Universidade Federal do Rio de Janeiro
Escola Politécnica

DATA: 05/12/2018

GRAUS	
1	
2	
3	
4	
5	

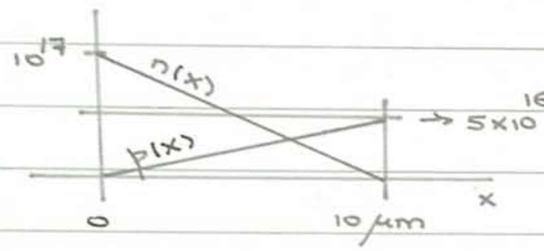
Aluno(a): Prova Final 2018-2 — Gabarito

Disciplina: Eletrônica I

Turma: 2018/2

Professor(a): José Gabriel

Questão 1



$$dn/dx = -10^{17}/(10\times10^{-4}) = 10^{20}/cm^4$$

$$dp/dx = (5\times10^{16})/(10\times10^{-4}) = 5\times10^{19}/cm^4$$

$$J = 1.6\times10^{-19}(-34\times10^{20} - 12\times5\times10^{19}) = -640\ A/cm^2$$

$$I = J.A = -640\times500\times10^{-7}\times500\times10^{-7} = \boxed{1.6\ \mu A}$$

$$(6.4\times25\times10^{6}\times10^{-14} = 160\times10^{-8}\ A)$$

Questão 2

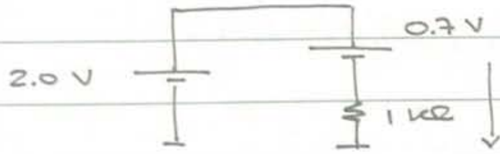
$$n_i = \underbrace{1.66\times10^{15}(400)^{3/2}}_{1.328\times10^{19}} \exp\left(\underbrace{\frac{-0.66\times1.6\times10^{-19}}{2\times1.38\times10^{-23}\times400}}\right) = 9.3146\times10^{14}/cm^3$$

$$\frac{-1.056\times10^{4}}{2.76\times4\times100} = \frac{-105.6}{11.04} = -9.565 \qquad (e^{-9.565} = 7.014\times10^{-5})$$

$$V_0 = \underbrace{\frac{1.38\times10^{-23}\times400}{1.6\times10^{-19}}}_{34.5\ mV} \ln\left(\underbrace{\frac{2\times10^{17}\times5\times10^{16}}{9.3146^2\times10^{28}}}\right) = 34.5\times9.352 = \boxed{323\ mV}$$

$$\frac{100\times10^{4}}{86.762} = 1.1526\times10^{4} \qquad (\ln(1.1526\times10^{4}) = 9.352)$$

Questão 3



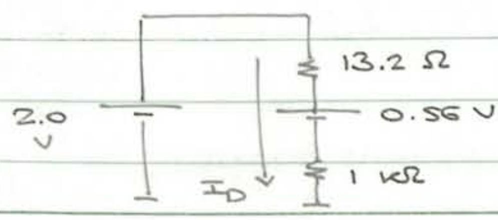
$$I = \frac{(20-0.7)}{1000} = 1.3\ mA$$

Então, vamos escolher um modelo linear para correntes em torno de 1.3 mA.

573 mV — 1 mA $\longrightarrow r_d = (692-573)/(10-1) = 119/9 = 13.2\ \Omega$

692 mV — 10 mA $\quad V_{D0} + 13.2\times10\times10^{-3} = 0.692\ V \longrightarrow V_{D0} = 0.56\ V$

Usando o modelo V_{D0}, r_d:



$$I_D = \frac{2-0.56}{1013.2} \longrightarrow \boxed{I_D = 1.42\ mA}$$

Questão 4

Chute inicial: $V_D = 0.7\,V \longrightarrow I_D = (2 - V_D)/1000 = 1.3\,mA$

Iteração 1: $V_D = 1.98 \times 0.026 \times \ln\left((1.3\times10^{-3})/(1.41\times10^{-8})\right) = 0.588\,V$

$I_D = (2 - 0.588)/1000 = 1.412\,mA$ $\quad (\ln(92200) = 11.43)$

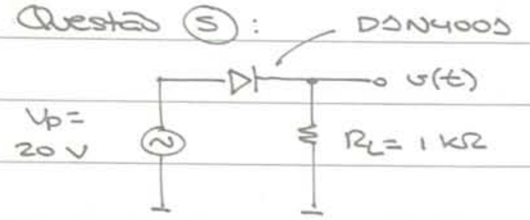
Iteração 2: $V_D = 1.98\times 0.026 \times \ln\left((1.412\times10^{-3})/(1.41\times10^{-8})\right) = 0.593\,V$

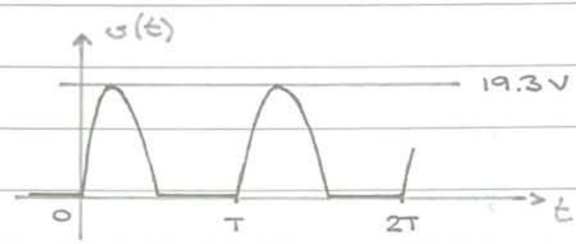
$I_D = (2 - 0.593)/1000 = 1.407\,mA$ $\quad (\ln(100142) = 11.51)$

Iteração 3: $V_D = 1.98 \times 0.026 \times \ln\left((1.407\times10^{-3})/(1.41\times10^{-8})\right) = 0.593\,V$

$I_D = (2 - 0.593)/1000 = \boxed{1.407\,mA}$ $\quad (\ln(99787) = 11.51)$

Questão 5:





$V_{RMS} = 19.3/2 = 9.65\,V$ $\qquad V_{AC,RMS} = \sqrt{9.65^2 - 6.15^2} = 7.44\,V$

$V_{DC} = 19.3/\pi = 6.15\,V$ $\qquad r = 7.44/6.15 \Rightarrow \boxed{r = 1.21}$ ou $\boxed{121\%}$

Questão 6

$(1 + \sqrt{3}\times 0.05)\,V_{DC} = 19.3 \longrightarrow V_{DC} = 17.8\,V \longrightarrow I_{DC} = 17.8\,mA$

$C = \dfrac{17.8\times10^{-3}}{2\times1.7\times60\times0.05\times19.3} = \dfrac{17.8}{197}\times10^{-3} = 90\,\mu F \longrightarrow \boxed{C = 100\,\mu F}$

Usando $C = 100\,\mu F$, temos $r = \dfrac{17.8\times10^{-3}}{2\times1.7\times60\times19.3\times0.1\times10^{-3}} = \dfrac{17.8}{394} = 4.5\%$

$V_{DC} = 19.3/(1 + \sqrt{3}\times 0.045) \longrightarrow V_{DC} = 17.9\,V \longrightarrow I_{DC} = 17.9\,mA \longrightarrow r = \dfrac{17.9}{394} = \boxed{4.5\%}$

Questão 7

Chute inicial: $r = 10\% \longrightarrow (1 + \sqrt{3}\times 0.1)\,V_{DC} = 16.3 \longrightarrow V_{DC} = 13.9\,V$

Então: $I_{DC} = (13.9 - 8.2)/180 = 32\,mA$

$r = \dfrac{32\times\cancel{10^{-3}}}{4\times1.7\times60\times16.3\times0.33\times\cancel{10^{-3}}} = \dfrac{32}{2194} = 1.5\%$

Repetindo: $r = 1.5\% \longrightarrow (1 + \sqrt{3}\times 0.015)\,V_{DC} = 16.3 \longrightarrow V_{DC} = 15.9\,V$

$I_{DC} = (15.9 - 8.2)/180 = 43\,mA \longrightarrow r = 43/2194 = 2\%$

$(1 + \sqrt{3}\times 0.02)\,V_{DC} = 16.3 \longrightarrow V_{DC} = 15.8\,V \longrightarrow I_{DC} = \dfrac{15.9 - 8.2}{180} = 42\,mA$

Agora que sabemos que $r = 2\%$ (capacitor) e $V_{DC} = 15.8\,V$, só falta encontrar r_2.

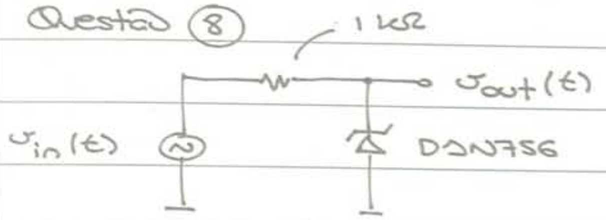
$I_{RL} = 8.2/330 = 25\ mA$

$I_Z = I_{DC} - I_{RL} = 42\ mA - 25\ mA = 17\ mA$

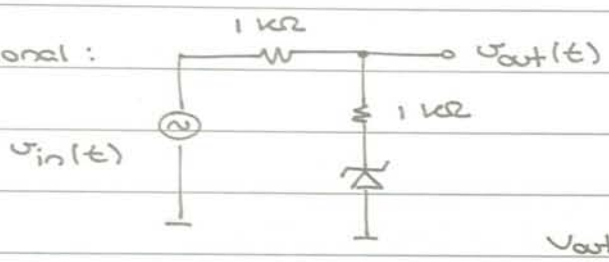
Usando pontos próximos de 17 mA na Tabela 3: $r_Z = \frac{8.2-8.161}{0.02-0.01} = 3.9\,\Omega$

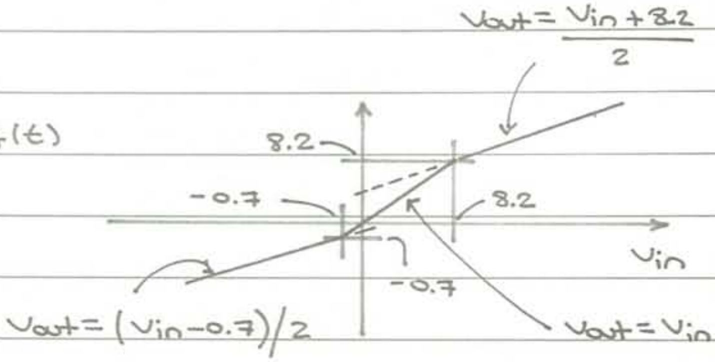
Então: $r_{RL} = 2\% \times \underbrace{\frac{3.9}{183.9} \times \frac{15.8}{8.2}}_{0.04} \Rightarrow \boxed{r = 0.08\%}$

Questão (8)

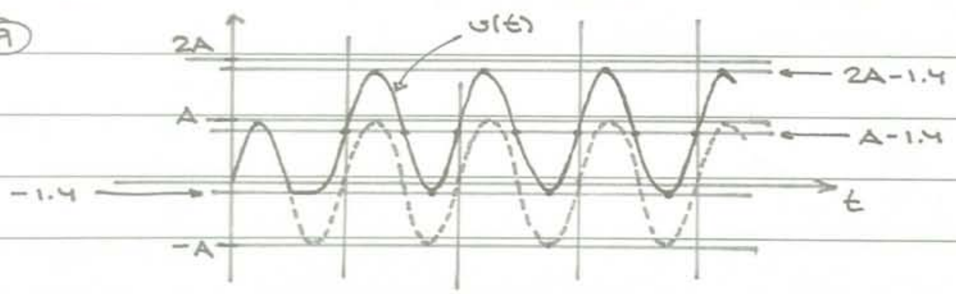


Item opcional:

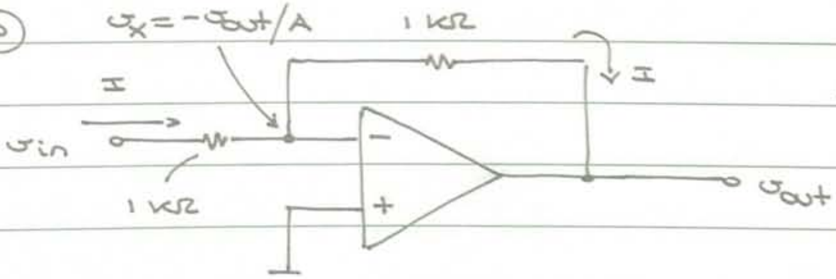




Questão (9)



Questão (10)



A = 100

$I = \frac{v_{in} + \frac{v_{out}}{A}}{1000}$

$v_{out} = \frac{-v_{out}}{A} - 1000 \frac{\left(v_{in} + \frac{v_{out}}{A}\right)}{1000} \Rightarrow v_{out}\left(1 + \frac{1}{A} + \frac{1}{A}\right) = -v_{in}$

$A = 100 \Rightarrow \frac{v_{out}}{v_{in}} = \frac{-1}{1 + \frac{2}{100}} = \frac{-1}{1.02} \Rightarrow \boxed{\frac{v_{out}}{v_{in}} = -0.98}$