Universidade Federal do Rio de Janeiro
Escola Politécnica

DATA 8/7/2019

GRAUS

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Aluno: Prova Final — Gabarito

Disciplina: Eletrônica I

Turma: 2019/1

Professor: José Gabriel

Questão (1)

$(dn/dx) = -2\times10^{17}/(5\times10^{-4}) = -4\times10^{20}\ cm^{-4}$; $(dp/dx) = 5\times10^{16}/(5\times10^{-4}) = 10^{20}\ cm^{-4}$

$J = 1.6\times10^{-19}\times(-34\times4\times10^{20} - 12\times10^{20}) = -2368\ A/cm^2$

$I = J.A = -2368\times200\times10^{-7}\times200\times10^{-7} = -2368 = 9.47\times10^{-7} = 0.95\ \mu A$

Questão (2)

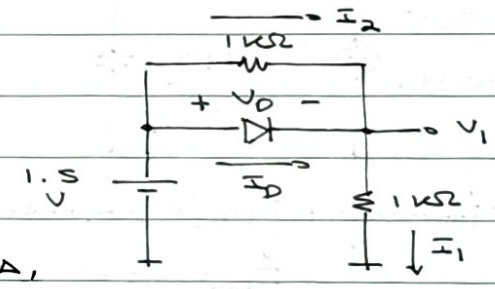
$0.026\times\ln\left(N_A N_D/(1.08^2\times10^{20})\right) = 0.7 \longrightarrow N_A N_D = 1.1664\times10^{20}\exp(26.9231) = 5.7465\times10^{31}$

$T = 400\ K \longrightarrow (kT/q) = 0.026\times(4/3) = 0.0347\ V$

$n_i = \underbrace{5.2\times10^{15}\times400^{1.5}}_{(4.16\times10^{-19})}\times\underbrace{\exp(-1.12\times1.6\times10^{-19}/(2\times1.38\times10^{-23}\times400))}_{(8.925\times10^{-8})} = 3.713\times10^{12}$

$V_b = 0.0347\times\underbrace{\ln(5.7465\times10^{31})}_{15.243}/(3.713^2\times10^{24}) = 0.529\ V$

Questão (3)



"Chute" inicial: $V_1 = 0.8\ V$ $(V_D = 0.7\ V)$

Atualizando correntes: $I_1 = 0.8\ mA$ e $I_2 = 0.7\ mA$,

então $I_D = 0.1\ mA$.

Recalculando V_D: $V_D = 1.98\times0.026\times\ln(0.1\times10^{-3}/(14.1\times10^{-9})) = 0.4565\ V$

Mais algumas iteraçes

	I_1(mA)	I_2(mA)	I_D(mA)	V_D(V)
	1.0435	0.4565	0.5870 →	0.5476
	0.9524	0.5476	0.4048 →	0.5284
	0.9716	0.5284	0.4432 →	0.5331
	0.9669	0.5331	0.4338 →	0.5320
$V_1 = 0.968\ V$ ←	0.9680	0.5320	0.4360 →	0.5323 ✓

Questão (4)

Modelos de bateria: $V_o = 8.2\,V + 0.7\,V = 8.9\,V$ (obs.: $I = 11\,mA$)

DSN756 / DSN4005

Modelos lineares por partes:

DSN4005:	0.692 V — 10 mA	$\Delta V/\Delta I = 35/10 = 3.5\,\Omega$	0.657 V
	0.727 V — 20 mA	~~$(\Delta V/\Delta I)$~~ $V_{D0} = 0.727 - 3.5\times0.02 =$	✓
DSN756:	8.161 V — 10 mA	$\Delta V/\Delta I = 39/10 = 3.9\,\Omega = r_z$	
	8.2 V — 20 mA	$V_{z0} = 8.2 - 3.9\times0.02 = 8.122\,V$	

V_{D0}, r_d

$I = (10 - 8.122 - 0.657)/(100 + 3.5 + 3.9) = 1.221/107.4 = 11.4\,mA$

$V_o = 8.122 + 0.657 + (3.5 + 3.9)\times 0.0114 \longrightarrow V_o = 8.863\,V$

Questão (5)

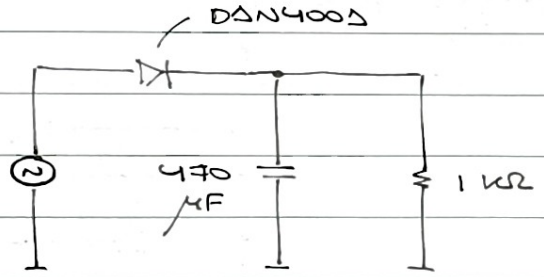
$V_{DC} = 2\,V$

$$V_{AC,RMS}^2 = \frac{1}{T}\left(\int_0^{T/2} 2^2\,dt + \int_{T/2}^{T}(-2)^2\,dt\right) = 4 \longrightarrow V_{AC,RMS} = 2\,V$$

$$V_{RMS} = \sqrt{V_{DC}^2 + V_{AC,RMS}^2} = \sqrt{4+4} = \sqrt{8}$$

$P = V_{RMS}^2/100 = 8/100 = 80\,mW$

Questão (6)



"Chute" inicial: $r = 0.1$

$(1 + \sqrt{3}\times 0.1)\,V_{DC} = 19.3$

$V_{DC} = 16.5\,V$

$I_{DC} = V_{DC}/(1\,k\Omega) = 16.5\,mA$

$2\sqrt{3}\times 60\times 0.47\times 10^{-3}\times 19.3 = 1.885$

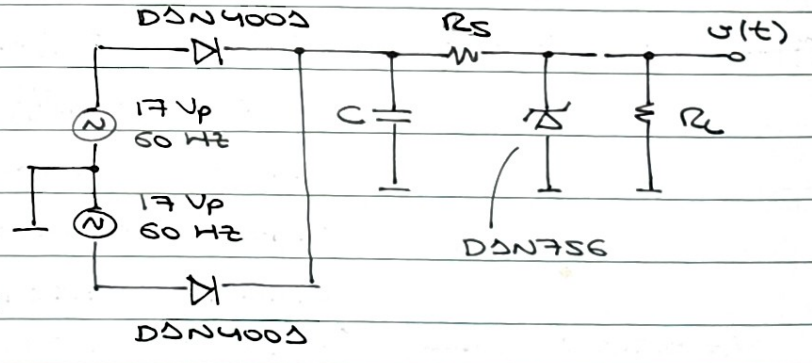
$r = 0.0165/1.885 = 0.0088$

2ª iteração: $(1 + \sqrt{3}\times 0.0088)\,V_{DC} = 19.3 \longrightarrow V_{DC} = 19.0\,V$

$I_{DC} = 19\,mA \longrightarrow r = 0.019/1.885 = 0.0101 \longrightarrow r = 1.01\%$

3ª iteração: $(1 + \sqrt{3}\times 0.0101)\,V_{DC} = 19.3 \longrightarrow V_{DC} = 19.0\,V$

Questão (7)



$r = 0.1$: $(1 + \sqrt{3}\times 0.1)\,V_{DC} = 16.3$

$V_{DC} = 13.9\,V$

$V_1 = 16.3\,V$; $V_{DC} = 13.9\,V$; $V_2 = 11.5\,V$

$(16.3 - 8.2)/R_{Smin} = 0.070 \longrightarrow R_{Smin} = 115\ \Omega$

$(11.5 - 8.2)/R_{Smax} = \underbrace{(8.2/470)}_{(17.4\ mA)} + \underbrace{5\ mA}_{(\text{"}I_{Zmin}\text{", escolhida arbitrariamente})} \longrightarrow R_{Smax} = 147\ \Omega$

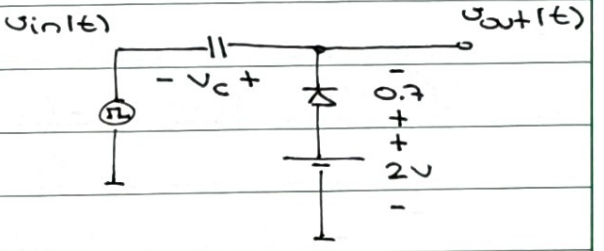
$115\ \Omega < R_S < 147\ \Omega \longrightarrow R_S = 120\ \Omega$

$I_{DC} = (13.9 - 8.2)/120 = 47.5\ mA$

$C = 47.5 \times 10^{-3}/(4 \times 1.732 \times 60 \times 0.1 \times 16.3) = 47.5 \times 10^{-3}/(0.678 \times 10^{3}) = 70\ \mu F$

Valor comercial escolhido: $C = 100\ \mu F$ (obs.: $r = 7\%$)

Questão (8)



Quando $v_{in}(t) = -5\ V$, temos

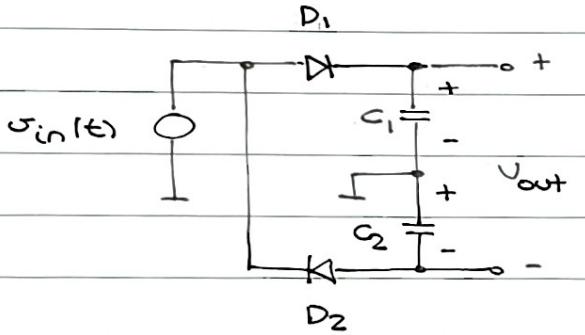
$v_{out}(t) = 2 - 0.7 = 1.3\ V$ e portanto

$V_C = 1.3 - (-5) = 6.3\ V$. Quando $v_{in}(t) = 5\ V$,

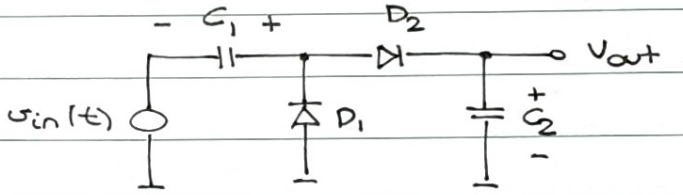
temos o diodo desligado e $v_{out}(t) = 5 + 6.3 = 11.3\ V$.

Portanto, $V_{DC} = (1.3 + 11.3)/2 = 6.3\ V$

Questão (9)

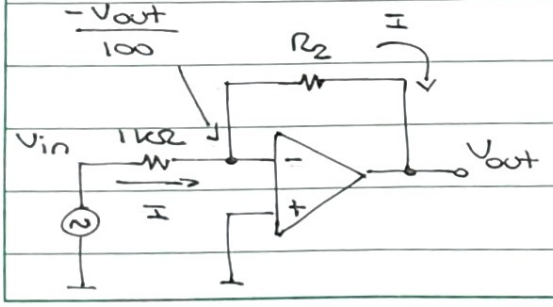


Neste circuito, C_1 detecta o pico positivo de $v_{in}(t)$ e C_2 detecta o pico negativo. A diferença $V_p - (-V_p) = 2V_p$ aparece em V_{out}.



Neste circuito, o primeiro estágio (C_1 e D_1) desloca $v_{in}(t)$ V_p volts para cima, gerando uma forma de onda cujo pico superior está em $2V_p$. Esse valor de pico é detectado por C_2 e aparece em V_{out}.

Questão (10)



$I = (V_{in} + (V_{out}/100))/1000$

$V_{out} = -V_{out}/100 - R_2(V_{in} + (V_{out}/100))/1000$

$\frac{V_{out}}{V_{in}} = \frac{-R_2/1000}{1 + (1/100) + (R_2/10^5)} = -5$

$-100R_2 = -5.05 \times 10^5 - 5R_2$

$95R_2 = 5.05 \times 10^5 \longrightarrow R_2 = 5316\ \Omega$