Universidade Federal do Rio de Janeiro
Escola Politécnica

DATA	02/12/2019
Aluno(a):	Prova Final — Gabarito
Disciplina:	Eletrônica I
Turma:	2019/2
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GRAUS

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Questão 1

$n = 10^{17}$ elétrons/cm^3 ; $p = 1.08^2 \times 10^{20} / 10^{17} = 1166$ lacunas/cm^3

$E = 10\,V/(10^{-4}\,cm) = 10^5\,V/cm$; $A = (50\times10^{-7}\,cm)\times(50\times10^{-7}\,cm) = 2.5\times10^{-11}\,cm^2$

$J = 1.6\times10^{-19}\times(1350\times10^{17} + 480\times1166)\times10^5 = 2.16\times10^6\,A/cm^2$

$I = 2.16\times10^6\times2.5\times10^{-11} \longrightarrow I = 54\,\mu A$

Questão 2

$$n_i = \underbrace{1.66\times10^{15}\times375^{3/2}}_{1.2055\times10^{19}} \times \underbrace{\exp(-(0.66\times1.6\times10^{-19})/(2\times1.38\times10^{-23}\times375))}_{\exp(-10.2029) = 3.7063\times10^{-5}} = 4.468\times10^{14}\,cm^{-3}$$

$kT/q = 1.38\times10^{-23}\times375/(1.6\times10^{-19}) = 32.3\,mV$

$$V_0 = 0.0323\times\underbrace{\ln(10^{17}\times10^{17}/(4.468^2\times10^{28}))}_{\ln(5.0093\times10^4) = 10.82} \longrightarrow V_0 = 0.35\,V$$

Questão 3

Chute inicial: $V_D = 0.7\,V \longrightarrow I_D = (5-0.7)/1000 = 4.3\,mA$

$V_D = 1\times0.0259\times\ln(4.3\times10^{-3}/10^{-15}) = 0.0259\times29.09 = 0.7534\,V$

$I_D = (5-0.7534)/1000 = 4.2466\,mA$ ($I_D = 4.247\,mA$)

$V_D = 1\times0.0259\times\ln(4.2466\times10^{-3}/10^{-15}) = 0.0259\times29.08 = 0.7532\,V$ ($V_D = 753\,mV$)

$I_D = (5-0.7532)/1000 = 4.2468\,mA$

Questão 4

Assumindo correntes na faixa de 5 mA até 10 mA:

$V_{D1} = 0.0259\times\ln(5\times10^{-3}/10^{-15}) = 0.757\,V$; $I_{D2} = 0.0259\times\ln(10^{-2}/10^{-15}) = 0.775\,V$

$r_d = \Delta V_D / \Delta I_D = (0.775 - 0.757)/(0.01 - 0.005) = 3.6\ \Omega$

Usando (V_{D1}, I_{D1}): $V_{D0} + r_d I_{D1} = V_{D1}$

$V_{D0} = 0.757 - 3.6 \times 0.005 \longrightarrow V_{D0} = 0.739\ V$

Então: $I_D = (5 - 0.739)/(1000 + 3.6) = 4.246\ mA$

$V_D = 0.739 + 3.6 \times 4.246 \times 10^{-3} = 0.754\ V$

Questão 5

$V_{DC} = 5\ V$; $V_{AC,RMS} = V_p/\sqrt{2} = 2\sqrt{2} = 1.41\ V$ (voltagem de pico da parcela senoidal)

$V_{RMS}^2 = V_{DC}^2 + V_{AC,RMS}^2 = 25 + 2 = 27 \longrightarrow V_{RMS} = \sqrt{27} = 5.2\ V$

$r = 1.41/5 = 28\%$

Questão 6

$r = 5\% \longrightarrow (1 + \sqrt{3} \times 0.05) V_{DC} = 19.3 \longrightarrow V_{DC} = 17.8\ V$

$I_{DC} = 17.8/220 = 81\ mA$

$C = 81 \times 10^{-3}/(4\sqrt{3} \times 60 \times 0.05 \times 19.3) = 81000/(401) \times 10^{-6} = 202\ \mu F$

Valor comercial: $C = 220\ \mu F$

(obs.: $r = 81 \times \cancel{10^{-3}}/(4\sqrt{3} \times 60 \times 0.22 \times \cancel{10^{-3}} \times 19.3) = 81/1765 = 4.6\%$

$V_{DC} = 19.3/(1 + \sqrt{3} \times 0.046) = 17.9\ V \longrightarrow I_{DC} = 81\ mA \longrightarrow r = 4.6\%$)

Questão 7

$V_{DC} = 18\ V$; $V_{R,P} = 1\ V$; $r_{cap} = 1/(\sqrt{3} \times 18) = 3.2\%$

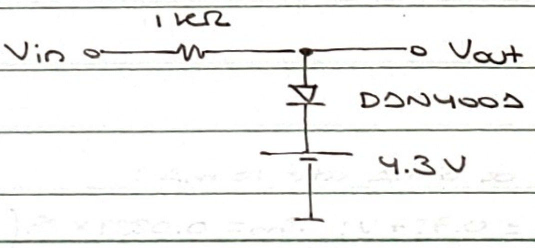
Modelo do diodo Zener: $I_Z \cong (18 - 8.2)/220 - 8.2/470 = 27\ mA$ (este é o valor DC de I_Z: os valores de I_Z flutuam entre 23 mA (a 17 V) e 32 mA (a 19 V)).

$V_Z = 8.105\ V$ —— $I_Z = 1\ mA$

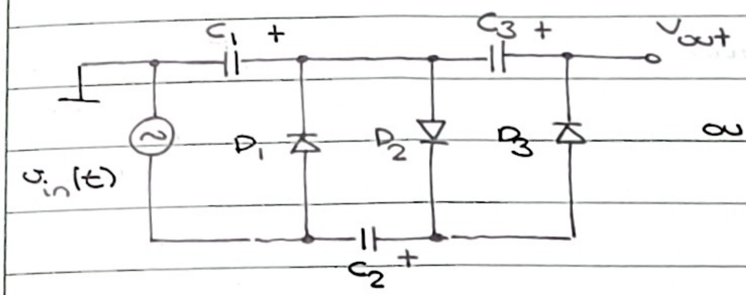
$V_Z = 8.2\ V$ —— $I_Z = 20\ mA$ $\qquad r_Z = \Delta V_Z / \Delta I_Z = 95/19 = 5\ \Omega$

$r_{RL} = 0.032 \times 5/225 \times 18/8.2 \longrightarrow r_{RL} = 0.16\%$

Questão 8



Questão 9



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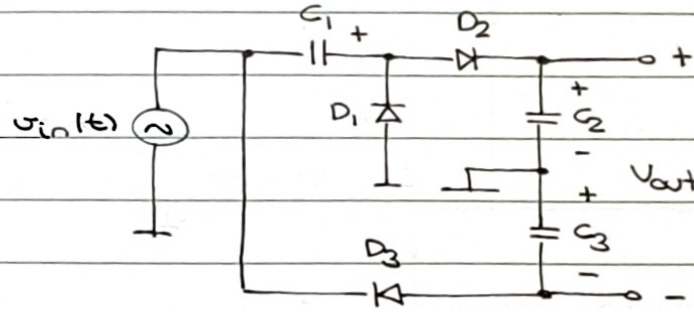

Questão 10

Se $V_{out} = +12\,V$, então $V_+ = V_{out}/2 = 6\,V$

Nesse caso, V_{out} permanece em +12 V desde que $V_{in} < 6\,V$

Se V_{in} ultrapassar 6 V ($V_{in} > 6\,V$), então V_{out} muda para −12 V.

Se $V_{out} = -12\,V$, então $V_+ = V_{out}/2 = -6\,V$

E, nesse caso, V_{out} permanece em −12 V desde que $V_{in} > -6\,V$

Se V_{in} for para um valor abaixo de −6 V, então V_{out} muda para +12 V.