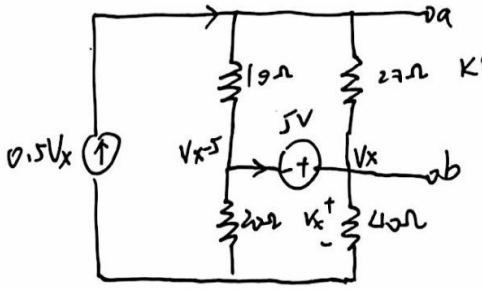
VE311 HW1.

Question 1.



$V_{oc} = V_a - V_x$.

KCL: $0.5V_x = \frac{V_a - V_x + 5}{10} + \frac{V_a - V_x}{20}$

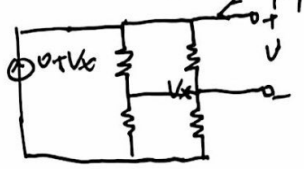
$0.5V_x = \frac{V_x - 5}{20} + \frac{V_x}{40}$.

$\Rightarrow V_x = -\frac{10}{17}$

$V_a = -\frac{130}{17}$

$V_{ab} = -\frac{90}{17}$

R_{eq}:

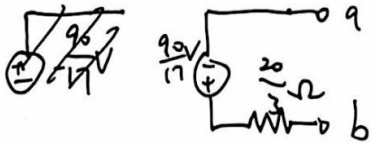


$I + 0.5V_x = \frac{3V}{20}$

$0.5V_x = \frac{2V_x}{40} \Rightarrow V_x = 0$

$R_{eq} = \frac{V}{I} = \frac{20}{3}\Omega$

$\Rightarrow$



Question 2.

(a) P: density of holes $= N_A = 10^{19}/cm^3$

density of free electrons $= \frac{n_i^2}{N_A} = 2.25/cm^3$

N: density of free electrons $= N_D = 10^{21}/cm^3$

density of holes $= \frac{n_i^2}{N_D} = 0.2251\,cm^3$

(b) $\varphi_0 = \frac{kT}{q} \ln\left(\frac{N_A \cdot N_D}{n_i^2}\right)$

$\approx 1.17eV$.

when $V_d = 0V$, $\varphi = \varphi_0 = 1.17ev$

when $V_d = 0.5V$: $\varphi = \varphi_0 - 0.5V = 0.67ev$

when $V_d = -1.7V$ $\varphi = 2.87eV$.

Question 3.

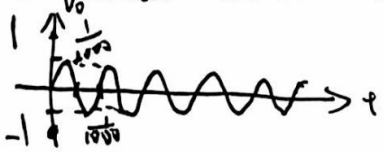
(A). $V = -3V$. $I = 0.1mA$.

(B) $V = 3V$ $I = 0A$

(C). $V = 2V$ $I = 1mA$.

Question 4.

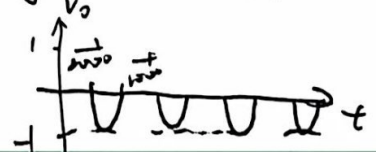
(A) $V_I = V_0 \sin(2000\pi t)$ (V) $= V_0$.



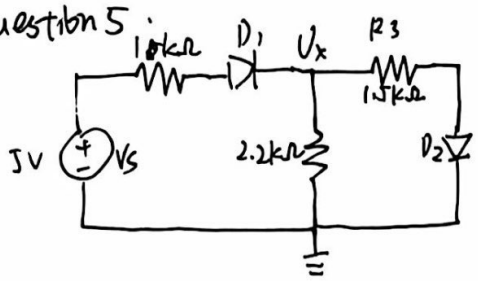
(B): $V_I = \sin(2000\pi t)$.

positive half period, $V_0 = 0V$.

negative: $V_0 = V_I$.



Question 5.



Assume no current flowing through D_2.

$U_{D2} = (5V - 0.7V) \cdot \frac{2.2}{1+2.2} > 2 \Rightarrow D_2$ in forward bias

Assumption not valid.

$\Rightarrow$. D_1, D_2 in forward bias

$$\frac{4.3 - V_X}{1} = \frac{V_X}{2.2} + \frac{V_X - 0.7}{1.5}$$

$$\Rightarrow V_X = 2.25\,V.$$

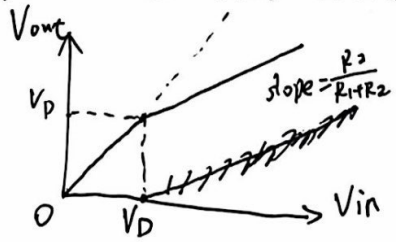
$$I_{R2} = \frac{V_X}{2.2k\Omega} = 1.02\,mA.$$

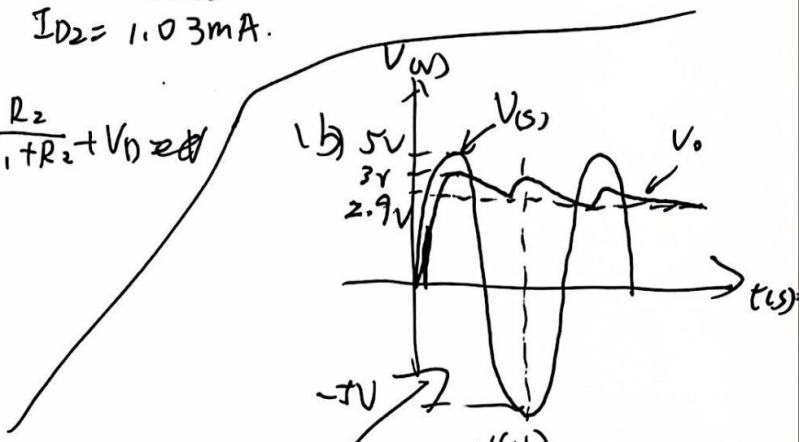
$$I_{D2} = 1.03\,mA.$$

Question 6

Assume turn-on voltage is V_D.

when $V_{in} > V_D$, $V_{out} = (V_{in} - V_D)\frac{R_2}{R_1+R_2} + V_D$





Question 7.

(a). $i_D = C\frac{dV_D}{dt} + \frac{V_o}{R}$

$V_{dc} = V_s - V_{on} = 4V$

$I_{dc} = \frac{V_{dc}}{R} = 0.04A$

$T = 0.01s$

$V_r \approx V_{dc} \cdot \frac{T}{RC} < 0.1\,V.$

$C > 4m\,F$

$\cos\theta_c = \frac{V_s - V_r}{V_s} = 0.98$

$\theta_c = 0.2$

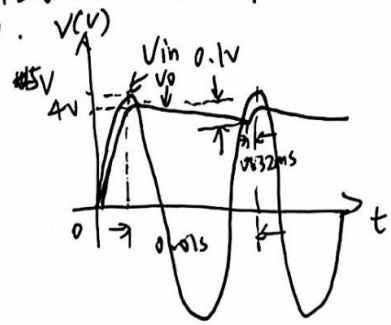
$\Delta T = \frac{\theta_c}{\omega} = 0.32\,ms$

$I_{peak} = \frac{2I_{dc}T}{\Delta T} = 2.5A.$

$I_{surge} = \omega C V_s = 4\pi \approx 12.6A$

$PIV = 2V_s - V_{on} = 9V$

(b). V(V)



Question 8

(a) $V_{dc} = 5 - 2\times1 = 3V$

$I_{dc} = 0.03A$

$T = 0.01s$

$C = \frac{2I_{dc}\cdot T}{V_r} = 3mF$

$\theta_c = \sqrt{\frac{2V_r}{V_s}} = 0.2$

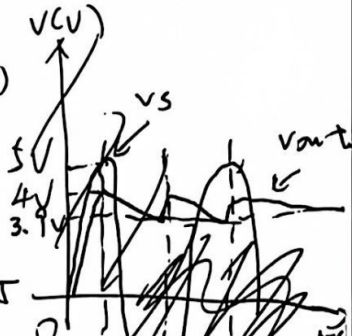
$\Delta T = 0.32ms$

$I_{peak} = \frac{2I_{dc}\cdot T}{\Delta T} = 4.7125A$

$I_{surge} = \omega C V_s = 4.7124A$

$PIV = 2V_s - V_{on} = 9.8V$

(b)



(b)