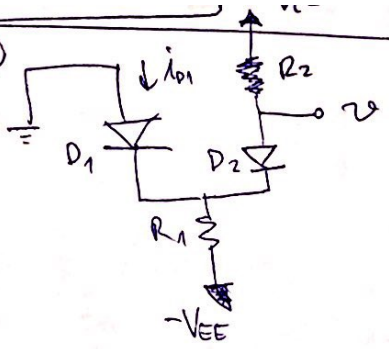
$i_D = I_S\left(e^{\frac{v_D}{V_t}} - 1\right)$

(5) a)

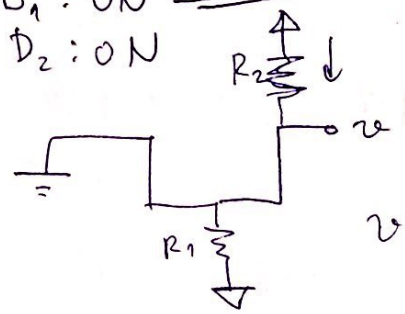


$V_{CC} = V_{EE} = 10V$

$R_2 = 2R_1 = 10k\Omega$

D_1 : ON (malla)

D_2 : ON



$v = 0V \quad i_{D2} = i_{R2} = \frac{V_{CC}}{R_2} > 0$

$i_{R1} = \frac{v - (-V_{EE})}{R_1} > 0$

$i_{D2} = 1mA$

$i_{R1} = \frac{10}{5k\Omega} = 2mA$

$i_{D1} = i_{R1} - i_{D2} > 0$

$i_{D1} = i_{D2} = 1mA$

b) $R_1 = 2R_2 = 10k\Omega$

D_1 - OFF D_2 - ON $\quad v = \frac{R_1}{R_1 + R_2} V \quad \frac{V_{CC} - v}{R_2} = \frac{v + V_{EE}}{R_1}$

$R_1 V - R_1 v = R_2 v + R_2 V \quad V(R_1 - R_2) = v(R_1 + R_2)$

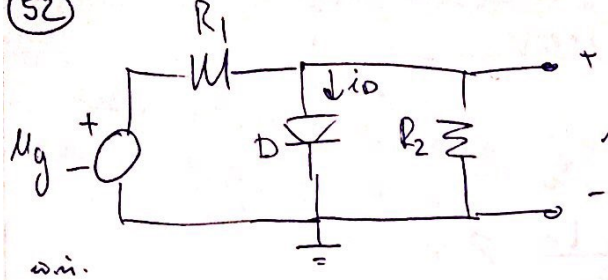
$v = \frac{R_1 - R_2}{R_1 + R_2} V = \frac{1}{3} V = 3{,}33V$

$V_{D1} = -3{,}33V < V_D$

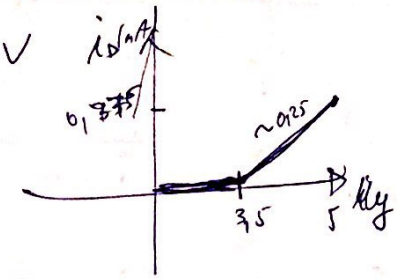
$i_{D2} = \frac{V_{CC} - v}{R_2} = 1{,}33mA$

$i_{D1} = 0$

(52)



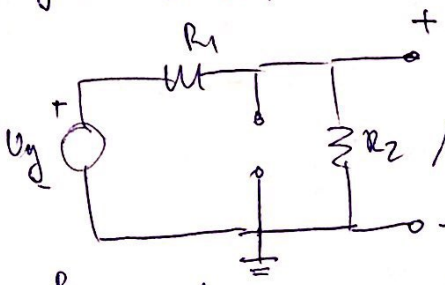
$0 \le u_g \le 5V$



3

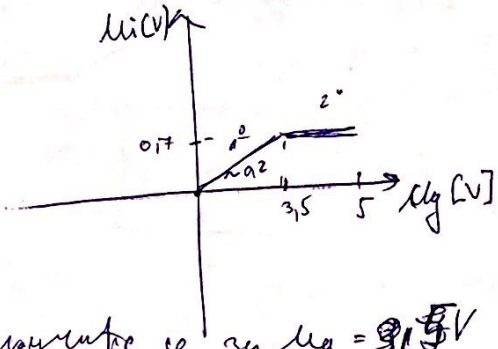
ако.

$u_g = 0$ D = OFF

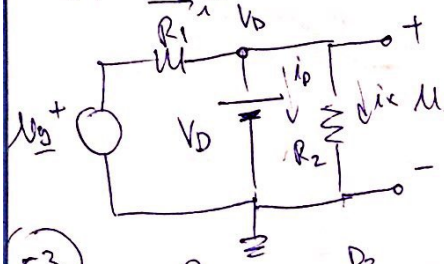


$u_O = u_i = \frac{R_2}{R_1+R_2} u_g$

$u_D < V_D$



$\frac{R_2}{R_1+R_2} = \frac{1}{5}$ $0,7 = \frac{1}{5} u_g$ $u_D = \frac{R_2}{R_1+R_2} u_g$ ↗ увеличите се за $u_g = 3,5V$

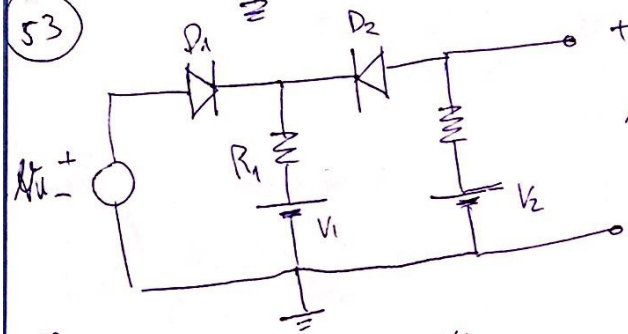


$i_{R1} = i_D + i_x$

$u_i = V_D$

$i_x = \frac{V_D}{R_2}$ $i_{R1} = \frac{u_g - V_D}{R_1}$ $i_D = \frac{u_g - V_D}{R_1} - \frac{V_D}{R_2} = \frac{1}{4} k\Omega\, u_g - 0,875$ ↗

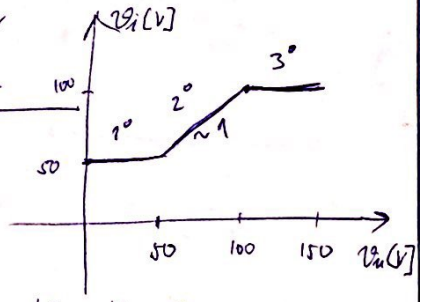
(53)



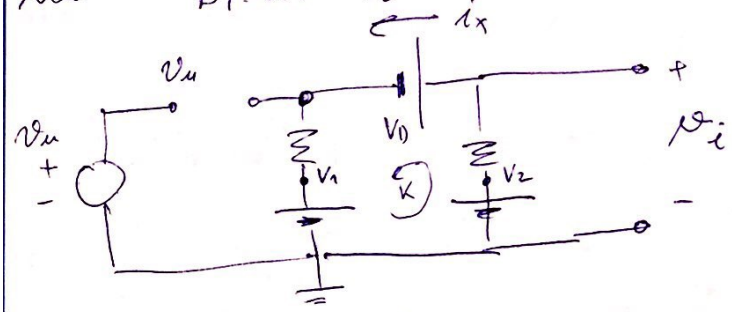
$0 \le u_u \le 150V$.

$V_1 = 25V$ $V_2 = 100V$

$R_1 = 100k$ $R_2 = 200k$



$u_u = 0$ D_1: OFF D_2: ON



$-V_2 - i_D(R_2+R_1) + V_D - V_1 = 0$

$i_D = \frac{V_2 - V_1}{R_2+R_1} > 0$

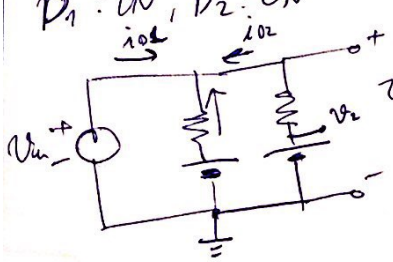
$i_0 \cdot R_1 = V_K - V_1$

$V_K = i_0 R_1 + V_1 = \frac{V_2 - V_1}{R_2+R_1} R_1 + V_1 = \frac{75}{300k} \cdot 100k + 25 = 50V$

$u_{O1} = u_u - 50V$ ↗

2. сегмент.

D_1: ON, D_2: ON

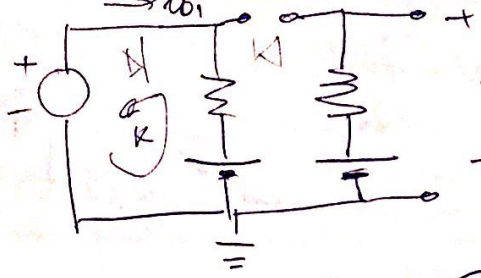


$u_i = u_u$

$i_{D2} = \frac{u_2 - u_u}{R_2}$ ↘

$i_{D1} = -\left(\frac{u_1 - u_u}{R_1} + \frac{u_2 - u_u}{R_2}\right) = \frac{u_u - u_1}{R_1} + \frac{u_u - u_2}{R_2}$ ↗

D_2 остава OFF за $u_u = u_2 = 100V$



$v_i = v_2 = 100V$

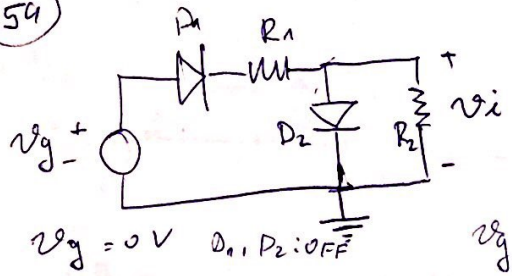
D_1 ocnuate ON
D_2 ocnuate OFF

$V_1 + i_{01} \cdot R_1 - v_u = 0$

$i_{01} = \frac{v_u - V_1}{R_1}$ ↗

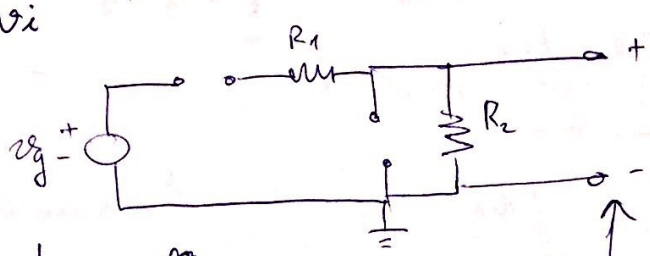
$v_{D2} = v_2 - v_u < V_D$

54)



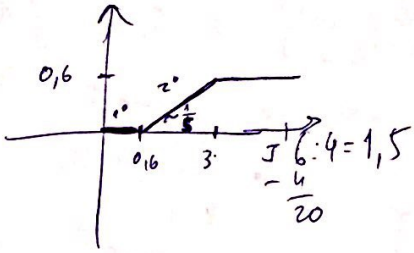
$0 \le v_g \le 5V$

$V_D = 0,6V$



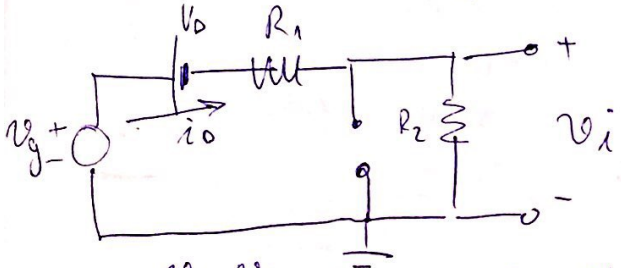
$v_g = 0V$ D_1, D_2 : OFF

$v_i = v_u \cdot \frac{R_2}{R_1+R_2} = \frac{1}{4} \cdot 0V = 0V = v_i$



$v_{D1} = v_g$ $v_{D2} = 0V$

D_1 ocnuate ON za $v_g = 0,6V$



$v_i = (v_g - V_D) \cdot \frac{R_2}{R_1+R_2}$ $\frac{1}{4}$ -

$v_{D2} = v_i$ ↗

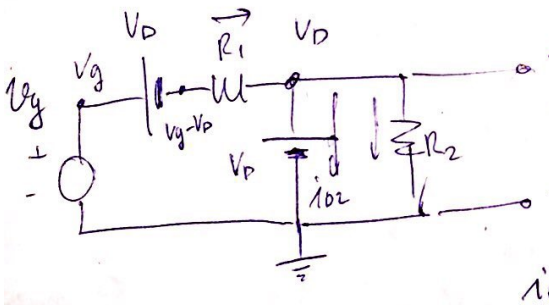
D_2 - ocnuate OFF za $v_i = V_D$ inj. $(v_g - V_D)\frac{R_2}{R_1+R_2} = V_D$

$v_g = V_D\left(1 + \frac{R_2}{R_1+R_2}\right) =$

$= 0,6 \cdot \frac{5}{4} = 0,75$

$= 3V$ $= 0,6V$

$i_0 = \frac{v_g - V_D}{R_1+R_2}$ ↗ D_1 - ocnuje ON



$i_{R2} = \frac{V_D}{R_2}$ $i_{D2} =$

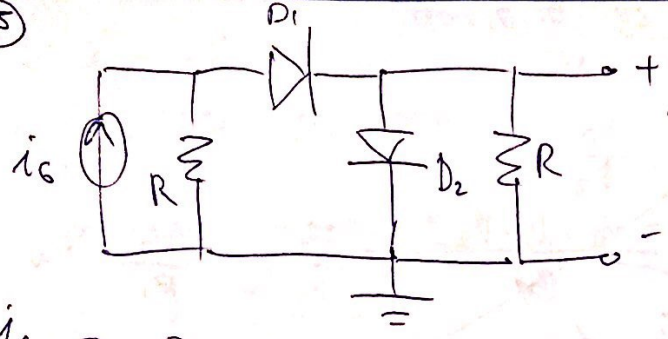
$i_{D2} + i_{R2} = i_{D1}$

$i_{D2} = i_{D1} - i_{R2}$

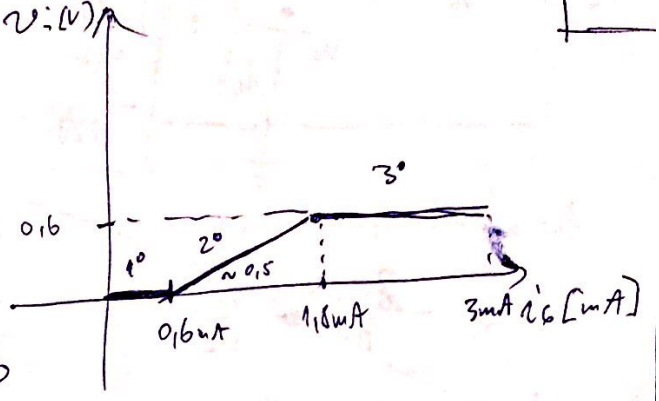
$i_{D1} = \frac{v_g - 2V_D}{R_1}$ ↗

$i_{D2} = \frac{v_g - 2V_D}{R_1} - \frac{V_D}{R_2}$ ↗ ocnuaju ON

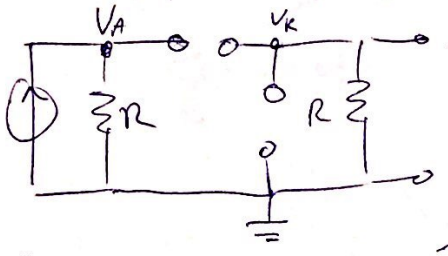
(55)



v_i v_i[V]

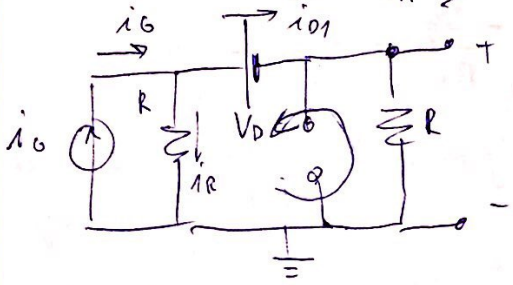


$i_G = 0$ D_1: OFF , D_2: OFF



1° v_i $v_i = 0$

$v_{D2} = 0$ $v_{D1} = V_A - V_K \to 0$ $V_A = i_g \cdot R$ ↗ за $i_g = 0{,}6\,mA$ D1 се отваря и



v_i $i_{D1} \cdot R + V_D - i_R \cdot R = 0$ $i_{D1} + i_R = i_G$

$i_{D1} R + V_D + i_{D1} R - i_G R = 0$ $i_R = i_G - i_{D1}$

$i_{D1} = i_G - \frac{V_D}{R}$

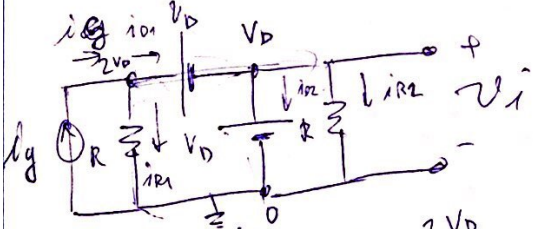
$i_{D1} \cdot R + V_D - i_g R + i_{D1} R = 0$ $v_i = v_{D1} = i_{D1} R = i_G R - V_D$

$i_{D1} = \frac{i_g}{2} - \frac{1}{2}\frac{V_D}{R} = \frac{1}{2} i_g + 0{,}3\,mA$

$v_i = \frac{1}{2} i_g R - 0{,}3\,V$ $V_D = \frac{1}{2} i_g R = 0{,}3\,V$ $i_g R = 0{,}3\,V$

$i_g = 0{,}3\,mA$

$\frac{1}{2} i_g R = 0{,}9\,V$ $i_g R = 1{,}8\,V$ $i_g = 1{,}8\,mA$



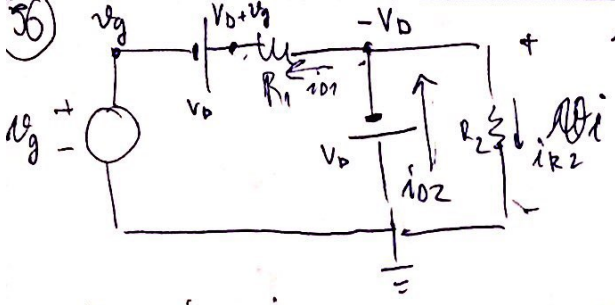
v_i $v_i = \frac{V_D}{R}$

$i_{R2} = \frac{V_D}{R}$ $i_{R1} = \frac{2V_D}{R}$

$i_{D1} = i_g - i_{R1} = i_g - \frac{2V_D}{R}$ ↗ D_1, D_2 – ventila ON

$i_{D2} = i_{D1} - i_{R2} = i_g - \frac{3V_D}{R}$ ↗

36)



$v_g = -5V$ D_1, D_2 : ON

$v_i = -V_D$

$i_{R2} = -\frac{V_D}{R_2}$

$i_{D1} = \frac{-V_D - V_D - v_g}{R_1} = -\frac{v_g}{R_1} - \frac{2V_D}{R_1}$

$i_{D1}' = \frac{5}{3} - \frac{1,2}{3} = \frac{3,8}{3}\,mA > 0$

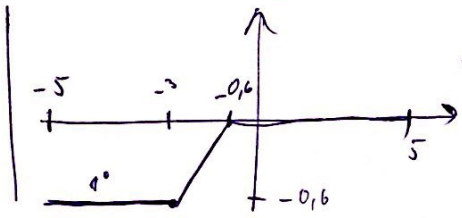
$i_{D2} = i_{D1} + i_{R2} =$

$= -\frac{v_g}{R_1} - \frac{2V_D}{R_1} - \frac{V_D}{R_2}$

$-\frac{v_g}{R_1} = \frac{2V_D}{R_1}$ $v_g = -2V_D = -1,2V$

$v_g = -2V_D - \frac{V_D}{R_2} \cdot R_1 = -1,2 - 0,2 = -1,4V$

$i_{R2} = -\frac{V_D}{R_2}$ $i_{D1} = \frac{-V_D - V_D - v_g}{R_1}$



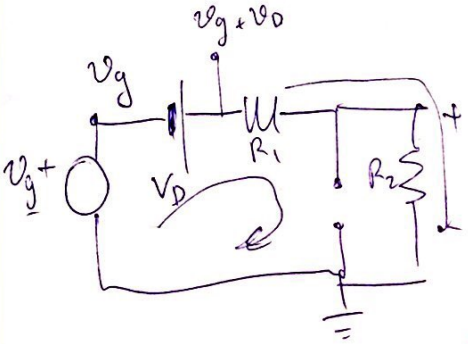
$v_g = -2V_D = -1,2V$

$i_{D2} = i_{D1} + i_{R2} =$

$= -\frac{v_g}{R_1} - \frac{2V_D}{R_1} - \frac{V_D}{R_2}$

$v_g = -2V_D - \frac{R_1}{R_2}V_D = -1,2 - 1,8V$

$= -3V$



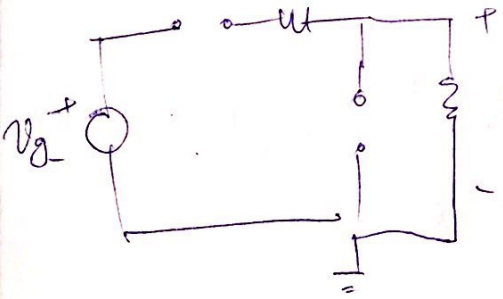
$v_i = (v_g + V_D)\frac{R_2}{R_1 + R_2}$

$i_{D1} = \frac{V_g + V_D}{R_1 + R_2}$ za $v_g = -V_D$

$D_1 \rightarrow$ OFF

$v_{DI} = \frac{V_g + V_D}{R_1 + R_2} \cdot R_2 = \frac{1}{4}v_g + \frac{1}{4}V_D =$

$v_D = -\frac{1}{4}v_g - \frac{1}{4}V_D$



$v_{D2} = 0$

v_i $v_i = 0$

$v_{D1} = -v_g$

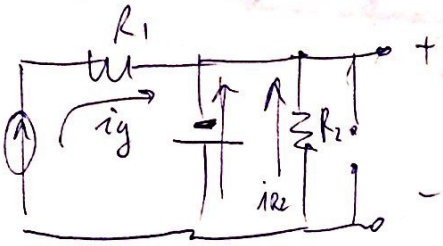
$v_i = 0$

57

$i_g = -2mA$

1°

D_1 : ON , D_2 : OFF



v_i

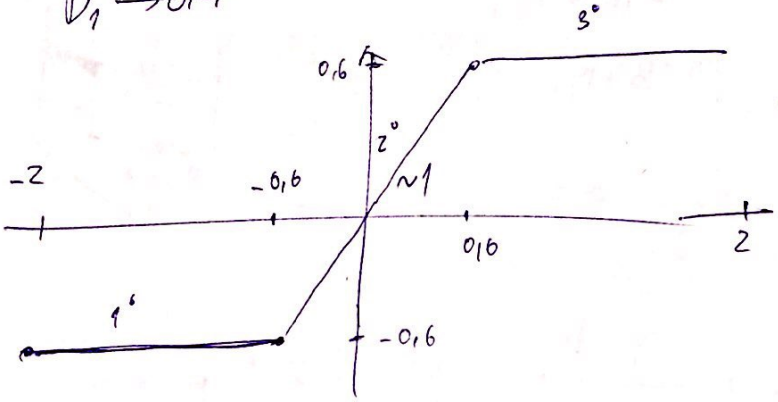
$$v_i = -\frac{V_D}{1}$$

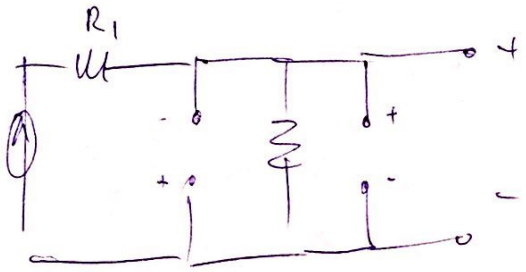
$v_{D2} = -V_D < V_D$

$i_{R2} = \frac{V_D}{R_2}$ $\quad i_{D1} = -i_g - i_{R2} = -i_g - \frac{V_D}{R_2} = 2 - 0{,}6mA > 0$

$i_{D1} = -i_g - \frac{V_D}{R_2}$ $\quad \searrow \quad i_g = -\frac{V_D}{R_2}$

$D_1 \rightarrow OFF$

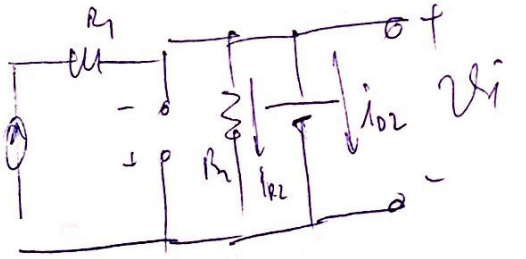




v_i

$v_i = i_g R_2$

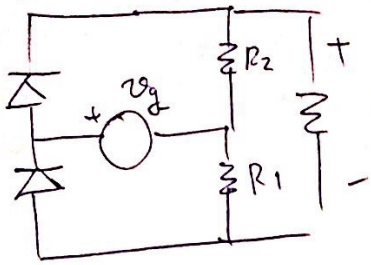
За $v_{D2} = V_D$ $D_2 \rightarrow ON$ иј. за $i_g = 0{,}6mA$



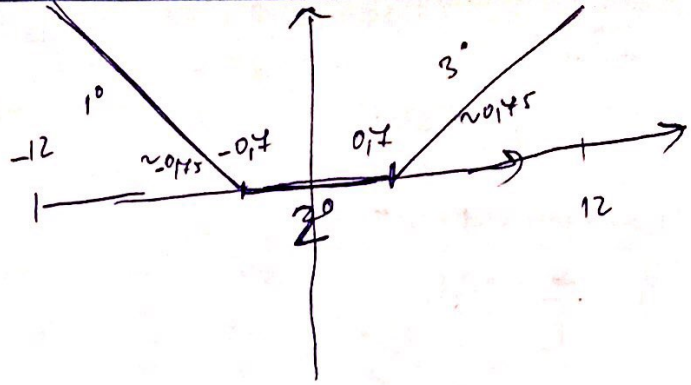
$i_{R2} = \frac{V_D}{R_2}$ а $\quad i_{D2} = i_g - i_{R2}$ ↗

D_2 остаје ON, D_1 остаје OFF

5.



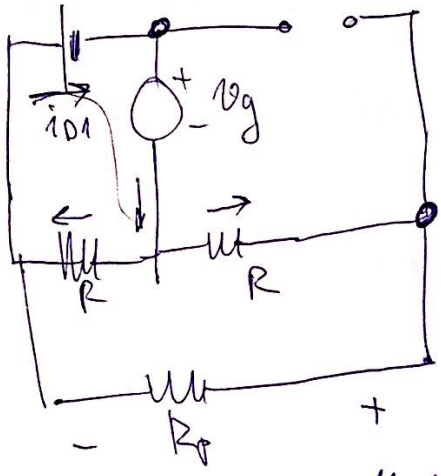
v_p



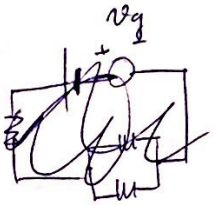
$v_g = -12V$

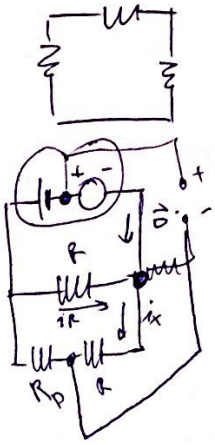
D_1 : ON D_2 : OFF

$v_g = -v_p$



$i_{D1} = -\dfrac{v_g + V_D}{R + (R + R_p)}$





$R \,//\, (R + R_p) = 1 // 4 = \frac{4}{5}\,k\Omega$

$i_x = i_D +$

$1 // 4 = \frac{1 \cdot 4}{1+4} = \frac{4}{5}$

$$\frac{v_g + V_D}{R} + \frac{v_g + V_D}{R + R_p} = (v_g + V_p)\left(\frac{1}{1} + \frac{1}{4}\right)$$

$i_D = -\frac{5}{4}\Omega \cdot v_g - \frac{5}{4}\Omega V_D$

$i_x = -\dfrac{v_g + V_D}{R + R_p}$

$$\boxed{v_p = -\frac{3}{4}(v_g + V_D)}$$

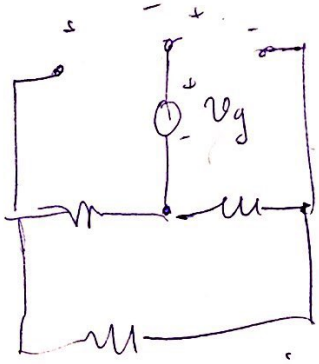
$3v_g = V_D$

$v_g = \frac{V_D}{3}$

$-\frac{1}{4}(v_g + V_D) + v_g = v_{D2}$ $v_{D2} = \frac{3}{4}v_g - \frac{1}{4}V_D$ ↗

2°

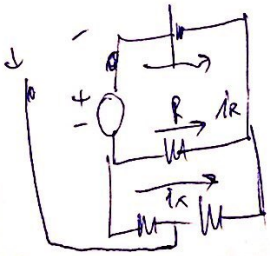
$\boxed{v_p = 0}$



3a $v_g = 0,7V$ $D_2 \to ON$ $v_p = \dfrac{v_g - V_D}{R + R_p} \cdot R_p$ ↗

$i_{D2} = \dfrac{v_g - V_D}{R + (R + R_p)} = \dfrac{\frac{1}{4}(v_g - V_D)}{4}$ ↗

$v_{D2} = V_D$



$i_x = -(i_{D2} + i_R)$

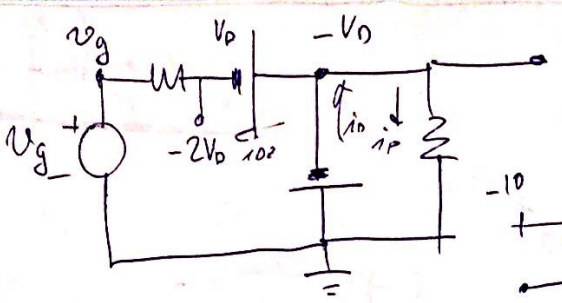
$i_x = \dfrac{-(v_g - V_D)}{R + R_p} \cdot v_g$

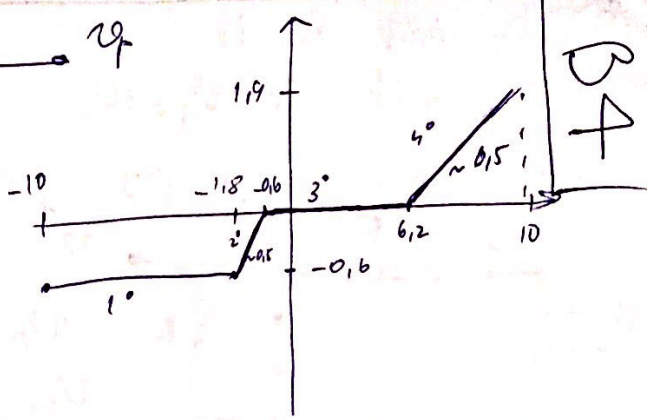
$v_{D2} = -v_g + \left(\dfrac{v_g - V_D}{R + R_p}\right) R =$

$= -v_g + \frac{1}{4}v_g - \frac{1}{4}V_D$

59) $v_g = -10V$

DZ, D: ON





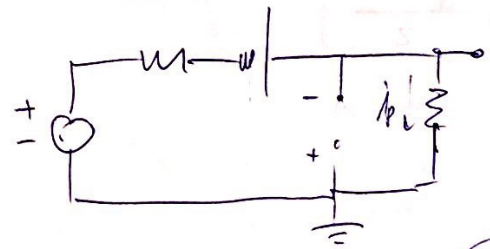
1°

$$v_p = -V_D$$

$$i_{DZ} = \frac{-2V_D - v_g}{R} \quad \searrow \quad v_g = -2V_D = -1,2V$$

$$i_D = i_{DZ} + i_p = \frac{-2V_D - v_g}{R} - \frac{V_D}{R} = -\frac{v_g}{R} - \frac{3V_D}{R} \qquad v_g = -3V_D = -1,8V$$

D → OFF



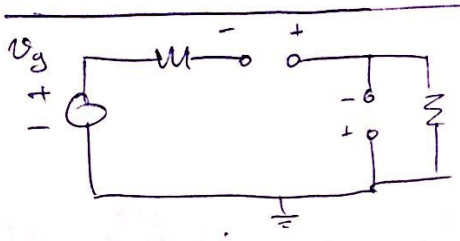
$$i_p = \frac{v_g + V_D}{2R} \qquad i_{DZ} = -\frac{v_g + V_D}{2R}$$

$$v_D = -i_p R = -\frac{v_g + V_D}{2}$$

За $v_g = -V_D$ DZ → OFF

$$v_p = \frac{v_g + V_D}{2} \quad 2°$$

3°

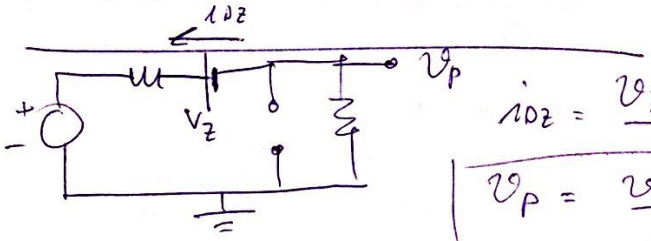


$v_D = 0$

$v_{DZ} = -v_g$

За $v_g = -V_Z$ D_Z → пробив

$$v_p = 0$$

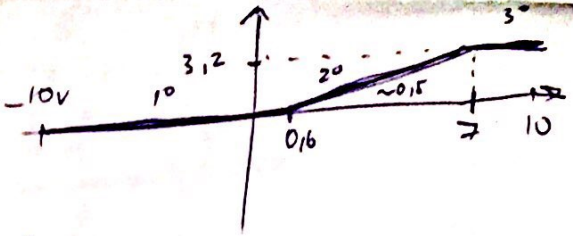


$$i_{DZ} = \frac{v_Z - v_g}{2R}$$

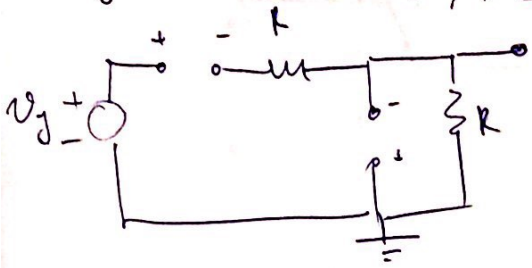
$$v_p = \frac{v_g - v_Z}{2} \quad 4° \quad \frac{10 - 6,2}{2} = 5 - 3,1 = 1,9$$

60) $V_D = 0{,}6V$ $R = 1k$

$V_Z = 3{,}2V$ $-10 \le v_g \le 10$



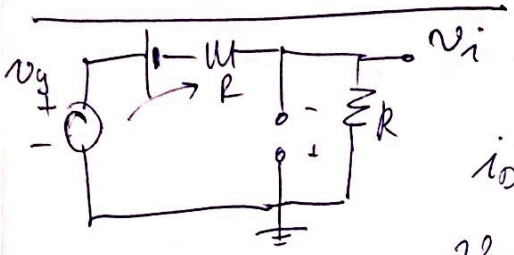
$v_g = -10V \rightarrow D, DZ : OFF$



1°

$v_D = v_g$ $\boxed{v_i = 0V}$

$v_{DZ} = 0V$ za $v_g = V_D \rightarrow$ [illegible] $= 0V$



$v_{DZ} = -v_i$

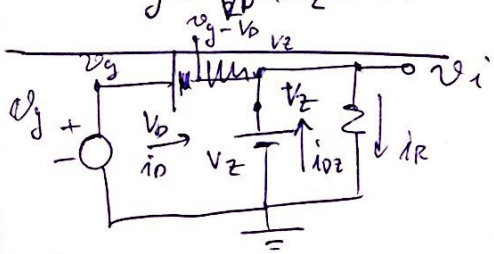
2°

$i_D = \dfrac{v_g - V_D}{2R}$ $\boxed{v_i = \dfrac{v_g - V_D}{2}}$

$v_{DZ} = \dfrac{V_D - v_g}{2}$ ↘

za $\dfrac{V_D - v_g}{2} = -V_Z$ $D_Z \rightarrow$ [illegible]

$v_g = V_D + 2V_Z = 7V$



3°

$\boxed{v_i = V_Z}$

$i_R = \dfrac{V_Z}{R}$ $i_{DZ} = i_R - i_D = \dfrac{V_Z}{R} - \dfrac{v_g - V_D - V_Z}{R} = -\dfrac{v_g - V_D - 2V_Z}{R} < 0$

$\dfrac{v_g - V_D - V_Z}{R} = i_D$ ↗ i_{DZ} ↘