Universidade Federal do Rio de Janeiro
Escola Politécnica

DATA: 12/12/2018

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Aluno(a): Prova de Segunda Chamada — Gabarito

Disciplina: Eletrônica I — EEL315

Turma: 2018/2

Professor(a): José Gabriel

Questão (1)

$p = 1.08^2 \times 10^{20} / 10^{15} = 1.1664 \times 10^5$ lacunas$/cm^3$

$J = 1.6 \times 10^{-19} (1350 \times 10^{15} + \underbrace{480 \times 1.1664 \times 10^5}_{\text{desprezível}}) \times 514 = 111.02\ A/cm^2$

$10 \times 10^{-6} = W^2 \times 111.02 \longrightarrow W = 3 \times 10^{-4}\ cm \longrightarrow \boxed{W = 3\ \mu m}$

Questão (2)

$n_i = 5.2 \times 10^{15} \times T^{3/2} \exp(-1.12 \times 1.6 \times 10^{-19} / (2 \times 1.38 \times 10^{-23} \times T))$

$\ln(n_i) = \ln(5.2 \times 10^{15}) + \ln(T^{3/2}) + \ln(\exp(-6492.8/T))$

$\left(\begin{array}{l} -1.12 \times 1.6 \times 10^{-19} / (2 \times 1.38 \times 10^{-23}) = -1.792 \times 10^4 / 2.76 = -6492.8 \\ \ln(5.2 \times 10^{15}) = 36.187 \end{array} \right)$

$\ln(n_i) = 36.187 + 1.5 \ln(T) - 6492.8/T$ //

E também: $0.8 = (kT/q) \ln(5 \times 10^{33} / n_i^2)$

$0.8 q/k = 0.8 \times 1.6 \times 10^{-19} / (1.38 \times 10^{-23}) = 9.275 \times 10^3$

$\ln(5 \times 10^{33}) = 77.595$

$9275 = T(77.595 - 2\ln(n_i)) \longrightarrow 2\ln(n_i) = 77.595 - 9275/T$ //

Então: $72.374 + 3\ln(T) - 12985.6/T = 77.595 - 9275/T$

$\boxed{5.221 + 3710.6/T - 3\ln(T) = 0}$

Questão (3)

$10^{-3} = I_S \exp(0.6/(0.026n))$ (I)

$10^{-6} = I_S \exp(0.3/(0.026n))$ (II)

Dividindo (I) por (II): $10^3 = \exp(0.3/(0.026n))$

$\frac{0.3}{0.026n} = \ln(10^3) = 6.91 \longrightarrow n = 1.67$ //

$10^{-3} = I_S \underbrace{\exp(0.6/(0.026\times 1.67))}_{1.003\times 10^{6}} \longrightarrow I_S = \dfrac{10^{-3}}{1.003\times 10^{6}} \longrightarrow I_S = 1\,nA$ //

a) Chute inicial : $V_D = 0.7\,V$

$I_D = (10-0.7)/100 = 93\,mA$

$V_D = 1.67\times 0.026\times \ln(93\times 10^{-3}/10^{-9}) = 1.67\times 0.026\times 18.35 = 0.797\,V$

$I_D = (10-0.797)/100 = 92\,mA$

$V_D = 1.67\times 0.026\times \ln(92\times 10^{-3}/10^{-9}) = 1.67\times 0.026\times 18.34 = 0.796\,V$

$I_D = (10-0.796)/100 \longrightarrow \boxed{I_D = 92\,mA}$

b) Chute inicial : $V_D = 0.7\,V$

$I_D = (10-0.7)/1000 = 9.3\,mA$

$V_D = 1.67\times 0.026\times \ln(9.3\times 10^{-3}/10^{-9}) = 1.67\times 0.026\times 16.05 = 0.697\,V$

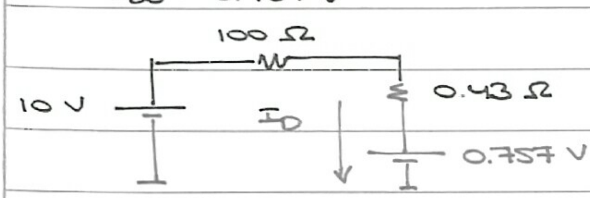
$I_D = (10-0.697)/1000 = \boxed{9.3\,mA}$

Questão 4

a) Para $R = 100\,\Omega$, usamos o modelo linear em torno de $I_D = 100\,mA$:

$V_{D0} + 0.43\times 0.1 = 0.8$

$V_{D0} = 0.757\,V$

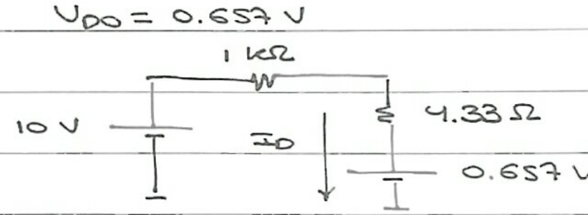


$I_D = \dfrac{10-0.757}{100.43} = \boxed{92\,mA}$

b) Para $R = 1\,k\Omega$, usamos o modelo linear em torno de $I_D = 10\,mA$:

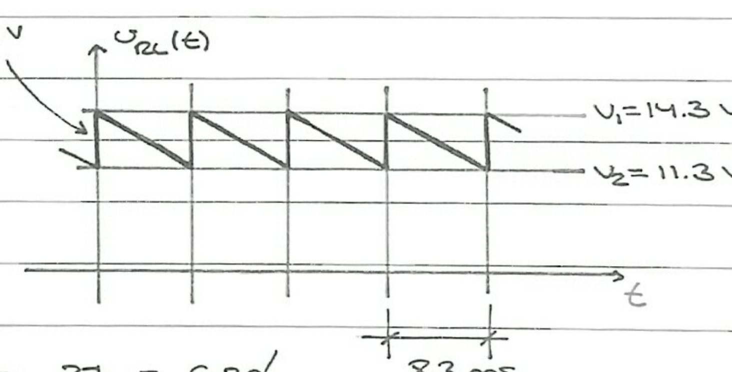
$V_{D0} + 4.33\times 0.01 = 0.7$

$V_{D0} = 0.657\,V$



$I_D = \dfrac{10-0.657}{1004.33} = \boxed{9.3\,mA}$

Questão 5



Chute inicial : $r = 10\%$

$(1+\sqrt{3}\times 0.1)\,V_{DC} = 14.3$

$V_{DC} = 12.2\,V$

$I_{DC} = 12.2/330 = 37\,mA$

$r = \dfrac{37\times \cancel{10^{-3}}}{4\times 1.7\times 6\cancel{0}\times 1\cancel{00}\times \cancel{10^{-6}}\times 14.3} = \dfrac{37}{583.4} = 6.3\%$

$(1+\sqrt{3}\times 0.063)\,V_{DC} = 14.3$

$V_{DC} = 12.9\,V$

$I_{DC} = 12.9/330 = 39\,mA \longrightarrow r = \dfrac{39}{583.4} = \boxed{6.7\%}$

$(1+\sqrt{3}\times 0.067)\,V_{DC} = 14.3$

$\boxed{V_{DC} = 12.8\,V}$

$I_{DC} = 39\,mA$ //

$V_{AC,rms} = r.V_{DC} = 0.067 \times 12.8 \longrightarrow \boxed{V_{AC,rms} = 0.86\,V}$

(Obs.: ou

$V_{R,pp} = 2\sqrt{3}\,V_{AC,rms} = 2 \times 1.7 \times 0.86 \longrightarrow \boxed{V_{R,pp} = 2.9\,V}$

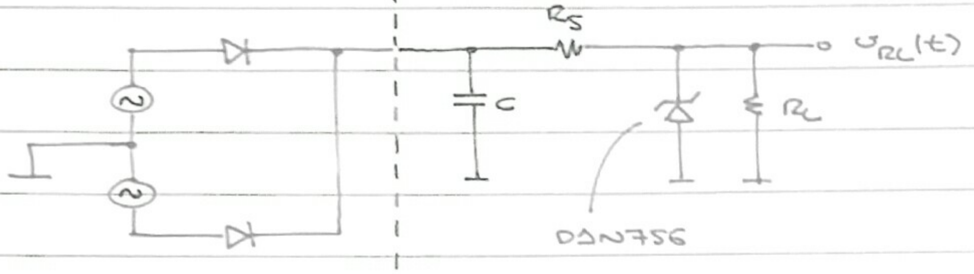
$V_{R,pp} = V_1 - V_2$

$V_{rms} = \sqrt{12.8^2 + 0.86^2} \longrightarrow \boxed{V_{rms} = 12.83\,V}$

$V_{R,pp} = 3.0\,V$)

$P = 12.83^2/330 \longrightarrow \boxed{P = 499\,mW}$

Questão 6

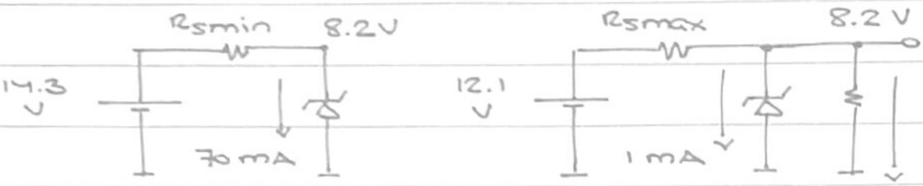


chute inicial

$(1+\sqrt{3}\times 0.05)\,V_{DC} = 14.3\,V$

$V_{DC} = 13.2\,V$

$V_2 = 13.2 - 1.1 = 12.1\,V$



$\boxed{R_S = 100\,\Omega} \longleftarrow$ $R_{Smin} = 87\,\Omega$ $R_{Smax} = 125\,\Omega$

Então: $I_{DC} = (13.2 - 8.2)/100 = 50\,mA$

$$C = \frac{50\times 10^{-3}}{4\times 1.7\times 60\times 0.05\times 14.3} = \frac{50\times 10^{-3}}{0.292\times 10^{3}} = 171\,\mu F \longrightarrow \boxed{C = 220\,\mu F}$$

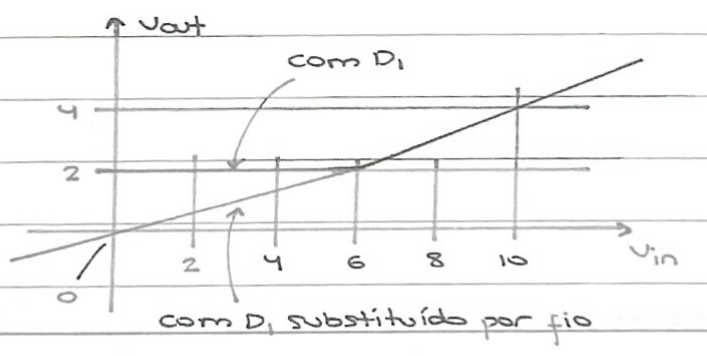
Usando $C = 220\,\mu F$, temos: $r = \dfrac{50\times 10^{-3}}{4\times 1.7\times 60\times 0.22\times 10^{-3}\times 14.3} = \dfrac{50}{1284} = 3.9\%$

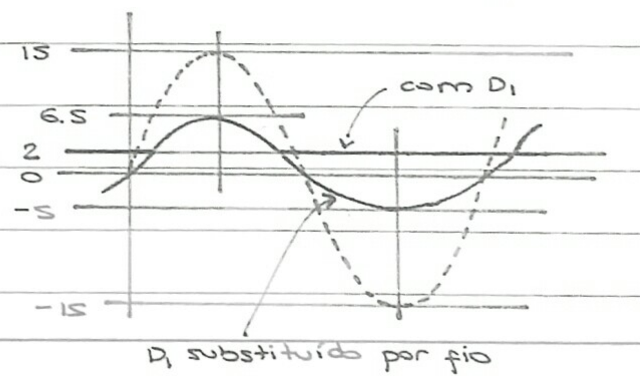
$(1+\sqrt{3}\times 0.039)\,V_{DC} = 14.3 \longrightarrow V_{DC} = 13.4\,V \longrightarrow (13.4 - 8.2)/100 = 52\,mA$

$\longrightarrow r = 52/1284 \longrightarrow \boxed{r = 4\%}$ (no capacitor)

Questão 7

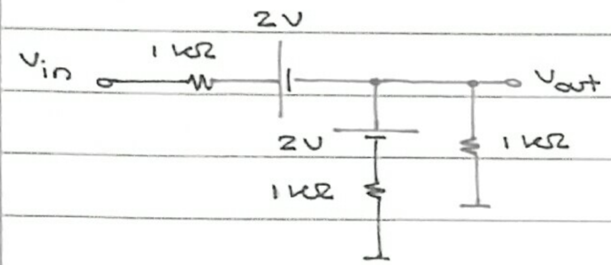
Com o diodo da caixa em polarização direta, temos: $I = (V_{in} - 2)/2000$, e portanto $\boxed{V_{out} = (V_{in}-2)/2}$. O diodo fora da caixa permanece desligado desde que $V_{out} > 2$, o que corresponde a $(V_{in}-2)/2 > 2$, ou seja, $V_{in} > 6\,V$. Se $V_{in} < 6\,V$, temos o diodo fora da caixa em polarização direta, o que significa que $\boxed{V_{out} = 2\,V}$ (neste caso, o diodo da caixa está desligado).





Quando D_1 é substituído por um fio, se o diodo fora da caixa estiver desligado, temos: $I = (v_{in} - 2)/2000$ e portanto $\boxed{V_{out} = (v_{in}-2)/2}$.

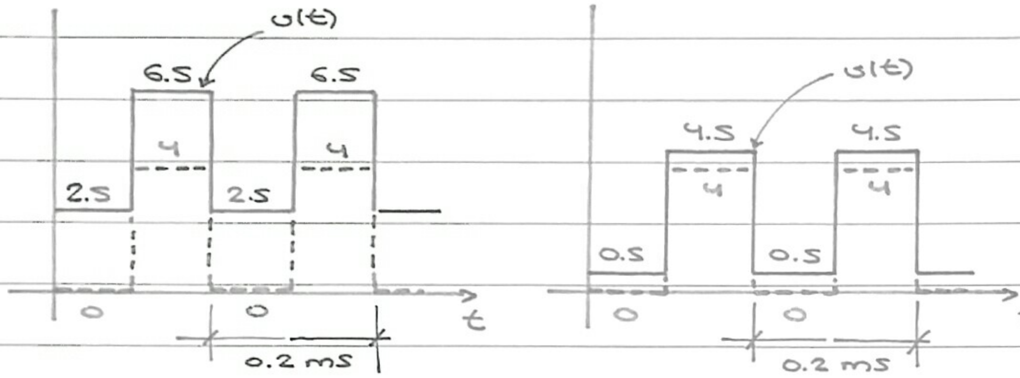
O diodo fora da caixa permanece desligado desde que $V_{out} > 2$, ou seja, desde que $v_{in} > 6\,V$. Se $v_{in} < 6\,V$, temos a seguinte situação:



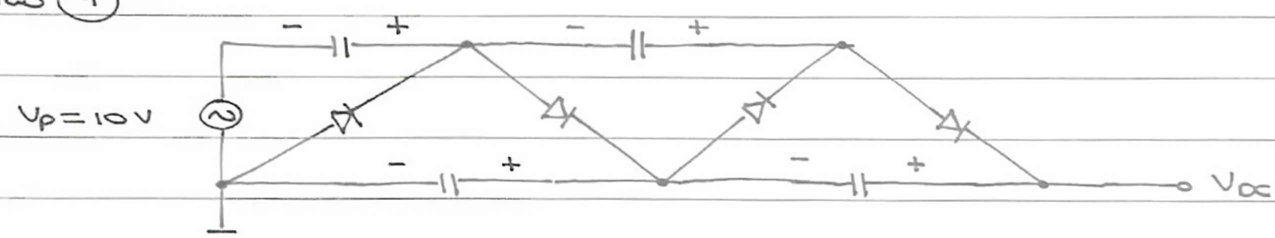
$$\frac{v_{in} - (V_{out}+2)}{1000} = \frac{V_{out}}{1000} + \frac{V_{out}-2}{1000}$$

$$\frac{v_{in}}{1000} = \frac{3V_{out}}{1000} \longrightarrow V_{out} = \frac{v_{in}}{3}$$

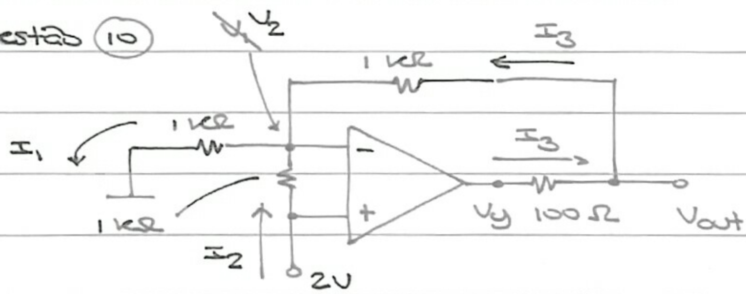
Questão (8)



Questão (9)



Questão (10)



$\cancel{V_1}\,V_2 = 2 - V_y/100$

$I_1 = \dfrac{2 - V_y/100}{1000}$

$I_2 = \dfrac{V_y/100}{1000}$

$I_3 = I_1 - I_2 \longrightarrow I_3 = \dfrac{2 - 2V_y/100}{1000}$

$(\cancel{V_1}\,V_2 + 1000 I_3 = V_y - 100 I_3)$

Então: $2 - \dfrac{V_y}{100} + 1000 \times \left(\dfrac{2 - \frac{2V_y}{100}}{1000}\right) = V_{out} = V_y - 100\left(2 - \dfrac{2V_y}{100}\right) \times \dfrac{1}{1000}$

$$2 - \frac{V_y}{100} + 2 - \frac{2V_y}{100} = V_y - 0.2 + 0.002V_y \longrightarrow 1.032V_y = 4.2$$

$V_y = 4.07\,V$

$V_y = 4.07\,V \longrightarrow I_3 = (2 - 2\times 0.0407)/1000 = 1.92\,mA \longrightarrow V_{out} = 4.07 - 0.192$

(obs.: $V_2 = 1.96\,V$; $I_1 = 1.96\,mA$; $I_2 = 0.04\,mA$)

$\boxed{V_{out} = 3.88\,V}$