Universidade Federal do Rio de Janeiro
Escola Politécnica

DATA: 17/7/2018

GRAUS

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Disciplina: Eletrônica I — EEL315

Turma: 2018-1

Professor(a): José Gabriel

Questão (1)

$$J_{tot} = 1.6\times10^{-19}\left(34\times\underbrace{(-9\times10^{16})}_{3\times10^{-4}} - 12\times\underbrace{3\times10^{16}}_{3\times10^{-4}}\right) = -1.6\times114\times10 = -1.824\times10^{3}\ A/cm^2$$

$$I_{dif} = J_{tot}\cdot A \Rightarrow I_{dif} = -1.824\times10^{3}\times\underbrace{(500\times10^{-7})^2}_{25\times10^{-10}\ cm^2} \Rightarrow \boxed{I_{dif} = -4.56\ \mu A}$$

Questão (2)

$$n_i = 5.2\times10^{15}\times(350)^{3/2}\exp\left(\underbrace{-1.12\times1.6\times10^{-19}}_{0.18551\times100 = 18.551}\Big/\underbrace{(2\times1.38\times10^{-23}\times350)}\right)$$

(10^{-19})

$$n_i = 5.2\times10^{15}\times6.548\times10^{3}\times8.778\times10^{-9} = 299\times10^{9} = 2.99\times10^{11}/cm^3$$

$$V_D = \underbrace{\frac{1.38\times10^{-23}\times350}{1.6\times10^{-19}}}_{30.19\ mV}\ln\underbrace{\left(\frac{10^{17}\times10^{17}}{(2.99)^2\times10^{22}}\right)}_{25.44} \Rightarrow \boxed{V_D = 768\ mV}$$

Questão (3)

$I_D = 10^{-15}\exp(V_D/0.026)$ (a)

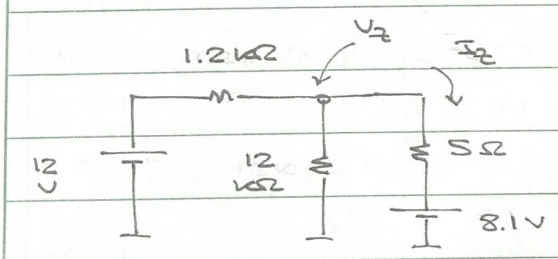
$V_D = (0.9 - 2200\,I_D)/2$ (b)

Chute inicial: $V_D = 0.4\ V$

Iteração (1): $V_D = 0.4V \xrightarrow{(a)} I_D = 4.802\ nA \xrightarrow{(b)} V_D = 0.45\ V$

Iteração (2): $V_D = 0.45\ V \xrightarrow{(a)} \boxed{I_D = 32.86\ nA} \xrightarrow{(b)} \boxed{V_D = 0.45\ V}$

Questão (4)



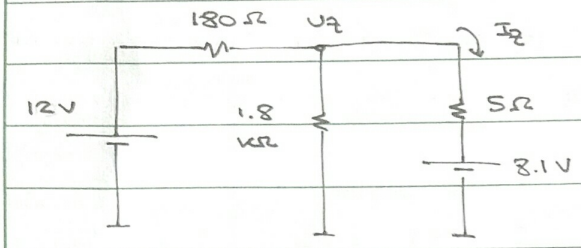
$$\frac{12 - V_z}{1200} = \frac{V_z}{12000} + \frac{V_z - 8.1}{5}$$

$$120 - 10V_z = V_z + 2400V_z - 2400\times8.1$$

$$2411\,V_z = 19560$$

$$\boxed{V_z = 8.113\ V} \qquad \boxed{I_z = 2.6\ mA}$$

(modelagem: ver PF)



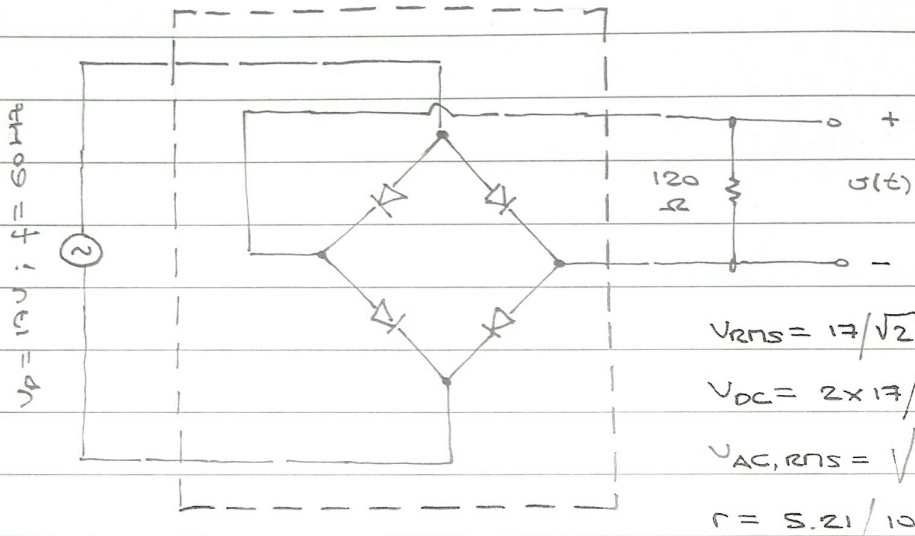
$$\frac{12 - V_z}{180} = \frac{V_z}{1800} + \frac{V_z - 8.1}{5}$$

$$120 - 10V_z = V_z + 360V_z - 360 \times 8.1$$

$$371 V_z = 3036$$

$$\boxed{V_z = 8.183\ V} \qquad \boxed{I_z = 16.6\ mA}$$

Questão (5)



$$V_{RMS} = 17/\sqrt{2} = 12.02\ V$$

$$V_{DC} = 2 \times 17/\pi = 10.83\ V$$

$$V_{AC,RMS} = \sqrt{12.02^2 - 10.83^2} = 5.21\ V$$

$$r = 5.21 / 10.83$$

$$P = 12.02^2/120 \Rightarrow \boxed{P = 1.2W}\ (1.2\ W)$$

$$\boxed{r = 48\%}$$

Questão (6)

$$(1 + \sqrt{3} \times 0.15)\, V_{DC} = 17 \longrightarrow V_{DC} = 13.55\ V$$

$$I_{DC} = 13.55/120 = 113\ mA$$

$$C = \frac{113 \times 10^{-3}}{\underbrace{(4 \times 1.7 \times 60 \times 0.15 \times 17)}_{1.04 \times 10^3}} = \frac{113 \times 10^{-6}}{1.04} = 109\ \mu F$$

Menor capacitância utilizável (valor comercial): $\boxed{C = 220\ \mu F}$

Obs.: com $C = 220\ \mu F$, temos $r = 113 \times 10^{-3} / (4 \times 1.7 \times 60 \times 0.22 \times 10^{-3} \times 17)$

$\Rightarrow r = 113/1526 = 7.4\% \Rightarrow V_{DC} = 17/(1 + \sqrt{3} \times 0.074) = 15.1\ V$

$\Rightarrow I_{DC} = 126\ mA \Rightarrow r = 126/113 \times 7.4 \Rightarrow r = 8.3\%$ (ok)

Obs. 2: com $C = 100\ \mu F$, temos $r = 113 \times 10^{-3} / (4 \times 1.7 \times 60 \times 0.1 \times 10^{-3} \times 17)$

$\Rightarrow r = 113/694 = 16.3\% \Rightarrow V_{DC} = 17/(1 + \sqrt{3} \times 0.163) = 13.3\ V$

$\Rightarrow I_{DC} = 111\ mA \Rightarrow r = 111/113 \times 16.3 \Rightarrow r = 16\%$ (> 15%!)

Questão (7)

Chute inicial: $r_{capacitor} = 2\% \Rightarrow V_{DC} = 17 / (1 + \sqrt{3} \times 0.02) = 16.4\ V$

$$I_{DC} = \frac{16.4}{120} + \frac{16.4 - 8.2}{120} = 205\ mA$$

$$r_{capacitor} = 205 \times 10^{-3} / (4 \times 1.7 \times 60 \times 0.68 \times 10^{-3} \times 17) = 205 / 4716 = 0.043$$

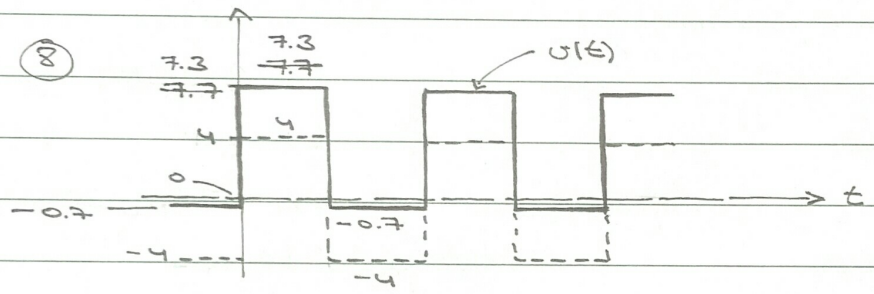
$$V_{DC} = 17 / (1 + \sqrt{3} \times 0.043) = 15.8\ V$$

$$I_{DC} = \frac{15.8}{120} + \frac{15.8 - 8.2}{120} = 195\ mA$$

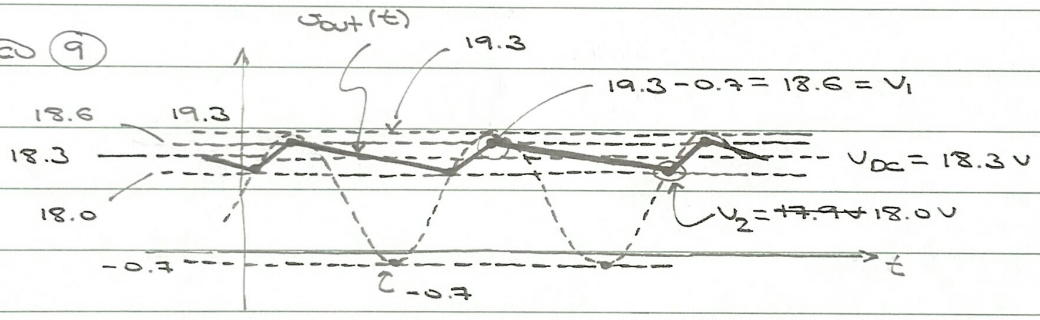
$$r_{capacitor} = 195 / 205 \times 0.043 = 4.1\%$$

$$r_{RL} = 0.041 \times \frac{5}{120 + 5} \times \frac{15.8}{8.2} \Rightarrow \boxed{r_{RL} = 0.32\%}$$

Questão (8)



Questão (9)

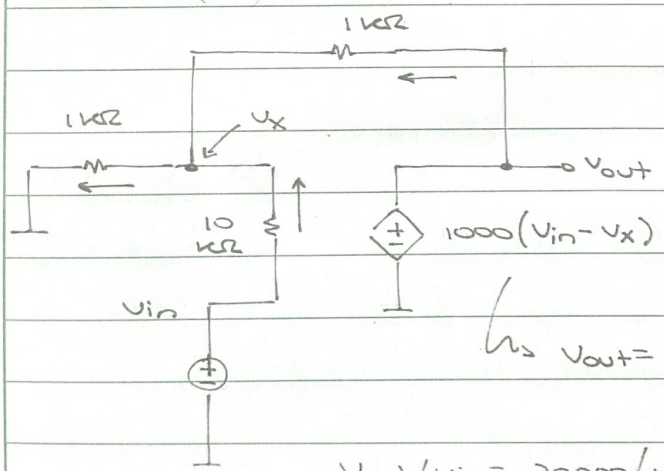


$V_{DC} \simeq 15\ V$ (chute inicial) $\Rightarrow r = (15/4700) / (4 \times 1.7 \times 30 \times 0.1 \times 10^{-3} \times 18.6)$

$r = 3.2/379 = 0.8\% \Rightarrow V_{DC} = 18.6 / (1 + \sqrt{3} \times 0.008) = 18.4\ V$

$r = 18.4 / 15 \times 0.8 \Rightarrow r = 1\% \Rightarrow V_{DC} = 18.6 / (1 + \sqrt{3} \times 0.01) = 18.3\ V$

Questão (10)



$$V_x + 10^3 \left(\frac{V_x}{10^3} - \frac{(V_{in} - V_x)}{10^4} \right) = 1000 (V_{in} - V_x)$$

$$V_x + V_x - 0.1 V_{in} + 0.1 V_x = 1000 V_{in} - 1000 V_x$$

$$1002.1 V_x = 1000.1 V_{in}$$

$$V_x = (10001/10021) V_{in}$$

$$V_{out} = 1000 \left(V_{in} - \frac{10001}{10021} V_{in} \right)$$

$$V_{out}/V_{in} = 20000/10021 \longrightarrow \boxed{V_{out}/V_{in} = 1.9958}$$