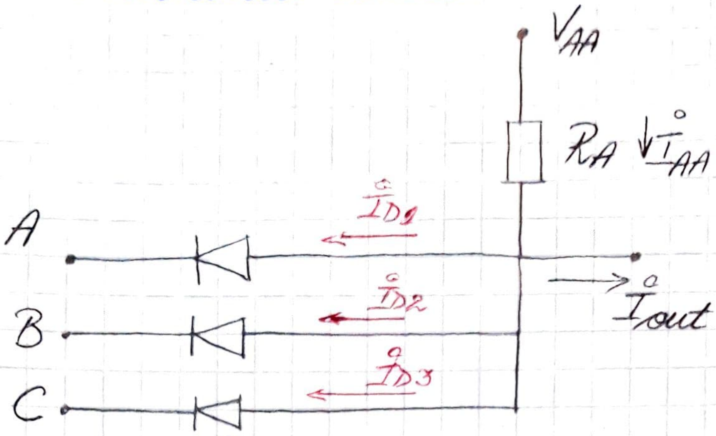
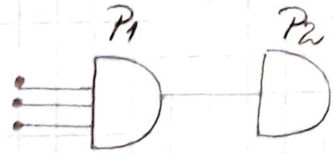
CURS3CD

Proiectarea circuitului



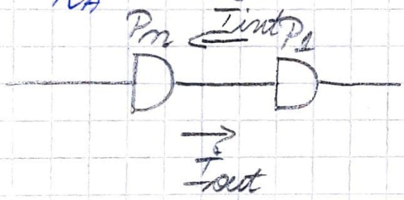


$\mathring{I}_{RA} \geq \mathring{I}_{out}$ = cunoscut

$$\mathring{I}_{RA} = \frac{V_{AA}-V_o}{R_A}$$

Cazul cel mai defavorabil: $V_o = V_H$ $V_A = V_B = V_C = V_H$

$$\frac{V_{AA}-V_H}{R_A} \geq \mathring{I}_{out} \Rightarrow R_A = \frac{V_{AA}-V_H}{\mathring{I}_{out}}$$



$\mathring{I}_{int\,max} = \begin{cases} V_A = V_L \quad V_B = V_C = V_H \\ D_1 \text{ conduce} \quad D_2, D_3 \text{ blocate} \\ V_B = V_L \quad V_A = V_C = V_H \end{cases}$

Pp. să luăm următorul scenariu: $V_A = V_L$ (0V)

$V_B = V_C = V_H$ (3÷5 V)

D_2, D_3 blocate

D_1 conduce

$\mathring{I}_{D1} = \mathring{I}_{int\,max} = \mathring{I}_{RA} + (n-1)\mathring{I}_o$ n = nr. de intrări

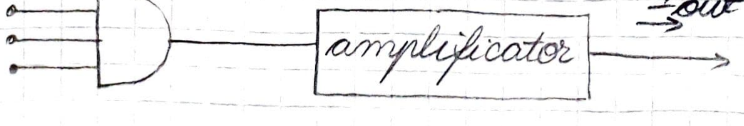
$\mathring{I}_{int}$ este maxim când: $V_o = V_L$ sau $V_A = V_L$

$$\Rightarrow \mathring{I}_{RA} = \frac{V_{AA}-V_L}{R_A}$$

$$\boxed{\mathring{I}_{int\,max} = \frac{V_{AA}-V_L}{R_A} + (n-1)\mathring{I}_o}$$

$$\boxed{E = \frac{\mathring{I}_{out}}{\mathring{I}_{int}} = \frac{V_{AA}-V_L}{R_A} \cdot \frac{1}{\frac{V_{AA}-V_L}{R_A} + (n-1)\mathring{I}_o}}$$ → eficiența

$E \leq 1$



$V_{AA} = 10V$

$R_A = 3{,}6\ k\Omega$

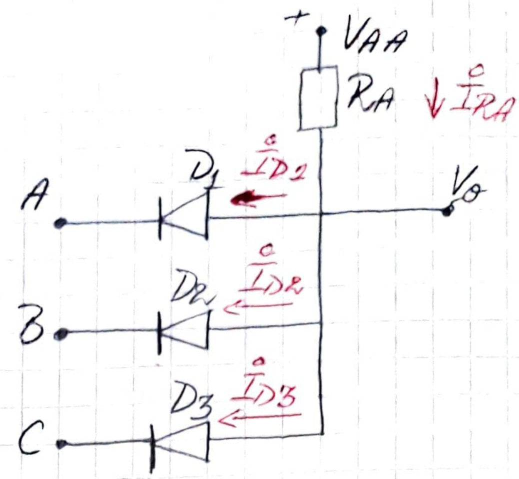
$R_i = 100\ M\Omega \quad (\mathring{I}_o \approx 0)$

$R_D = 20\Omega$

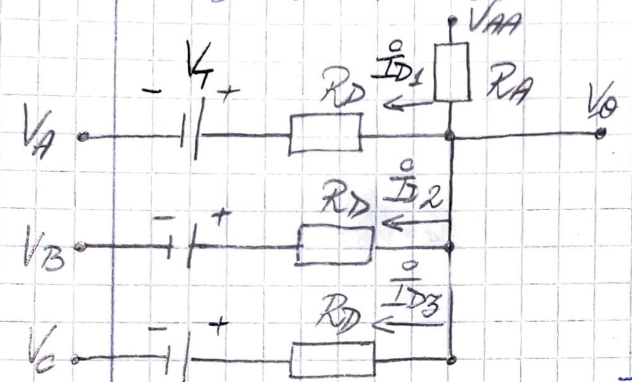
$V_L = 0V$

$V_H = 5V$

$V_o = ?$



a) $V_A = V_B = V_C = V_H$ (D_1, D_2, D_3 cond.)



$$\boxed{\mathring{I}_{RA} = \mathring{I}_{D1} + \mathring{I}_{D2} + \mathring{I}_{D3}} \quad (1)$$

$$\mathring{I}_{RA} = \frac{V_{AA} - V_o}{R_A}$$

$$\mathring{I}_{D1} = \frac{V_o - V_T - V_A}{R_D}$$

$$\mathring{I}_{D2} = \frac{V_o - V_T - V_B}{R_D}$$

$$\mathring{I}_{D3} = \frac{V_o - V_T - V_C}{R_D}$$

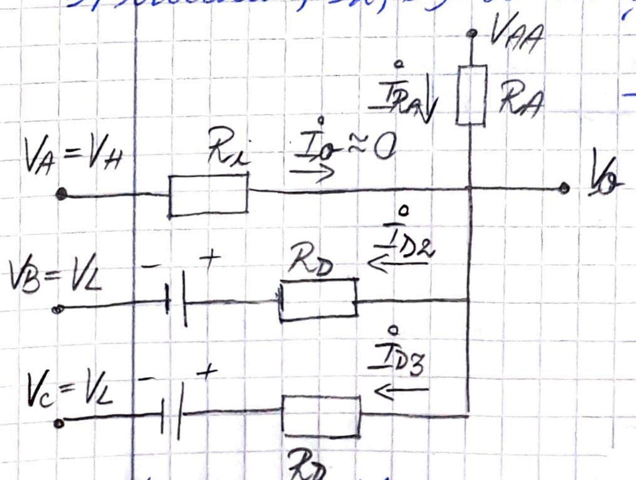
$$(1) \Rightarrow \frac{R_{AA} - V_o}{R_A} = \frac{V_o - V_T - V_A}{R_D} + \frac{V_o - V_T - V_B}{R_D} + \frac{V_o - V_T - V_C}{R_D} \qquad V_A = V_B = V_C = V_H = 5$$

$\Rightarrow V_o = 5{,}62V$

b) $V_A = V_C = V_B = V_L = 0 \Rightarrow V_o = 0{,}618V$ (la fel ca la a))

c) $V_A = V_H$; $V_B = V_C = V_L$

D_1 blocată; D_2, D_3 conducție $\quad \mathring{I}_{RA} = -\mathring{I}_o + \mathring{I}_{D2} + \mathring{I}_{D3}$



$$\left.\begin{aligned} \mathring{I}_{RA} &= \frac{V_{AA} - V_o}{R_A} \\ \mathring{I}_{D2} &= \frac{V_o - V_T - V_B}{R_D} \\ \mathring{I}_{D3} &= \frac{V_o - V_T - V_C}{R_D} \\ V_B &= V_C = V_D = 0V \end{aligned}\right\} \Rightarrow V_o = 0{,}628V$$

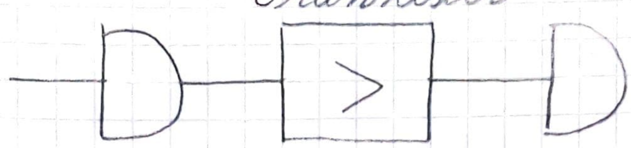
d) $V_A = V_B = V_H \quad V_C = V_L \quad D_1, D_2$ blocate D_3 conduce $\quad \mathring{I}_{RA} = \mathring{I}_{D3}$

14 $\quad \mathring{I}_{RA} = \frac{V_{AA} - V_o}{R_A} \qquad \mathring{I}_{D3} = \frac{V_o - V_T - V_C}{R_D} \qquad V_C = 0V \quad \Rightarrow V_o = 0{,}656\ V$

$$V_o = V_i \begin{cases} = V_L \\ = V_H \end{cases} + V_T$$

Poarta își introduce o deplasare de nivel cu tensiunea de prag V_T pozitivă (mai mare decât V_i)

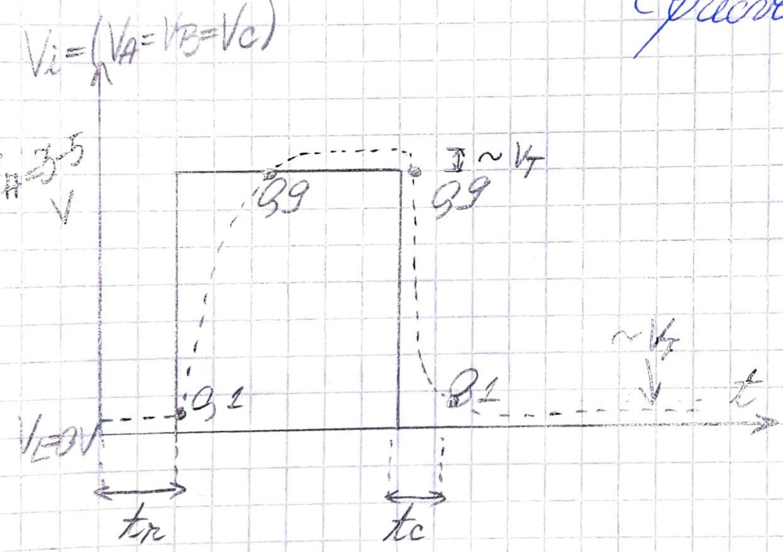
Compatibilitatea nivelelor de tensiune între intrare și ieșire $V_o \simeq V_i$ ($V_A = V_B = V_C = \ldots$)

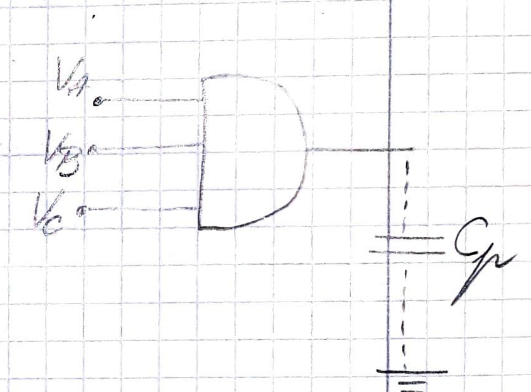


$\mathring{I}_{out} > \mathring{I}_{int}$

$V_o = V_i$

Parametrii dinamici $\begin{cases} \text{timp (f.f. mic)} \\ \text{frecvența (f.f. mare)} \end{cases}$





$C_p = C_o + C_{fir} + \sum C_i$

↳ capacitate parazită

$$t_r = \tau \ln \frac{V_H - 0{,}1(V_H - V_L)}{V_H - 0{,}9(V_H - V_L)}$$

$$t_r = \tau \ln \frac{V_H - 0{,}1 \cdot V_H}{V_H - 0{,}9 \cdot V_H} = \tau \cdot \ln 9 \approx 2{,}2\,\tau$$

$\tau = R_A \cdot C_p$

$t_r = R_A \cdot C_p \cdot \ln 9$

$$t_c = \tau_1 \ln \frac{V_L - 0{,}9(V_H - V_L)}{V_L - 0{,}1(V_H - V_L)} \qquad V_L = 0V$$

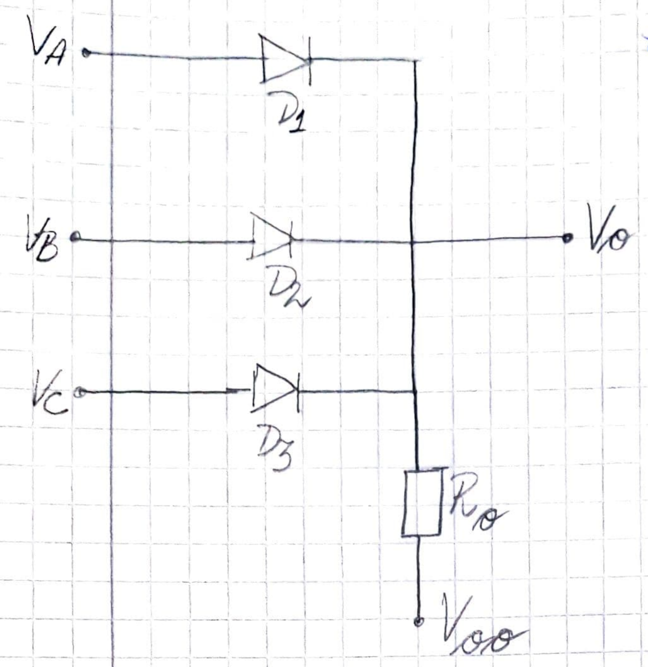
$t_r = \tau_1 \ln 9$, unde $\tau_1 = R_D \cdot C_p$

$t_c = 2{,}2 \cdot R_D \cdot C_p \ll t_r$, deoarece $R_A \gg R_D$

SAU cu diode

$|V_{00}| > V_H > V_L$

ex: $V_{00} = -10V$ $V_H = 3V$ $V_L = 0V$



(A) Funcționarea logică

a) $V_A = V_B = V_C = V_H$

D_1, D_2, D_3 în conducție $\Rightarrow V_0 = V_i - V_T$ } $V_0 = V_i = V_H$

Dacă V_T se neglijează

b) $V_A = V_B = V_C = V_L$

D_1, D_2, D_3 în conducție $\Rightarrow V_0 = V_i - V_T$ } $\Rightarrow V_0 \simeq V_i = V_L$

Dacă V_T neglijabilă

c) Dacă la cel puțin o intrare avem V_H

- Fie $V_A = V_H$; $V_B = V_C = V_L$

D_1 cond $\rightarrow V_0 = V_H - V_T \approx V_H \Rightarrow D_2, D_3$ blocate

V_A	V_B	V_C	V_0
V_L	V_L	V_L	V_L
V_L	V_L	V_H	V_H
V_L	V_H	V_L	V_H
V_L	V_H	V_H	V_H
V_H	V_L	V_L	V_H
V_H	V_L	V_H	V_H
V_H	V_H	V_L	V_H

V_A	V_B	V_C	V_0
V_H	V_H	V_H	V_H

$2^3 = 8$

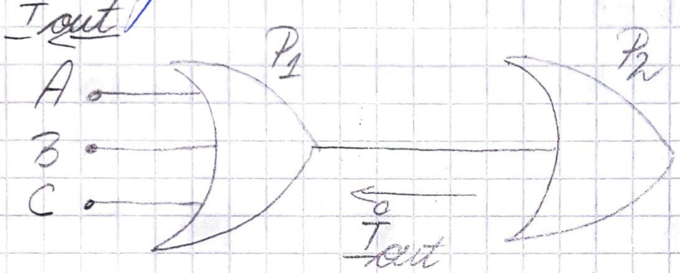
$V_H \rightarrow$ „1"

$V_L \rightarrow$ „0"

A	B	C	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

$$\boxed{f = A + B + C}$$

B) Dimensionarea circuitului (proiectare) → cazul cel mai defavorabil

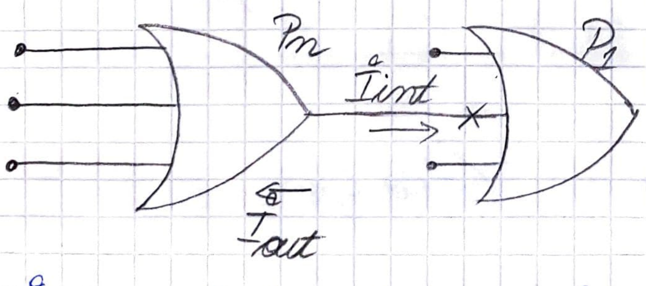


$\overset{\circ}{I}_{R_O} \geq \overset{\circ}{I}_{out}$ (cunoscut ca dată de proiectare)

$$\overset{\circ}{I}_{R_O} = \frac{V_O - (-V_{OO})}{R_O} = \frac{V_O + V_{OO}}{R_O}$$

Cazul cel mai defavorabil → $V_O = V_L$ ($V_A = V_B = V_C = V_L$)

$$\frac{V_L + V_{OO}}{R_O} \geq \overset{\circ}{I}_{out} \qquad \boxed{R_O \leq \frac{V_{OO} + V_L}{\overset{\circ}{I}_{out}}}$$



$\overset{\circ}{I}_{int\,max}$ { doar intrarea folosită este pe nivelul de tensiune maximă, adică $V_i = V_H$
și celelalte intrări sunt pe nivelul cel mai mic

Fie $V_A = V_H$; $V_B = V_C = V_L$

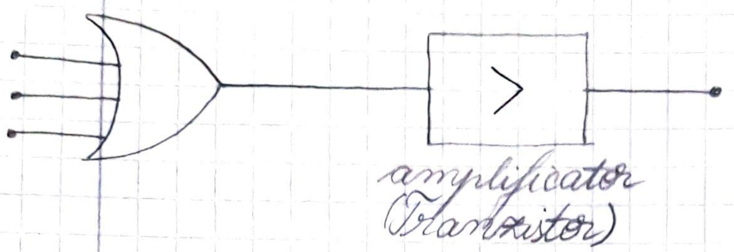
D_1 cond D_2, D_3 bl.

avem $\overset{\circ}{I}_{D1} = \frac{V_i - V_T - V_O}{R_D}$ $\qquad \overset{\circ}{I}_{D2} = \overset{\circ}{I}_{D3} = -\overset{\circ}{I}_O$

$$\mathring{I}_{int\,max} = \mathring{I}_{R_0} + (n-1)\mathring{I}_0 = \frac{V_0 - (-V_{00})}{R_0} + (n-1)\mathring{I}_0$$

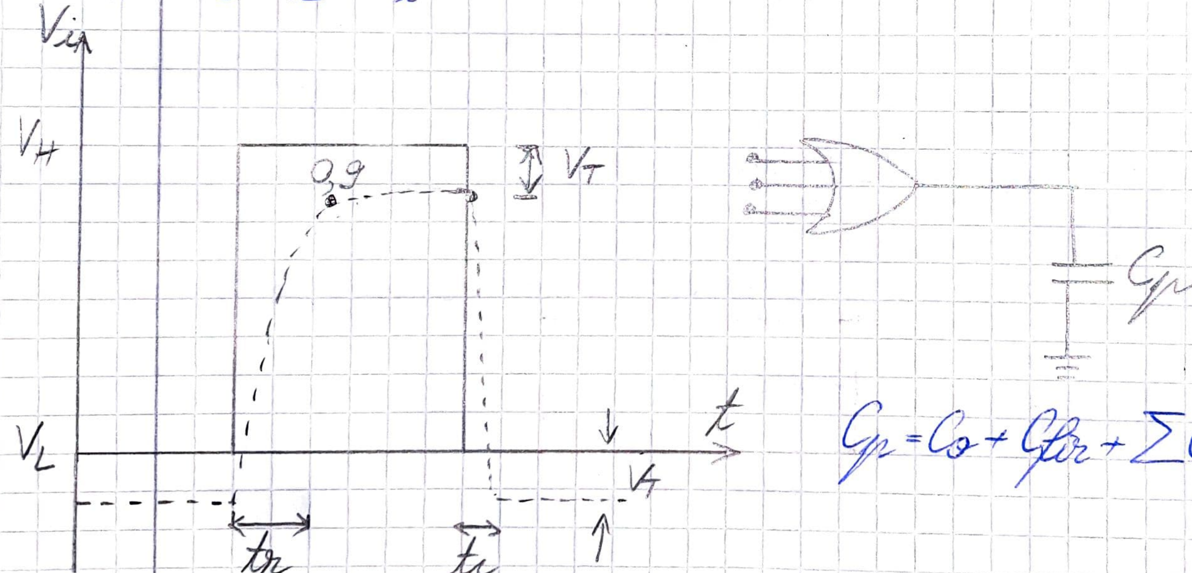
$$\boxed{\mathring{I}_{int\,max} = \frac{V_H + V_{00}}{R_0} + (n-1)\cdot\mathring{I}_0}$$

$$E = \frac{\mathring{I}_{out}}{\mathring{I}_{int}} = \frac{V_{00}+V_L}{R_0}\cdot\frac{1}{\frac{V_{00}+V_H}{R_0}+(n-1)\mathring{I}_0}$$



- reface min de tens. de la ieșire
- compatibile $V_i = V_0$
- $E > 1$

$V_A = V_B = V_L = V_i$



$C_p = C_0 + C_{tr} + \sum C_i$

$$t_c = \tau \ln \frac{-V_{00} - 0{,}9(V_H - V_L)}{-V_{00} - 0{,}1(V_H - V_L)} \qquad \tau = R_0 \cdot C_p$$

$$V_L = 0V \Rightarrow t_c = R_0 \cdot C_p \cdot \ln \frac{V_{00} + 0{,}9V_H}{V_{00} + 0{,}1V_H}$$

$$t_r = \tau_1 \ln \frac{V_H - 0{,}1(V_H - V_L)}{V_H - 0{,}9(V_H - V_L)} \qquad V_L = 0$$

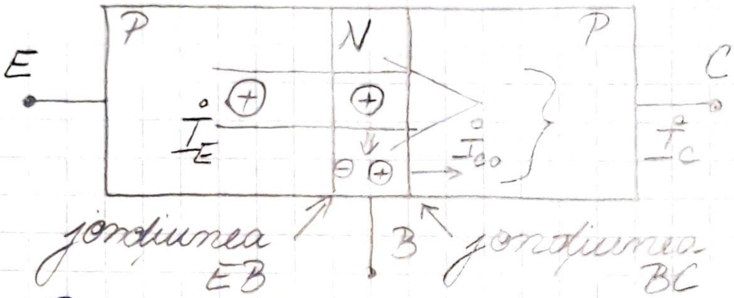
$$t_r = \tau_1 \ln 9,\ \text{unde}\ \tau_1 = R_D \cdot C_p$$

Tranzistorul bipolar

(A) funcționare

$$\mathring{I}_C = \mathring{I}_{C0} + \alpha \mathring{I}_E$$

$$\alpha - (0,9 \div 0,99) \mathring{I}_E$$

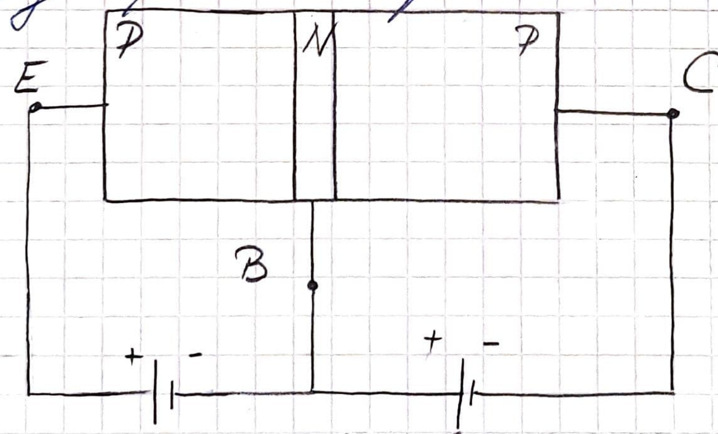


Baza - substratul din mijloc
- slab dopat cu impurități
- cantitate mică de sarcini libere

Emitorul - puternic dopat cu impurități
- cantitate mare de sarcini libere

Colectorul - slab dopat cu impurități
- cantitate mică de sarcini libere

a) joncțiunea BC polarizare inversă



BC polarizare inversă

$\mathring{I}_{C0}$ - curent de colector rezidual
- sarcini minoritare din B
- saturat (limitat ca valoare)

b) joncțiunea BE polarizare directă
- conținut mare de sarcini, majoritatea din E