SE

Ficha 3

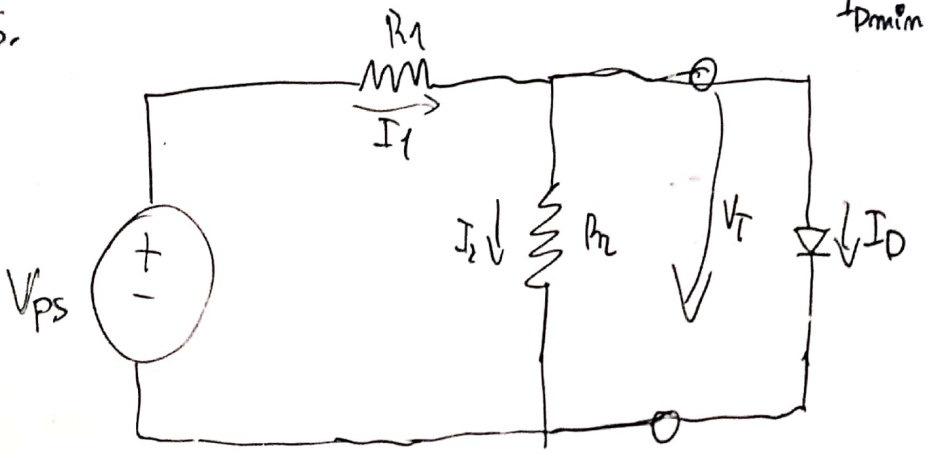
$I_{D\,mín}$ $\quad$ $I_{D\,máx}$

$5{,}6\,V \leq V_{ps} \leq 10{,}6\,V$

$V_\gamma = 0{,}6\,V$

$I_{D\,mín} = 2\,mA$

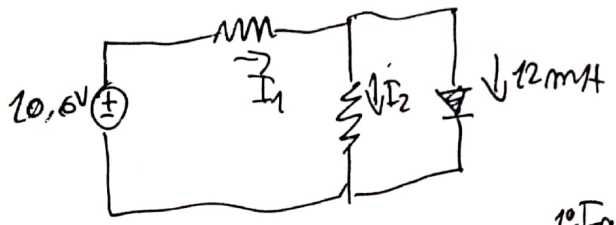
6.



$P_{D\,máx} = 7{,}2\,mW = V_D I_{D\,máx}$

$\Rightarrow I_{D\,máx} = \frac{7{,}2 \cdot 10^{-3}}{0{,}6}$

$= 12\,mA$



$I_2 = \frac{V_D}{R_2} = \frac{0{,}6}{R_2}$ $\quad$ $I_1 = I_2 + I_D$

$I_1 = (V_{ps} - V_D)/R_1$

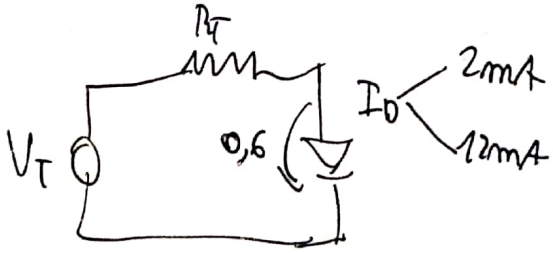
1º Eq, $V_{ps} = 10{,}6$

2º Eq, $V_{ps} = 5{,}6$

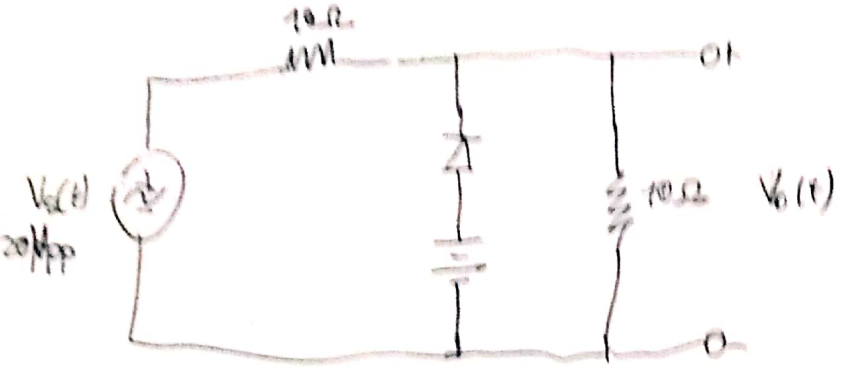
Thevinen

$V_T = V_{ps} \times \frac{R_2}{R_1 + R_2}$

$R_T = R_2 // R_1$



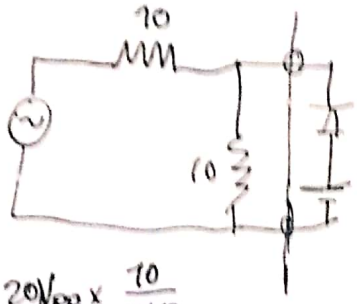
9.

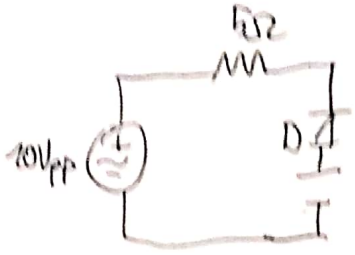


Cap 3
slide 22
fig meio

10. slide 23.

Corrente máx → 10V
tensão 1mV → 10V



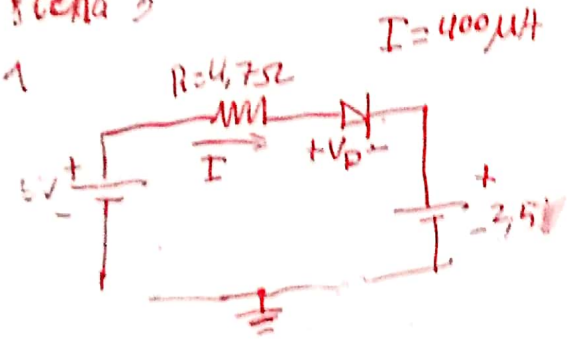


$V_T = 20V_{pp} \times \frac{10}{10+10}$

$P_T = 10 // 10$

Ficha 3

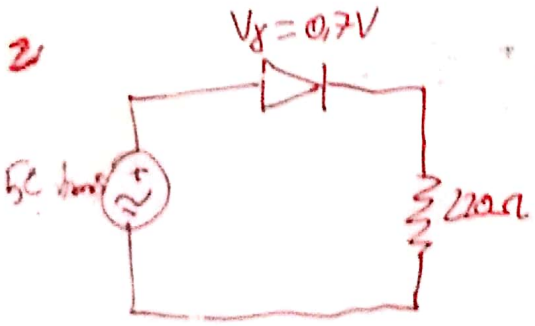
1



$V_D = (5-2,5) - (4,7 \cdot 10^3 \times 400 \cdot 10^{-6})$

$= 0,02V$

2

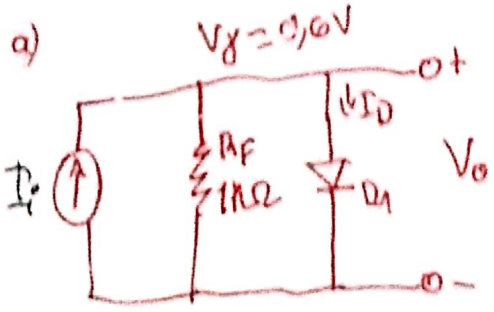


$V_{rms} = \frac{V_{máx}}{\sqrt{2}}$

$V_{PIV} = V_{máx} = 50 \times \sqrt{2} = 70,71V$

$I_{máx} = \frac{70,71 - 0,7}{220} = 0,318\ A$

3 a)



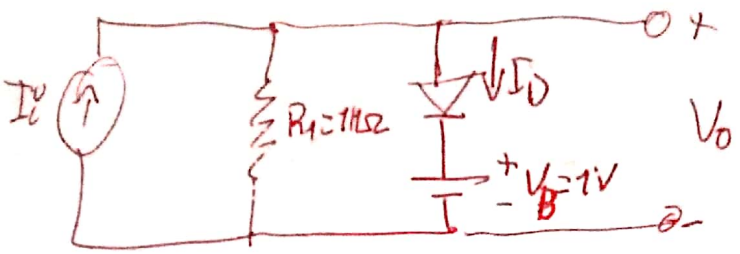
$V_o = V_{R_F}$ $I_{min} \Rightarrow V_o$ 0,6V

$V_o = R_F \times I_i$ $I_{máx} = \frac{0,6}{1k} = 600\mu A$

$I_I = I_D + I_{R_F}$

$I_D = I_I - I_{R_F} \Leftrightarrow I_D \approx 56 \cdot 10^{-4} - \frac{0,6}{1000} \Rightarrow I_D = 5mA$

b)



$V_o = V_{R1}$

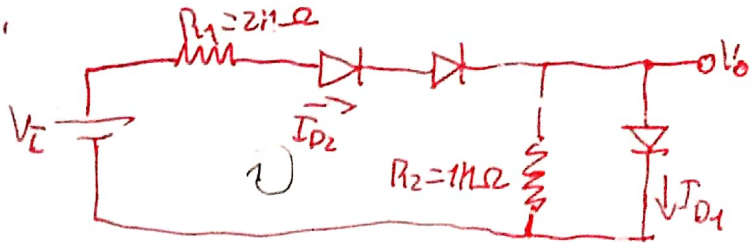
$I_{min} \Rightarrow V_o \geq 5,6V$

$1000 \times I_i^o = 1,6 \iff I_{min}^o = \frac{1,6}{1000} \iff I_{min}^o = 1,6\,mA$

Se $I_i^o = 5,6\,mA \Rightarrow I_D = ?$

$I_i^o = I_{R_1} + I_D \iff I_D = 5,6\,mA - \frac{1,6}{1000} \iff I_D = 4,0\,mA$

4.



$V_y = 0,65V$

$V_I = 8V$

V_o? I_{D_1}? I_{D_2}?

$V_o = 0,65V$

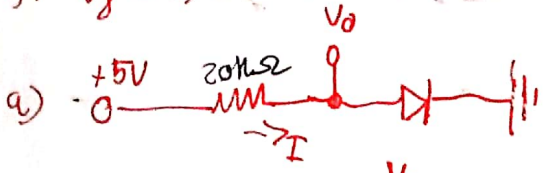
$I_{D_2} = \frac{8 - 3x(0,65)}{2k\Omega} \iff I_{D_2} = 3,025\,mA$

$I_{D_1} = 3,025\,mA - \frac{0,65}{1k\Omega}$

$= 2,375\,mA$

5. $V_y = 0,6V$

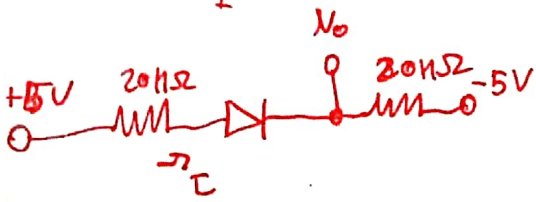
a)



$V_o = 0,6V$

$I = \frac{5 - 0,6}{20k\Omega} = 220\mu A$

b)



$I = \frac{5 - (-5) - 0,6}{40k\Omega} = 235\mu A$

$V_o = 5 - 20 \cdot 10^3 \times I - 0,6$

$= -0,3V$

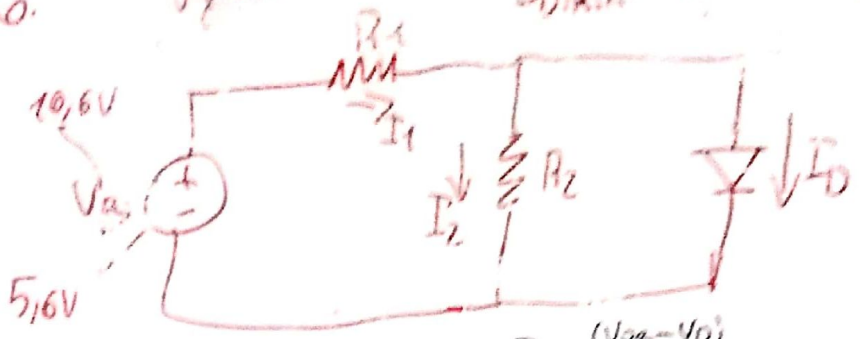
c) $I = \frac{(2 - (-8) - 0,6)V}{25k\Omega} = 376\mu A$

$V_o = 2 - 5 \times 376 \cdot 10^{-6}$

$= 0,12V$

d) $I = 0$ // $V_o = -5V$ //

6. $V_\gamma = 0,6\ V$ $I_{D\,mín} = 2mA$ $P_{máx(D)} = 7,2mW = V_\gamma \times I_{D\,máx}$ $P = V \times I$



$I_{D\,máx} = \frac{7,2\,mW}{0,6\,V} = 12\,mA$

$I_1 = I_2 + I_D$

$I_1 = \frac{(V_{ps} - V_D)}{R_1}$ $I_2 = \frac{V_D}{R_2}$

(10,6V) $I_1 = I_2 + 12mA \Leftrightarrow \frac{10,6-0,6}{R_1} = \frac{0,6}{R_2} + 12mA$

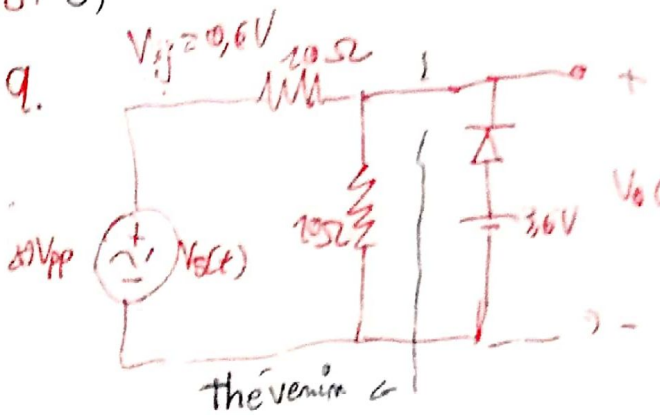
(5,6V) $I_1 = I_2 + 2mA \Leftrightarrow \frac{5,6-0,6}{R_1} = \frac{0,6}{R_2} + 2mA$

$\Leftrightarrow \begin{cases} \frac{10}{R_1} - \frac{0,6}{R_2} = 12 \\ \frac{5}{R_1} - \frac{0,6}{R_1} = 2 \end{cases} \Leftrightarrow \begin{cases} R_1 = 500\Omega \\ R_2 = 75\Omega \end{cases}$

7. ')

8. c)

9. $V_{ij} = 0,6V$

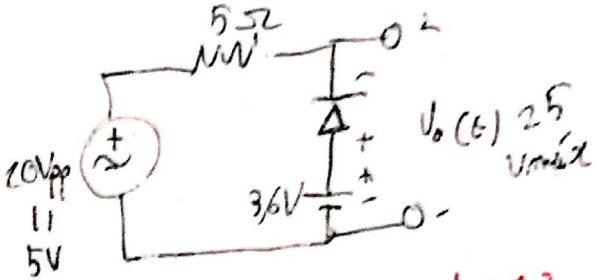


$V_T = 20\,V_{pp} \times \frac{10}{10+10} = 10\,V_{pp}$

$R_T = (10//10) = 5\Omega$

$I_{máx} \rightarrow -10V$

$V_{PIV} \rightarrow 10V$



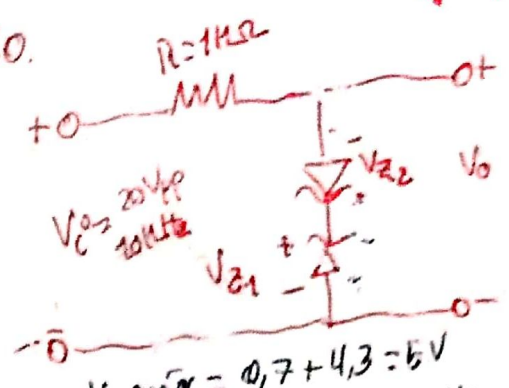
$5V = 5I - 3,6 - 0,6 \Leftrightarrow I_{D\,máx} = \frac{5+3,6-0,6}{5\Omega} = 1,6V$

$V_{máx} = 5 - 3,6 = 1,4V$

$I = \frac{V_i - V_o}{R}$ $I_{máx} = \frac{V_i - V_{o\,mín}}{R}$ $I_{mín} = \frac{V_i - V_{o\,máx}}{R}$

$V_\gamma = 0,7$ $V_{Z1} = 4,3V$ $V_{Z2} = 3,3V$

10.



$I_{máx} = \frac{10-(4,3+0,7)}{1k\Omega} = 5\,mA$

$I_{mín} = -\left(\frac{10-(3,3+0,7)}{1k\Omega}\right) = 6\,mA$

sentido oposto

$I_{méd} = \frac{5-6}{2} = 0,5mA$

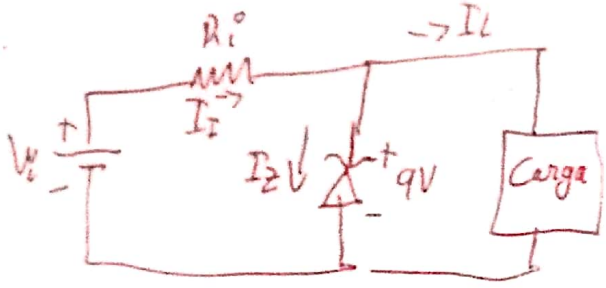
$V_{o\,máx} = 0,7 + 4,3 = 5V$

$V_{o\,mín} = -3,3 - 0,7 = -4V$

$V_{o\,méd} = \frac{5-4}{2} = 0,5V$

Ficha 3.

11.



$V_{imax} = 15V$

$V_{Ripple} = 3V$

$P_{carga} = 0,81W$ ou $0W$

$V_Z = 9V \rightarrow I_Z \geq 10mA$

a) $I_L = \frac{P_{carga}}{V_{carga}} = \frac{0,81}{9} = 90mA$

$V_{carga} = V_Z = 9V$

$V_i^o = 15 - V_{Ripple} = 12V$

Carga = $0W$

$I_I = 90mA + 10mA = 100mA$

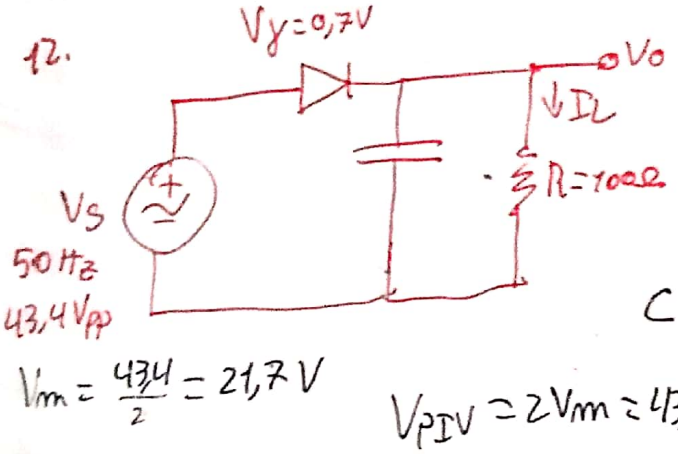
$R_i^o = \frac{12-9}{100mA} = 30\Omega$ //

b) Se $V_i^a = 15V$ e Carga Off

$I_I = \frac{15-9}{30} = 0,2A = I_Z$ $\quad P_Z = 9 \times 0,2 = 1,8V$ //

c) $P_R = 0,2 \times (15-9) = 1,2W_P$ //

12.



$V_m = \frac{43,4}{2} = 21,7V$

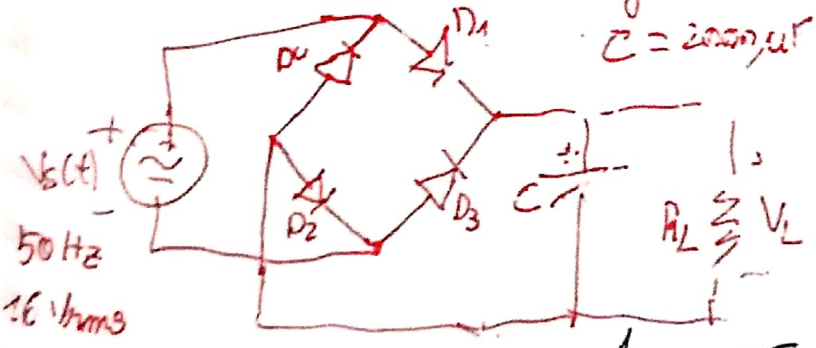
$V_{PIV} = 2V_m = 43,4V$ //

$V_R = 2V = \frac{I_{Lmed} \times T}{C}$

$I_{Lmed} = \frac{V_{Lmed}}{R} = \frac{V_m - V_y - \frac{V_R}{2}}{12} = 0,2A$

$C = \frac{I_{Lmed} \times T}{V_R} = \frac{0,2 \times \frac{1}{50}}{2} = 2mF$ //

13.



$V_r = I_{Lmed} \times \frac{T}{2C}$

$I_{Lmed} = \frac{V_m - 2V_y - \frac{V_Z}{2}}{100} = \frac{16\sqrt{2} - 1,6 - \frac{5}{2} I_{Lmed}}{100}$

$\times \frac{1}{50 \times 2 \times 2000 \cdot 10^{-6}}$

$V_r = I_{Lmed}$

$V_r = 5 I_{Lmed}$

$V_r = 1V$ //

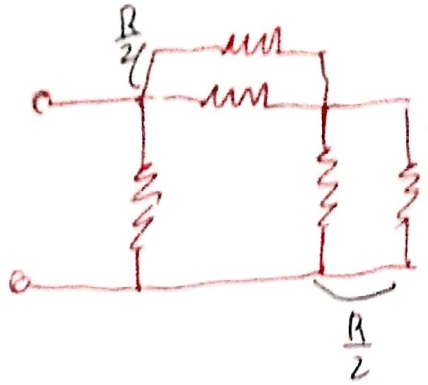
E2) $I = 0,21 - 0,025 I$

$27 I \geq 0,2$

Teste 1 17-18

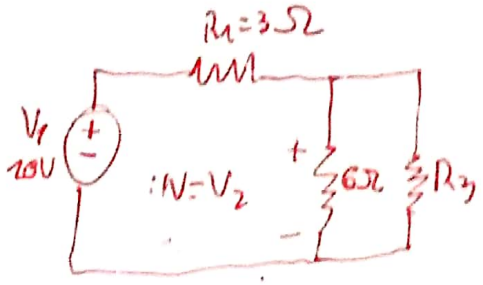
$V = RI$

1. $P = VI$
$= RI^2 \Rightarrow I = \sqrt{\frac{P}{R}} = 3\,mA$ b)

2. 

$R_{eq} = R // (R) = \frac{R}{2}$

$V = RI$

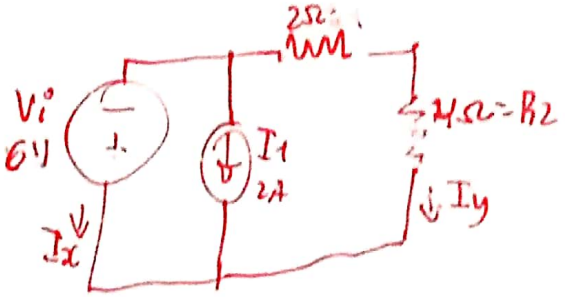
3. 

$I_1 = \frac{10-4}{3} = 2A \quad I_2 = \frac{4}{6}A \quad I_3 = \frac{2}{6}$

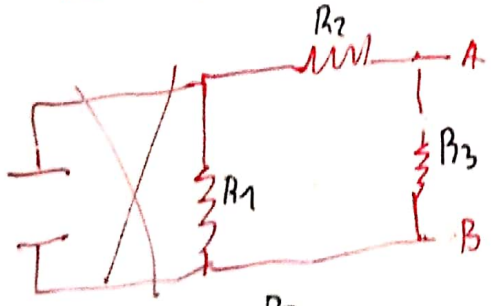
$V_{R3} = V_2 = 4V \quad R_3 = \frac{4}{2/6} = 3\Omega //$

4. $if = i_2 + i_{R3} \Rightarrow if = -i_2 + (i_4 + i_5)$

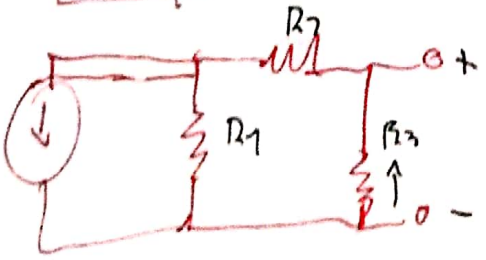
$i_{R3} \rightarrow -(i_4 + i_5)$

5. 

$I_y = 0 + (-1) = -1$

6. 

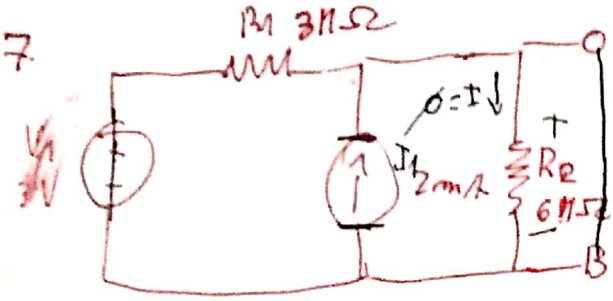
$R_{Th} = (R_1 + R_2) // R_3$
$= 16 // 4 = 3{,}2\,\Omega$



em série
$I_{R_3} = I_{R_2} = 10mA \frac{10}{(4+6)+10} = 5mA$

$V_{Th} = -5mA \times 4\,\Omega = -20V //$

7.



$R_N = R_1 // R_2 = 2k\Omega$

$V_{n2} = 0$

$I_{n2} = 0$

$I_N = I_{R1} + I_1$

$= \frac{3}{3k} + 2mA = 3mA$

8. $I_x = -1mA$

$V_2 = -10V$

$V_0 = -V_2 \times \frac{2k}{4k} = +5V$

9. $V_{med} = \frac{1}{10.10^{-9}s} \times (9 \times 2ns - 1 \times 8ns) = 1V$

$\frac{100.10^{-3}}{10} = \frac{1}{\sqrt{1+\left(\frac{f}{f_c}\right)^2}}$

$0,01 = \frac{1}{\sqrt{1+\left(\frac{f}{f_c}\right)^2}} \Leftrightarrow 100^2 = 1+\left(\frac{f}{f_c}\right)^2$

$100^2 - 1 = \frac{f^2}{f_c^2}$

10. $V_{ef} = \frac{V_m}{\sqrt{2}} = \frac{3\sqrt{5}}{\sqrt{2}}$ $P = 5W$

11. $V_{pp} = 10\ V_{pp}$

90% de $V_{pp} = 9V$ 10% de $V_{pp} = 1V$

10V — 20ns

8V — x

x = 16ns

12. $V_c = 10V$ descarga

$V_f = 3,68V$

$3,68 = 10e^{-\frac{1.10^{-3}}{2.10^3 C}}$

$\Leftrightarrow -1 = -\frac{1.10^{-3}}{2.10^3 C} \Leftrightarrow \frac{1}{1k} = 2.10^3 C \Leftrightarrow 500mF$

$= 0,5\mu F$

13. $f_B = \frac{1}{2\pi RC} = 80k\Omega$ PA => C em sónic com o trajeto V_{in} para V_{out}

14. PB

$f_C = 1kHz$

$H_f = \frac{0,1}{10} = 10^{-2}$

$H_{f_{db}} = 20\log(10^{-2}) = -40db$

Num PB, a partir do f_C, o ganho cai com um declive de -20db/decada, pelo que, se o ganho caiu -40db, isso significa que a frequência está 2 décadas acima de f_C.

Isto é, $f = 100 f_C = 1300kHz = 1,3MHz$

15. $L = 1mH$

$C = 1,2\mu F$

$Z_C = \frac{1}{jwC} = -j\,wC = 0,035$ $W = 2\pi f =$

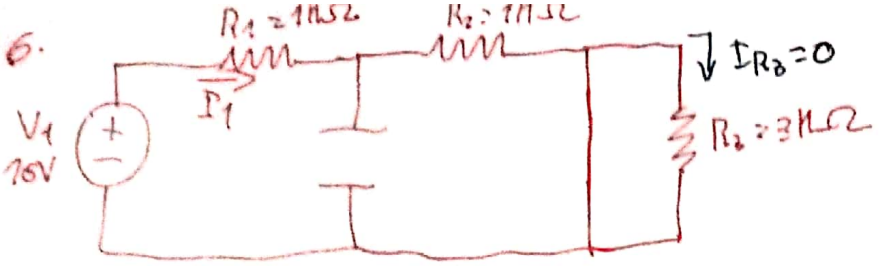
$Z_L = jwL = 28,9j$

$|Z| = 0\Omega$ $-\arctg(j) = -90°$

$jwL + \frac{1}{jwC} = \frac{jwL\,jwC + 1}{jwC}$

$= \frac{1 - w^2LC}{jwC} \simeq \frac{0}{jwC}$

16.



$I_1 = \frac{10}{R_1+R_2} = 5mA.$

Teste 16/17.

1. b) 2. c)

3. $I_{R_2} = \frac{4}{6}$ $I_{R_1} = \frac{4}{6} + \frac{4}{3} = 2A$ $R_1 = \frac{V}{I} = 3\Omega$

$I_{R_2} = \frac{4}{3}$ $V_{R_1} = 10 - 4 = 6V$

4. c)

5. $I_y = \frac{-V_1}{R_1+R_2} = -1A$ $I_y + I_x + I_1 = 0 \Leftrightarrow I_x = -I_1 - I_y \Leftrightarrow I_x = -1A$

6. $V_{ABa} = V_i^o \times \frac{R_2}{R_1+R_2} = 2V$ $I_1 \rightarrow$ circuito-aberto

$V_{TH} = 6V = 4+2$

$V_{HB_b} = I_1 \times (R_2 // R_1) = 4V$ $V_4 \rightarrow$ curto-circuito $R_{Th} = 2M\Omega$

7. c) e8 fazer.

9. a)

10. d)

11. 20 — 10 $V_{pp} = 10 V_{pp}$ 90% → 8V

8 — x 10% = 1V

$x = 16ms$

12. $V_{TH} = 500\Omega \times 10mA$ t < 0s

$= 5V$ C está carregado com 5V

$R_{Th} = 500\Omega$

t > 0s

C descarrega $\tau = RC$ $V(1ms) = 5e^{-\frac{1.10^{-3}}{1M \times 1\mu}}$

$R = 500\Omega + 500\Omega = 1M\Omega$ $= 1,84V$

13. PB → C está em paralelo com o trajeto $V_{in} \rightarrow V_{out}$

$f_c = \frac{1}{2\pi RC} \approx 160\,kHz$ b) //

14. PA

$f_c = 80\,kHz$

$8\,kHz = \frac{f_c}{10}$, ou seja, 1 década abaixo de f_c. Num PA, às baixas freq, o declive é de 20 dB/década, pelo que, a 8 kHz a relação $V_0/V_i = -20\,dB$, ou seja, $V_0/V_i = 0{,}1 \Leftrightarrow V_0 = 0{,}1 V_i$. //

15. $Z = \frac{R \times \frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{R}{(1 + j\omega RC)} = \frac{1M}{1 + j 2\pi \times 6k \times 1k \times 100 \times 10^{-9}} = \frac{1000}{1 + j1}$

$|Z| = \frac{1000}{\sqrt{1^2 + 1^2}} = \frac{1000}{\sqrt{2}} = 0{,}7\,k\Omega$ $\phi(Z) = -\arctg\left(\frac{1}{1}\right) = -45^\circ$ //

16. b) 17. d)

18. $V_i = \pm 8\,V_p$ circuito simétrico basta calcular para $V_i = +8V_p$

$V_0 = \pm 3 V_p$

Com $V_i = +8V$ $V_0 = 3V = 0{,}6 + V_Z \Leftrightarrow V_Z = 2{,}4V$

$V_{Z1} = 0{,}6V$

$V_{Z2} = V_Z$

19. $V_{L\,med} = V_m - V_\gamma - \left(\frac{V_r}{2}\right)$ $V_r = \frac{I_{L\,med}}{f \times C} = 2\,I_{L\,med}$

$V_{sp} = 14 \times \sqrt{2} = 19{,}8\,V$

$I_{L\,med} = \frac{V_{L\,med}}{R_L}$

$V_{L\,máx} = 19{,}8 - 0{,}8 = 19V$ //

$V_{L\,med} = V_{L\,máx} - \frac{V_r}{2}$

$V_r = 2\left(\frac{V_{L\,med}}{R_L}\right) = 2\,\frac{19 - \frac{V_r}{2}}{18} \Leftrightarrow \frac{V_r}{2} = \frac{19 - \frac{V_r}{2}}{18} \Leftrightarrow \frac{V_r}{2} \times 18 = 19 - \frac{V_r}{2} \Leftrightarrow$

$\Leftrightarrow 9V_r = 19 - \frac{V_r}{2} \Leftrightarrow V_r = 2V$

$V_{L\,min} = V_{L\,máx} - V_r = 17V$ //

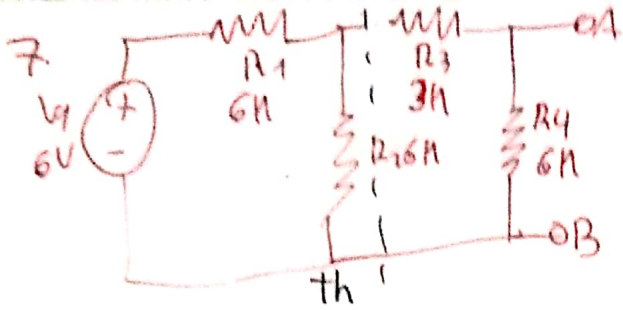
20. $I_1 = \frac{V_i - V_\gamma - V_{Z1}}{R_1} = \frac{22 - 0{,}6 - 12}{470} = 0{,}02\,A$

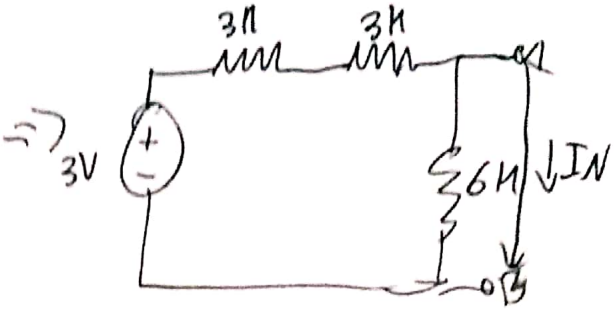
$I_2 = \frac{12}{1{,}2k} = 0{,}01\,A$

$I_Z = 0{,}02 - 0{,}01 = 0{,}01\,A$

$P_{Z1} = 12 \times 0{,}01A = 0{,}12W$

7.





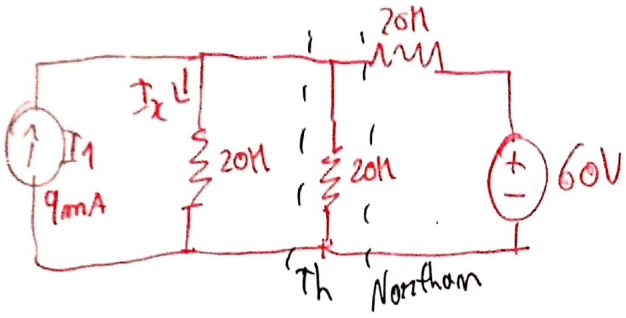
$V_{th} = 6 \times \frac{6}{12} = 3V$

$R_{Th} = 6\Omega // 6\Omega = 3\Omega$

$I_N = \frac{3}{3+3} = 500\mu A$

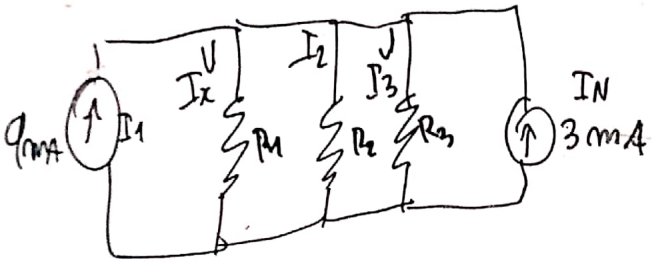
$R_N = (3+3) // 6 = 3\Omega //$

8.



$R_N = 20\Omega$

$I_N = \frac{60}{20\Omega} = 3mA$



$12mA = I_1 + I_N = I_x + I_2 + I_3$

$R_1 = R_2 = R_3 \Rightarrow I_x = I_2 = I_3$

$I_x = \frac{12\,mA}{3} = 4mA //$

$V_{in} = 5,65$

$I_{máx} \Rightarrow V_{máx} = 5,65$

$V_{L\,máx} = 5,65 - 0,6 = 5,05 \triangleq 5050\Omega //$

Trabalho Prático 3.

Parte 1.

1. Circuito A -> Amplificador Inversor

$A_V = \frac{V_o}{V_{in}} = -\frac{R_2}{R_1}$

Circuito B -> Amplificador Não Inversor

$A_V = \frac{V_o}{V_{in}} = 1 + \frac{R_2}{R_1}$