Assignment - 1

ELECTRONIC DEVICES

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Sec : ECE-3

Semister : III rd sem

① A Si diode operating at room temp with a forward voltage of 650mV has a reverse saturation current of 20nA. Determine its Dynamic resistance.

Given $I_{rs} = 20nA$, $V_f = 650mV$, $V_T = 20mA$, $\eta = 2$ ($\because$ Si diode)

we know that Dynamic resistance (r) = $\dfrac{\eta V_T}{I_0 \cdot e^{V/\eta V_T}}$

$$r = \frac{2 \times 26 \times 10^{-3}}{20 \times 10^{-9} e^{\frac{650}{2 \times 26}}} = \frac{52 \times 10^{-3}}{20 \times 10^{-9} \times 268337.287} \Omega$$

$$r = \frac{52}{5.366} = 9.689 \Omega$$

② A diode has a leakage current of 10mA at a certain Temp. Asses its value when the temperature is increased by 25°C.

we know that $I_2 = I_1 \times 2^{\frac{T_2 - T_1}{10}}$

given $I_1 = 10mA$.

$\Rightarrow I_2 = 10mA \times 2^{2.5}$

$I_2 = 56.5\,mA$.

(5) A si diode indicates forward current of 2mA and 10mA when diode voltage are 0.6V and 0.7V resp. Estimate the operating temp of the diode junction.

Given $I_{0.6} = 2mA$, $V_D = 0.6$

$\eta = 1$ ($\because$ Si diode)

$I_{0.6} = 10mA$, $V_D = 0.7$

we know that

$$I = I_{sh}\, e^{\frac{V_D}{\eta V_T}}$$

$$2 = I_{sh} \cdot e^{\frac{0.6}{2V_T}} \quad —(1)$$

also $\Rightarrow$ $$10 = I_{sh}\, e^{\frac{0.7}{2V_T}} \quad —(2)$$

$\frac{(2)}{(1)} \Rightarrow$ $$5 = e^{\left(\frac{0.7}{2V_T} - \frac{0.6}{2V_T}\right)}$$

$$\Rightarrow 5 = e^{1/V_T (0.05)}$$

$$\ln(5) = \frac{1}{V_T}(0.05) \Rightarrow V_T = \frac{0.05}{\ln 5}$$

$$V_T = 0.0310$$

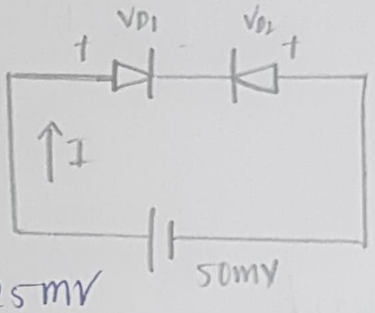
$$V_T = \frac{T}{11,600} = 0.310$$

$$T = (11,600 \times 0.310)K$$

$$T = 360.374 K.$$

$$T = 87.37°C$$

(4). The circuit given below consists of two identical diodes with $\eta = 1$. Assume $V_T = 25mV$. Evaluate V_{D1} and V_{D2}.



Given $\eta = 1$, $V_T = 25mV$

And from circuit $V_{D1} + V_{D2} = 50mV$

We know that $I = I_{sh}\left(e^{V_D/\eta V_T} - 1\right)$

$$\cancel{I_{sh}}\left[e^{\frac{V_{D1}}{V_T}} - 1\right] = -\cancel{I_{sh}}\left[e^{\frac{-V_{D2}}{\eta V_T}} - 1\right]$$

$$e^{\frac{V_{D1}}{25}} + e^{\frac{-V_{D2}}{25}} = 2.$$

$$e^{\frac{V_{D1}}{25}} + e^{-\left(\frac{0.05 - V_{D1}}{V_T}\right)} = 2.$$

$$e^{V_{D1}/25}\left[1 + e^{-0.05/25}\right] = 2.$$

$$\frac{V_1}{25} = \ln 2 \Rightarrow V_1 = 0.693 \times 25mV \Rightarrow V_1 = 0.01732V$$

as $V_1 + V_2 = 0.05\,mV$

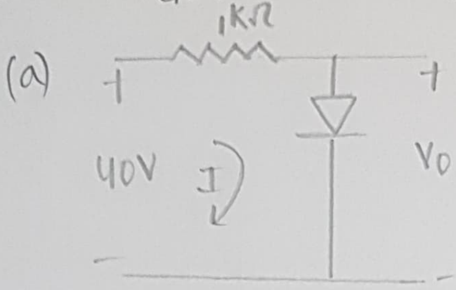
$$V_2 = 0.05 - 0.01732$$

$$V_2 = 0.033 \Rightarrow V_1 = 0.017 = 17.32\,mV$$

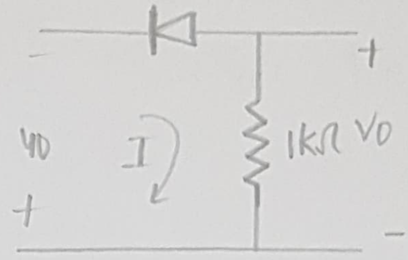
$$V_2 = 33\,mV$$

(5) Interpret the following circuits assuming ideal diodes and determine I and V_0.

(a)



(b)



As diode is in Forward baise and Ideal. It can be considered as shortcut circuit. By applying KVL we have.

$$-40 + 1000I = 0.$$

$$\Rightarrow I = \frac{40}{1000} = 4mA.$$

$$\Rightarrow V_0 = IR = \frac{40}{1000} \times 0 = 0V$$

As diode is in Forward baise and Ideal it can be replaced by a short circuit and.

$$I = \frac{-V}{R} = \frac{-40}{1000}$$

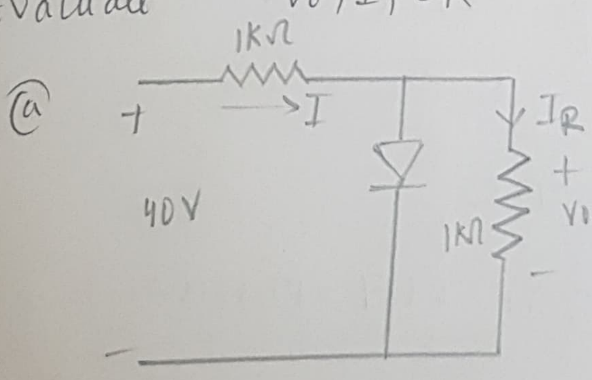
$$I = -40mA$$

$$V_0 = IR = -40 \times 10^{3} \times 10^{-3}$$

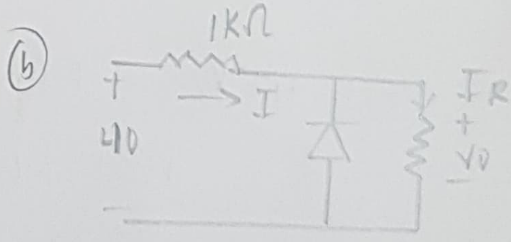
$$\boxed{V_0 = -40V}$$

(6) Evaluate V_0, I, I_R and I_0 assuming ideal diodes.

(a)



(b)



(a) As the diode is connected in Forward baise-we can replace it by short circuit then no current passes through.

1KΩ i.e, $\boxed{I_R = 0}$

$$I = \frac{V}{1K\Omega} = \frac{40}{1K\Omega} = 40mA.$$

$$I_R = 0 \Rightarrow V = I_R \times 1K\Omega = 0.$$

(b) As the diode is connected in reverse biase It can be replaced by open circuit. i.e, $\boxed{I_D = 0}$

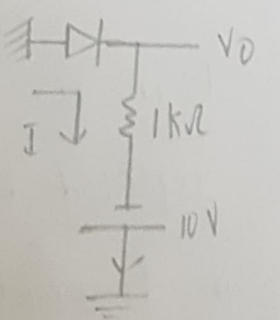
and $$I = I_R = \frac{V}{R_{eff}} = \frac{V}{2K\Omega} = \frac{40}{2K\Omega} = 20mA$$

$$\Rightarrow I = I_R = 20mA, \quad I_D = 0$$

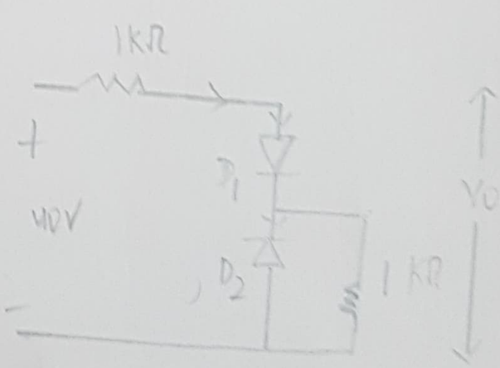
$$V_o = I_R \times 1K\Omega = 20m \times KV = 20V.$$

(7) Find I and Vo assuming ideal diodes.

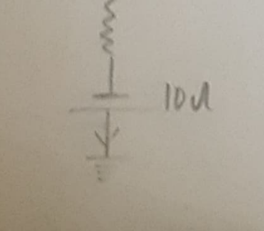
(a)



(b)



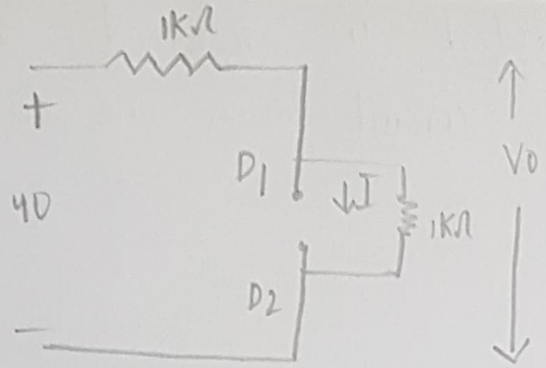
(a)



As diode is connected in forward biased - It can be replaced by short circuit $\Rightarrow V_o = 0$.

$$I = \frac{V}{R} = \frac{10}{1K\Omega} = 10mA.$$

(6)

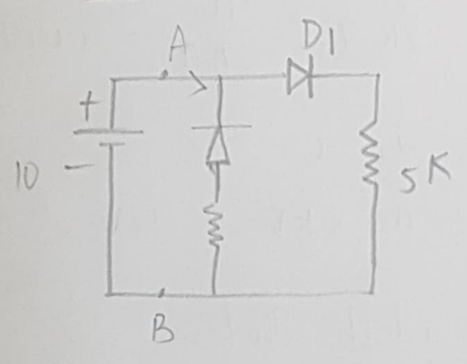


Hear D_1 is in Forward biase can replace It by short circuit D_2 Is in reverse biase can be replaced by open circuit as shown In fig. since $I = 0$.

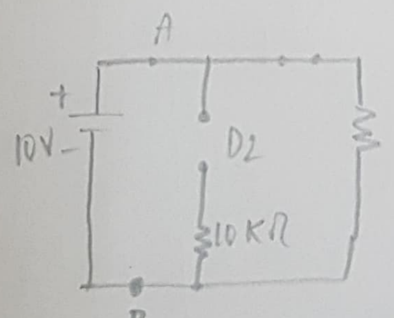
$$V_0 = \frac{1 \times 40}{1+1} = \frac{40}{2} V = 20V.$$

$I = 0, V_0 = 20V.$

(8) Determine the impedance between points A and B assuming ideal diodes.



Ans.



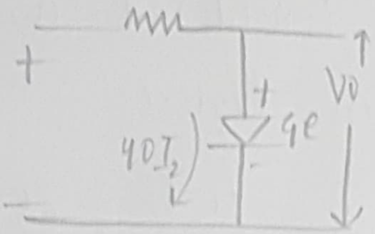
Since D_2 Is in reverse baise It can be replaced by open circuit. D_1 is in forward baise It can be replaced by short circuit.

$Z = R = 5K\Omega$ $\boxed{Z = 5K\Omega}$

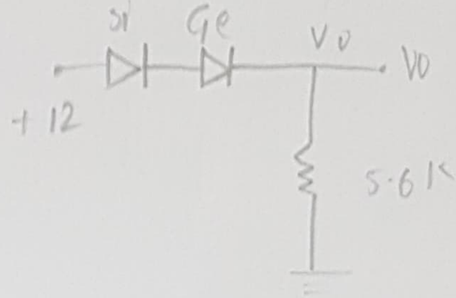
$$\boxed{Z = 5K + 0j}$$

9. Analyse the circuit given below assuming practical diodes and estimate I and V_0.

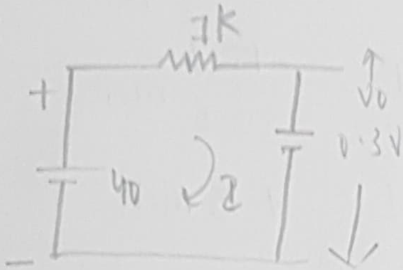
(a)



(b)



(a)



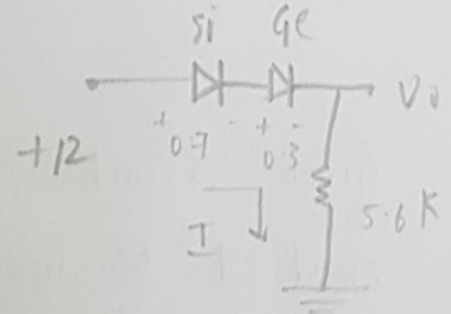
Since Ge diode is practical It can be replaced by voltage source of 0.3V

Applying KVL $-40 + I \times 1000 + 0.3 = 0$

$\Rightarrow I = \frac{39.7}{1000} = 39.7 mA.$

$V_0 = 0.3$

(b)

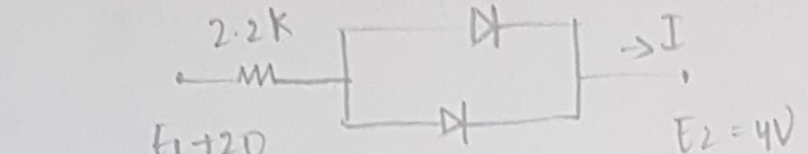


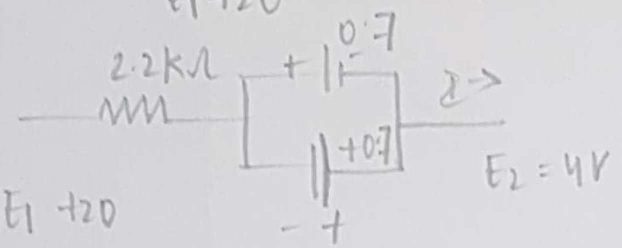
Hear Si diode can be considered as voltage source of 0.7 V and Ge diode can be considered as voltage source of 0.3 V as shown in figure.

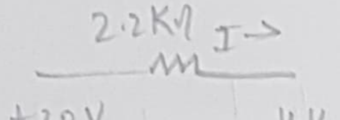
$\Rightarrow V_0 = 12 - 0.7 - 0.3 = 11V \Rightarrow I = \frac{V_0 - 0}{5.6} = 1.96 mA.$

10. Assen the value of I in the following circuit given

$V_{\gamma Si} = 0.7V$







Given circuit can be considered as shown in figure.

Here, $I = \frac{E_1 - E_2}{R} = \frac{20 - 4.03}{2.2 \times 1000} A$

$I = \frac{15.7}{2.2} mA$

$I = 7.13 \, mA.$

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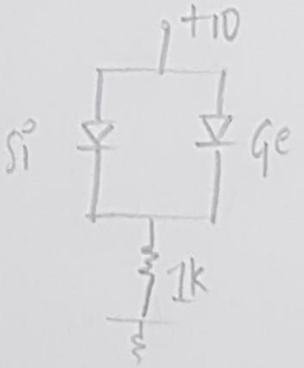
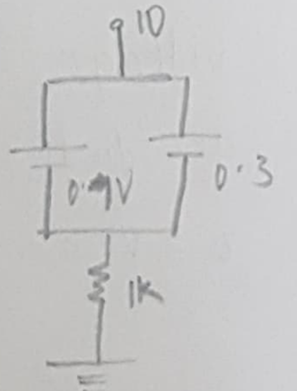
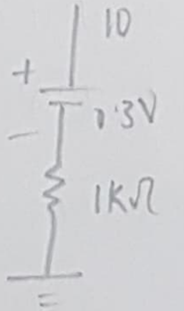
(11) Analyze the circuit below and determine V_o given $V_r = 0.7V$ for Si and $0.2V$ for Ge.



Sol.





Given circuit can be considered as shown in figure.

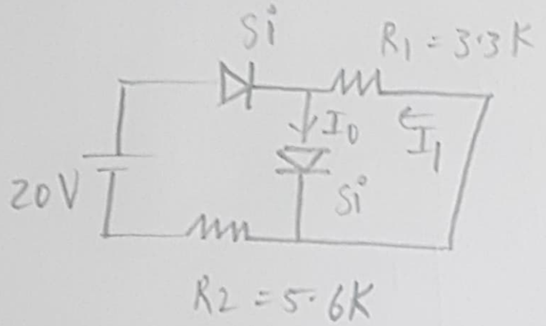
$-10 + 0.3 + 1000 \, I = 0$

$\Rightarrow I = 9.7 mA$

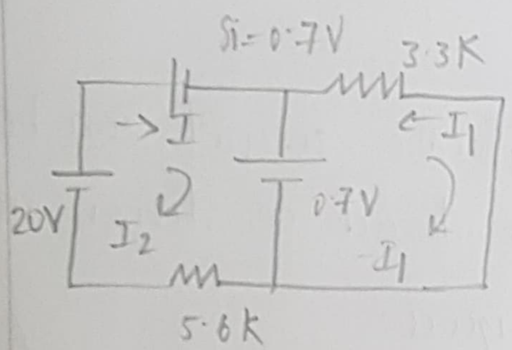
$V_o = IR = 9.7 mA \times 1000 \Omega$

$\boxed{V_o = 9.7V}$

(12) Determine I_o in the circuit below considering practical diode.



Sol.



Given circuit can be considered as circuit shown in figure. Applying KVL in loop 1.

$$-20 + 0.7 + 0.7 + I_2(5.6K) = 0$$

$$I_2 = \frac{20 - 0.7 - 0.7}{5.6 \times 1000} = \frac{18.6}{5.6 \times 1000}$$

$$I_2 = 3.32 mA$$

Applying KVL in loop 2.

$$-0.7 - 3.3K\,I_1 = 0 \Rightarrow I_1 = \frac{-0.7}{3.3 \times 1000} = -0.212 mA$$

Here Applying KCL at node A.

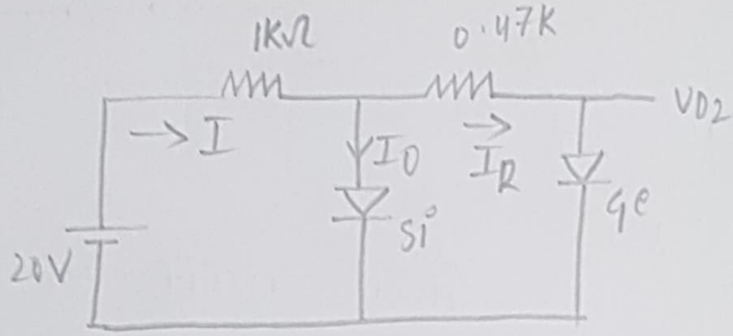
we have, $I_2 + I_o = -I_1$

$$I_o = I_1 + I_2 = 3.32 - 0.212$$

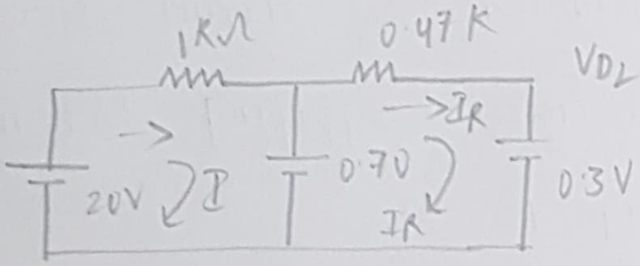
$$I_o = 3.11 mA.$$

$\therefore I_1 = 0.21 mA$, $I_2 = 3.32 mA$, $I_o = 3.11 mA$

(B) Assess the value of V_{01}, V_{02}, I and I_R assuming practical diodes.



Sol.



Given circuit can be considered as shown in figure.

$I_D = I - I_R$ (Node equation)

Applying KVL for first loop.

$-20 + 1000 I + 0.7 = 0$

$\Rightarrow I = \frac{19.3}{1000} = 19.3 mA.$

Applying KVL for second loop.

$-0.7 + 470 I_R + 0.3 = 0$

$470 I_R = 0.4 \Rightarrow I_R = 0.85 mA.$

$I_D = 19.3 - 0.85 = 18.44 mA.$

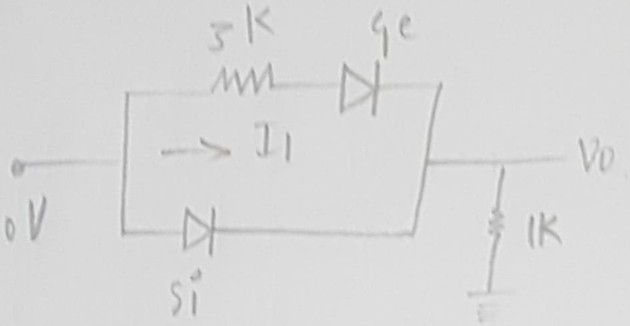
∴ Applying KVL for loop 2

we have $-0.7 + 0.47K I_R + V_D = 0$

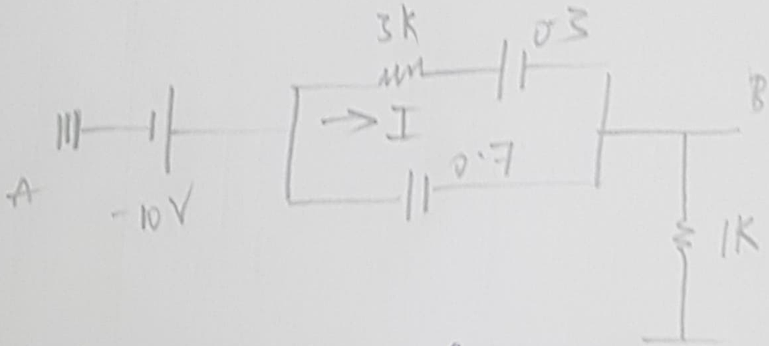
$V_D = 0.39 V$

$V_{D2} = 0.39V$, $I = 19.3 A$, $I_R = 0.85 mA$, $I_D = 18.44 mA$.

(14) Estimate V_o and I_1 in the circuit below assuming practical diode.



Sol:



Applying KVL from A→B =

we have $-10 + 0.7 + V_o = 0$

$V_o = 9.3V$

Applying KVL in loop

$3000 I + 0.3 - 0.7 = 0$

$I = \frac{0.4}{3000} = 0.13 \, mA$

$V_o = 9.3 \Rightarrow I = 0.13 \, mA.$