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UNIT-1, Numericals

Q NO 1 A Si° diode has a saturation Current of 5 nA at 25°C. What is saturation Current at 100°C.

Solⁿ:- We know $\boxed{I_D = I_0\left[e^{\frac{V}{\eta V_T}} - 1\right]}$

$\Rightarrow V_T = \frac{T \text{ in kelvin}}{11,600} = \frac{25+273}{11,600} \Rightarrow \boxed{V_T = 25.68\,mV}$

$\Rightarrow$ For Si°, $\boxed{\begin{matrix} V = 0.7\,V \\ \eta = 2 \end{matrix}}$, $I_0 = 5\,nA = 5\times10^{-9}\,Amp.$

$\therefore I_D = 5\times10^{-9}\left[e^{\frac{.7}{2\times25.68\times10^{-3}}} - 1\right]$

$\boxed{I_D = 4.15\,mA}$

$\Rightarrow$ At 100°C :- $I_D = I_0\left[e^{\frac{V}{\eta V_T}} - 1\right]$

$V_T = \frac{T}{11,600} = \frac{100+273}{11,600}$, $\boxed{V_T = 32.15\,mV}$

$\eta = 2$
$V = 0.7\,V$

$\Rightarrow \quad \therefore \; 4.15\times10^{-3} = I_0\left[e^{\frac{.7}{2\times32.15\times10^{-3}}} - 1\right]$

$\Rightarrow \quad I_0 = \dfrac{4.15\times10^{-3}}{53422.17}$

$\boxed{I_0 = 77.68\,\mu A}$ Ans

Imp

* Q2) At what Voltage, the Current Flowing through Ge diode will reach 80% of its saturation Value at room temp.

Soln: Given $\eta = 1$, For Ge

$I_D = .8\,I_0$

$\dfrac{V}{T} = \dfrac{T}{11,600} = \dfrac{27+273}{11,600}$

$\boxed{V_T = 25.8\,mV}$

We know

$$I_D = I_0\left[e^{\frac{V}{\eta V_T}} - 1\right]$$

$$\Rightarrow \quad .8 I_0 = I_0 \left[e^{\frac{V}{1 \times 25.8 \times 10^{-3}}} - 1 \right]$$

$$\Rightarrow \quad .8 = e^{\frac{V}{25.8 \times 10^{-3}}} - 1$$

$$\Rightarrow \quad 1.8 = e^{\frac{V}{25.8 \times 10^{-3}}}$$

$\Rightarrow$ Take $\log_e$ on both sides :-

$$\Rightarrow \quad \log_e 1.8 = \log_e e^{\frac{V}{25.8 \times 10^{-3}}}$$

$$\log_e 1.8 = \frac{V}{25.8 \times 10^{-3}}$$

$$\boxed{V = 15.16 \text{ mV}} \quad \text{Ans}$$

Q.No3 The diode Current and reverse saturation Current of a Si diode at room temp are 3.4 mA and 5 nA respectively. Calculate the value of voltage drop across the diode at room temp.

Soln We know $I_D = I_0 \left[e^{\frac{V}{\eta V_T}} - 1 \right]$

$$\Rightarrow \quad \frac{V}{T} = \frac{T}{11,600} = \frac{27+273}{11,600} \Rightarrow \boxed{\frac{V}{T} = 25.8 \text{ mV}}$$

$$3.4\times10^{-3} = 5\times10^{-9}\left[e^{\frac{V}{2\times25.8\times10^{-3}}} - 1\right]$$

⇒ After solving and taking $\log_e$ on both sides –

$$\boxed{V = 694.9\ mV}$$

QNO4 I_0 at 350 K = 5 nA

V_D at 350 K = 0.6 V

Find I_D at 350K for si diode.

Sol^n

$$I_D = I_0\left[e^{\frac{V_D}{\eta V_T}} - 1\right]$$

$$\Rightarrow V_T = \frac{T}{11,600} = \frac{350}{11,600} = \underline{\underline{30.18\ mV}}$$

$$\therefore I_D = 5\times10^{-9}\left[e^{\frac{.6}{2\times30.18\times10^{-3}}}\right]$$

$$= 5\times10^{-9}\left[e^{9.94035} - 1\right]$$

$$I_D = 0.103 \text{ mA}$$ Ans

QNO5) Find the dynamic resistance of a p-n junction diode at a forward current of 2 mA. Assume $\frac{K'T}{e} = 25 \text{ mV}$.

Sol^n:- Given $I = 2 \text{ mA}$, $\eta = 1$ (For Ge) Assume

$$V_T = \frac{K'T}{e} = 25 \text{ mV}$$

$\Rightarrow$ Dynamic Resistance $r = \frac{\eta V_T}{I} = \frac{1 \times 25 \times 10^{-3}}{2 \times 10^{-3}}$

$$r = 12.5 \Omega$$ Ans

Imp.

QNO6 * Calculate the dynamic forward resistance and reverse resistance of a p-n junction diode when the applied voltage is 0.25V at temp of T = 300K. Given $I_0 = 2 \mu A$

Sol^{n}:- We know Dynamic forward Resistance

$$r = \frac{\eta V_T}{I_0 e^{V/\eta V_T}}$$

⇒ Assume $\eta = 1$, For Ge

⇒ $$V_T = \frac{T}{11,600} = \frac{300}{11,600} = 25.86\ mV$$

⇒ $V = .25V$, $I_0 = 2\mu A$

$$r = \frac{1 \times 25.86 \times 10^{-3}}{2 \times 10^{-6}\ e^{.25/1 \times 25.86 \times 10^{-3}}}$$

$$r = 0.8167\ \Omega$$

⇒ Reverse Resistance $= \frac{V}{I_0} = \frac{.25}{2 \times 10^{-6}}$

$$= 125\ K\Omega$$

Ans

QNO7 A diode Current is 0.6 mA when applied voltage is 400 mV and 20 mA when applied voltage is 500 mV. Find η. Assume $V_T = 26$ mV.

Sol^n: $I_D = I_0\left[e^{\frac{V}{\eta V_T}} - 1\right]$

$\Rightarrow$ $I_D \simeq I_0 e^{\frac{V}{\eta V_T}}$, put the values, we get:-

$$0.6\ mA = I_0 e^{\frac{400}{26mV\eta}} \longrightarrow (1)$$

$\Rightarrow$ Similarly $\quad 20\ mA = I_0 e^{\frac{500}{26\eta}} \longrightarrow (2)$

$\Rightarrow$ Divide eq^n (2) by eq^n (1), we get

$$\Rightarrow \frac{e^{\frac{500}{26\eta}}}{e^{\frac{400}{26\eta}}} = \frac{20}{0.6}$$

$$\Rightarrow e^{\frac{100}{26\eta}} = \frac{20}{0.6} \quad \Rightarrow e^{\frac{100}{26\eta}} = 33.33$$

$\Rightarrow$ Take $\log_e$ on both sides:- $\frac{100}{26\eta} = \log_e 33.33$

$$\eta = \frac{100}{26 \times \log_e 33.33} \Rightarrow \boxed{\eta = 1.097}$$ Ans

Imp

* QNo8 What is the ratio of Current for forward bias mode with Voltage 0.05V to the Current with same magnitude of reverse bias.

2014 We know $\boxed{I = I_0\left[e^{\frac{V}{\eta V_T} - 1}\right]}$

When Forward Bias

$$I_F = I_0\left[e^{\frac{0.05}{\eta V_T} - 1}\right]$$

Assume $\eta = 1$, For Ge

& $V_T = \frac{T}{11,600} = \frac{27+273}{11,600}$ at room temp.

$$\boxed{V_T = 25.8\ mV} \cong \underline{26\ mV}$$

$$\therefore \quad I_F = I_0\left[e^{\frac{0.05}{26\times10^{-3}} - 1}\right] \longrightarrow (1)$$

Similarly

When Reverse bias :.

$$\downarrow$$

$$\boxed{V = -0.05V}$$

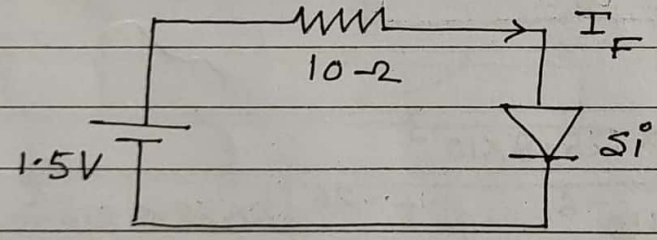
$$I_R = I_0\left[e^{\frac{-0.05}{26\times10^{-3}} - 1}\right] \longrightarrow$$

Divide (i) / (ii), we get –

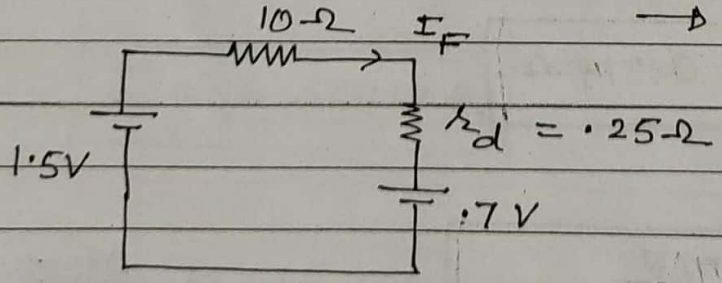
$$\Rightarrow \frac{I_F}{I_R} = \frac{e^{0.05/26\times10^{-3}} - 1}{e^{-0.05/26\times10^{-3}} - 1} = \frac{5.842}{-0.8538}$$

$$\Rightarrow \boxed{\frac{I_F}{I_R} = -6.84} \text{ Ans}$$

QN09 Calculate forward Current I_F for Si diode with dynamic resistance $r_d = .25\Omega$



Sol^n:



→ Replace Si diode by a battery of 0.7V.

⇒ Apply KVL

$$1.5 - 10I_F - .25I_F - .7 = 0$$

$$\therefore I_F = \frac{1.5 - .7}{10 + .25} \Rightarrow \boxed{I_F = 87.8\,mA}$$ Ans

Q No 10 For a Ge diode, the reverse saturation current is 2 μA at reverse voltage of 0.26 V.

Calculate the forward and reverse dynamic resistance, if the forward biased voltage is 0.26 V at room temp.

Sol:- Given $I_0 = 2\,\mu A$

$\eta = 1$ For Ge

$V_{reverse} = -0.26\,V$

$V_{forward} = 0.26\,V$

At Room temp

$V_T = \frac{T}{11,600} = \frac{27+273}{11,600}$

$\boxed{V_T = 25.8\,mV}$

We know

$$\boxed{r = \frac{\eta V_T}{I_0 e^{V/\eta V_T}}}$$

⇒ (1) $$r_f = \frac{2 \times 25.8 \times 10^{-3}}{2 \times 10^{-6}\ e^{+.26 \,|\, 2 \times 25.8 \times 10^{-3}}}$$

$$\boxed{r_f = 0.519\,\Omega}$$

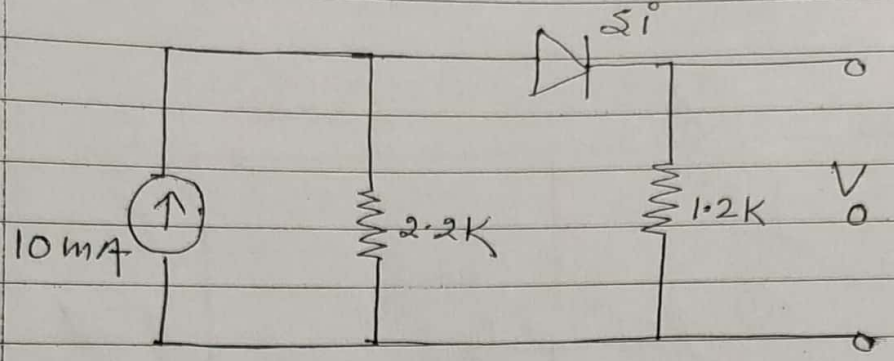
(2) $$\boxed{r_r = \frac{\eta V_T}{I_0\, e^{-V/\eta V_T}}} \Rightarrow r_r = \frac{2 \times 25.8 \times 10^{-3}}{2 \times 10^{-6}\ e^{-0.26 \,|\, 2 \times 25.8 \times 10^{-3}}}$$

$$\boxed{r_r = 310.34\,M\Omega}$$

Ans

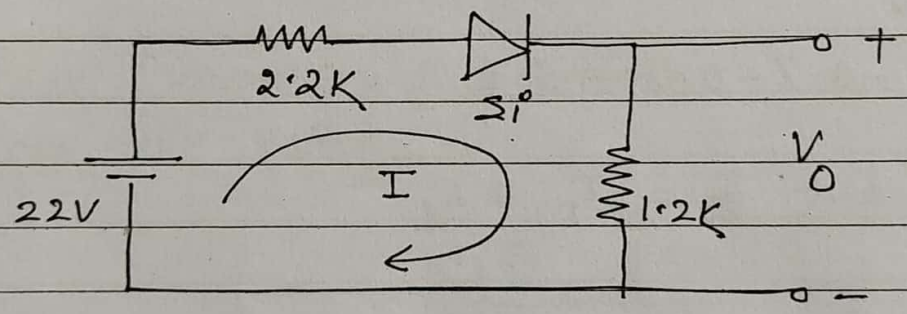
⇒ Numericals based on Series And parallel of diodes.

QNO1)



Find V_o.

Sol^n Converting current source into voltage source.



⇒ Apply KVL

$$22 - 2.2I - 0.7 - 1.2I = 0$$

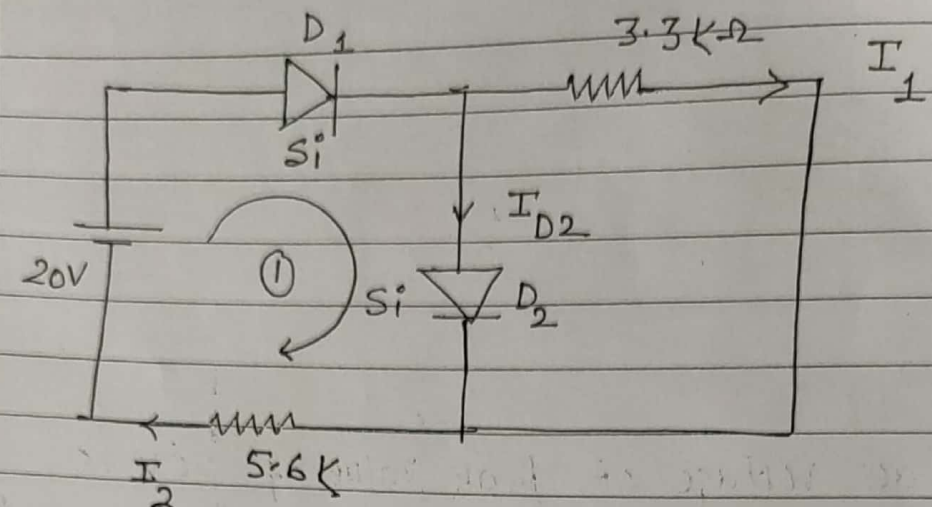
$$\boxed{I = 6.264\,mA}$$

$$\therefore V_o = 6.264\,mA \times 1.2K$$

$$\boxed{V_o = 7.52V}$$

Ans

. QNo3 Find I_1, I_2 and I_{D2}.



⇒ Apply KVL in Loop 1

$$20 - 0.7 - 0.7 - 5.6\, I_2 = 0$$

but $I_2 = I_{D2} + I_1$

∴

$$20 - .7 - .7 - 5.6\,(I_{D2} + I_1) = 0$$

∴ $$I_{D2} + I_1 = 3.32 \longrightarrow (1)$$

⇒ Apply KVL in Loop 2

$$-3.3\, I_1 + 0.7 = 0$$

$$\boxed{I_1 = 0.212 \text{ mA}}$$, put in eq^n (1)

$$\boxed{I_{D2} = 3.108 \text{ mA}}$$

$$I_2 = I_{D2} + I_1$$

$$= 3.11 + .212$$

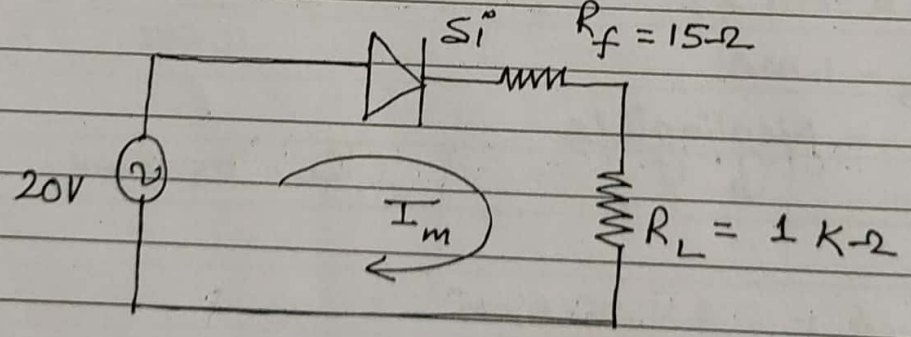
$$\boxed{I_2 = 3.32\ mA}$$

Ans

QNO3 An ac voltage of peak value of 20V is connected in series with a Si diode and load resistance of 1K-Ω. If the forward resistance of diode is 15-Ω. Find –

(1) Peak Current through diode
(2) Peak O/P voltage.

Sol^n



⇒ Apply KVL

$$20 - 0.7 - I_m \times 15\Omega - I_m \times 1K\Omega = 0$$

$$I_m = \frac{20 - 0.7}{15\Omega + 1000\Omega} = \frac{19.3}{1015\Omega}$$

(1) $\boxed{I_m = 19\,mA}$

(2) Peak o/p voltage - $V_{o(max)} = I_m \times R_L$

$= 19\,mA \times 1K\Omega$

$= 19V$ Ans

QNO4 What is the magnitude of r for Si p-n junction diode at room temp and for dc current of 1 mA

Sol^n We know

$$\boxed{r = \frac{\eta V_T}{I_D + I_0}}$$

$\eta = 2$ For Si

$I_D = 1\,mA$

$I_0 =$ Negligible

Room temp

$$V_T = \frac{T}{11,600} = \frac{27+273}{11,600} = \frac{300}{11,600}$$

$V_T = 25.8\,mV$

$$\Rightarrow \quad r = \frac{2 \times 25.8 \times 10^{-3}}{1 \times 10^{-3}}$$

$\boxed{r = 51.6\,\Omega}$ Ans

Imp

* QNO5 A diode operating at 300°K at a forward voltage of 0.4V carries a current of 10 mA. When the voltage is changed to 0.42 V, the current becomes twice. Calculate the value of I_0 and η for diode.

Soln Given $T = 300K$

$V_1 = 0.4V$

$I_1 = 10\,mA$

$V_2 = 0.42V$

$I_2 = 20\,mA$

$V_T = \frac{T}{11,600} = \frac{300}{11,600}$

$\boxed{V_T = 25.8\,mV}$

We know $I_1 = I_0\left[e^{\frac{V_1}{\eta V_T}} - 1\right]$

$10 = I_0\left[e^{\frac{0.4}{\eta V_T}} - 1\right] \longrightarrow (1)$

Similarly

$I_2 = I_0\left[e^{\frac{V_2}{\eta V_T}} - 1\right]$

$20 = I_0\left[e^{\frac{0.42}{\eta V_T}} - 1\right] \longrightarrow (2)$

Divide eqn (1) by (2) :-

$$\frac{10}{20} = \frac{e^{\frac{0.4}{\eta V_T}} - 1}{e^{\frac{0.42}{\eta V_T}} - 1}$$

$$\Rightarrow \frac{1}{2} = \frac{e^{\frac{0.4}{\eta V_T}} - 1}{e^{\frac{0.42}{\eta V_T}} - 1}$$

$\Rightarrow$ As diode is Forward biased $\therefore e^x >>> 1$, Neglec

$$\Rightarrow \frac{1}{2} = \frac{e^{\frac{0.4}{\eta V_T}}}{e^{\frac{0.42}{\eta V_T}}} \Rightarrow \text{Taking } \log_e \text{ on both sid}$$

$$\Rightarrow \log_e 0.5 = \log_e e^{\frac{0.4}{\eta V_T}} - \log_e e^{\frac{0.42}{\eta V_T}}$$

$$\Rightarrow -0.693 = \frac{0.4}{\eta V_T} - \frac{0.42}{\eta V_T}$$

$$\Rightarrow \eta V_T = \frac{-0.02}{-0.693} \Rightarrow \eta V_T = 0.0289$$

$$\therefore \eta = \frac{.0289}{25.8 \times 10^{-3}} \Rightarrow \boxed{\eta = 1.11}$$

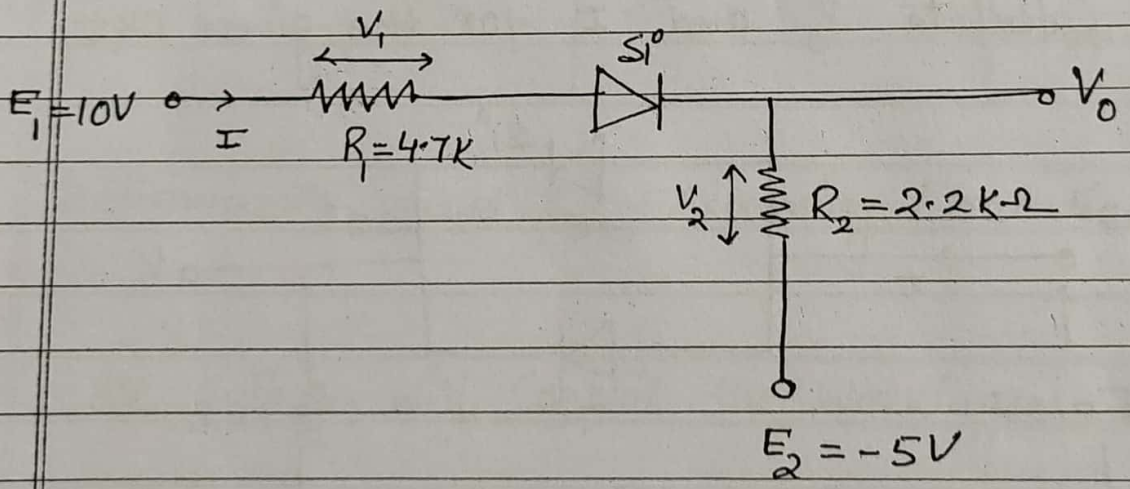
$$\therefore \quad I_D = \frac{I_1}{e^{\frac{V_1}{\eta V_T}} - 1}$$

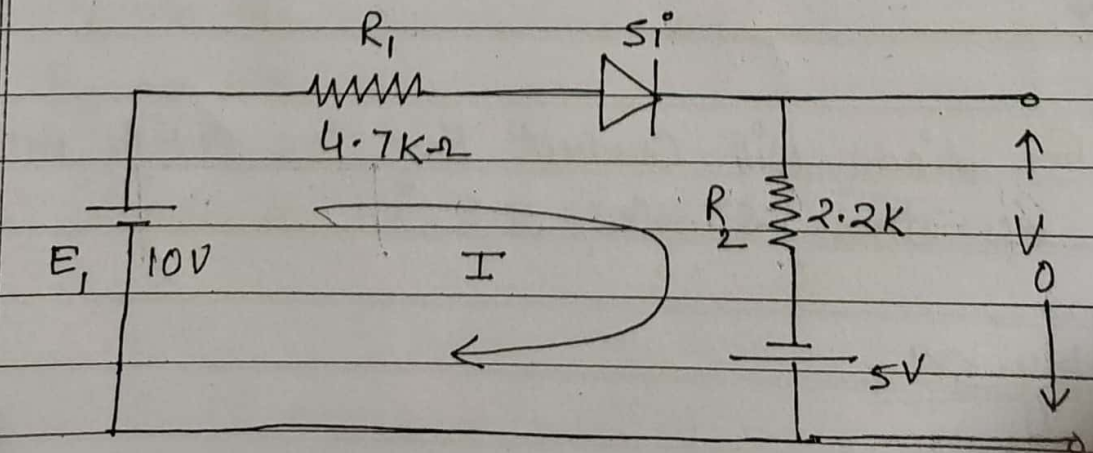
$$= \frac{10 \times 10^{-3}}{e^{\frac{0.4}{1.11 \times 25.8 \times 10^{-3}}} - 1}$$

$$\boxed{I_D = 9.066\ mA} \quad \text{Ans}$$

Int

QNO6 Determine I, V_1, V_2 and V_0.





⇒ Apply KVL :- $10 - I \times 4.7 - 0.7 - I \times 2.2 + 5 = 0$

$$I = 2.07\,mA$$

① $\therefore V_1 = IR_1 = 2.07 \times 4.7K = 9.73V$

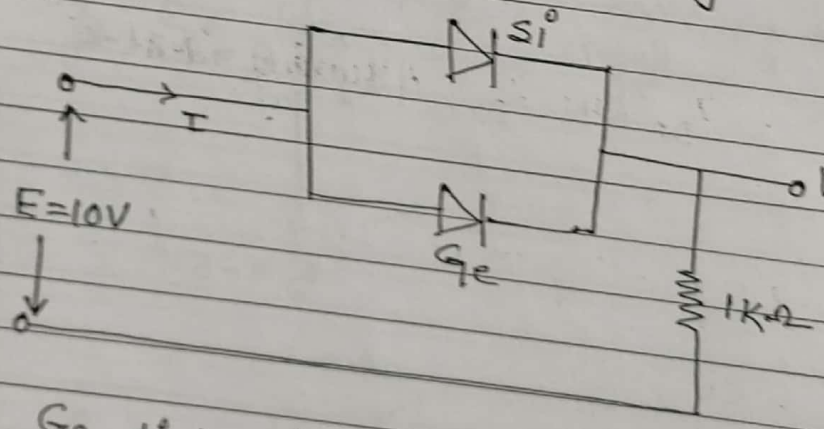
② $V_2 = IR_2 = 2.07\,mA \times 2.2K\Omega = 4.55V$

③ $V_0 = IR_2 - 5$

$= 4.55 - 5$

$V_0 = -0.446V$ Ans

QNO7 Calculate V_0 and I for the given ckt.



Soln Ge diode will conduct b'coz its cut in voltage is less than Si diode.

⇒ Apply KVL

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$10 - 0.3 - I \times 1K\Omega = 0$

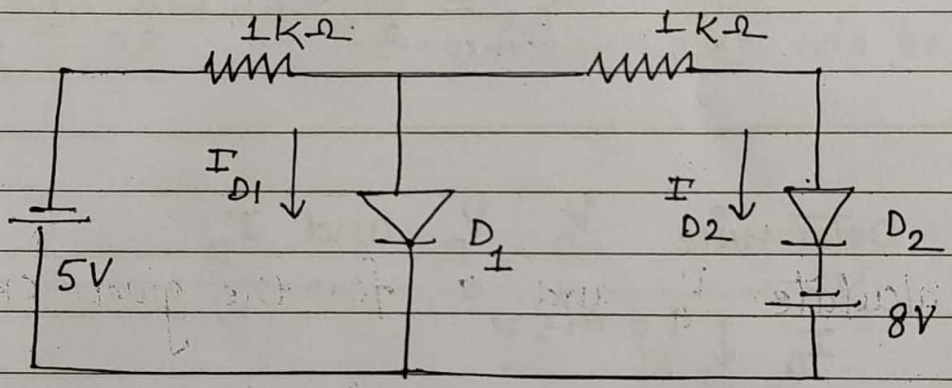
$\boxed{I = 9.7\,mA}$

$\therefore V_0 = I \times 1K\Omega$

$= 9.7mA \times 1K\Omega$

$\boxed{V_0 = 9.7V}$ Ans

QNO8



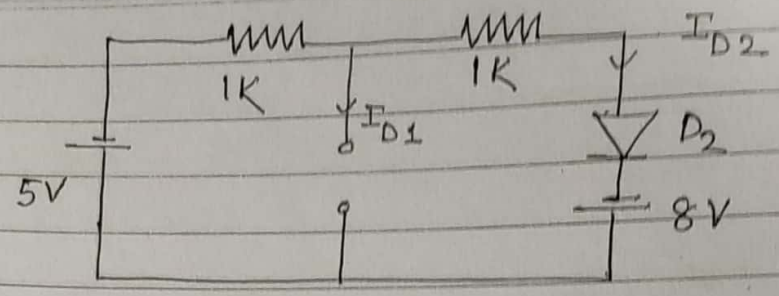
Determine I_{D1} and I_{D2}, Assuming ideal diode.

2014 8V battery will control the working.

$D_1 \rightarrow RB$

$D_2 \rightarrow FB$

$\therefore$ Diode D_1 will be open circuited.

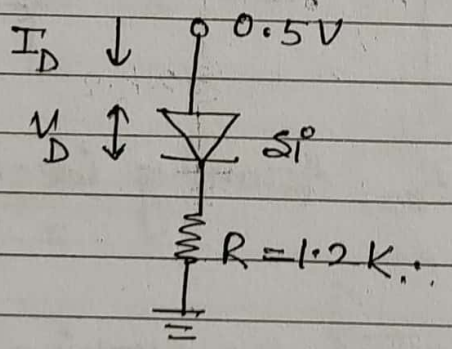


① $\boxed{I_{D1} = 0}$

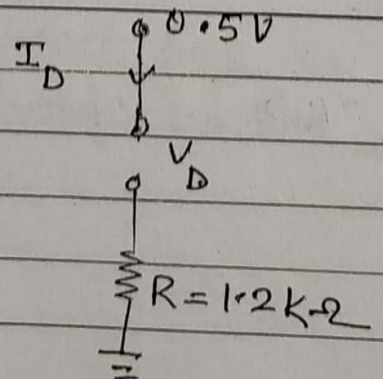
② Apply KVL $\quad -5 - I_{D_2} - I_{D2} + 8 = 0$

$$I_{D2} = \frac{3}{2} = 1.5\,mA \quad \text{Ans}$$

QNO9 Determine V_D, V_R and I_D.



Sol^n Since the input voltage is insufficient to turn the silicon diode 'ON', therefore equivalent ckt will be –



① $\therefore \boxed{I_D = 0}$

② $\boxed{V_D = 0.5V}$

③ $V_R = I_D \times R$

$\boxed{V_R = 0}$ Ans

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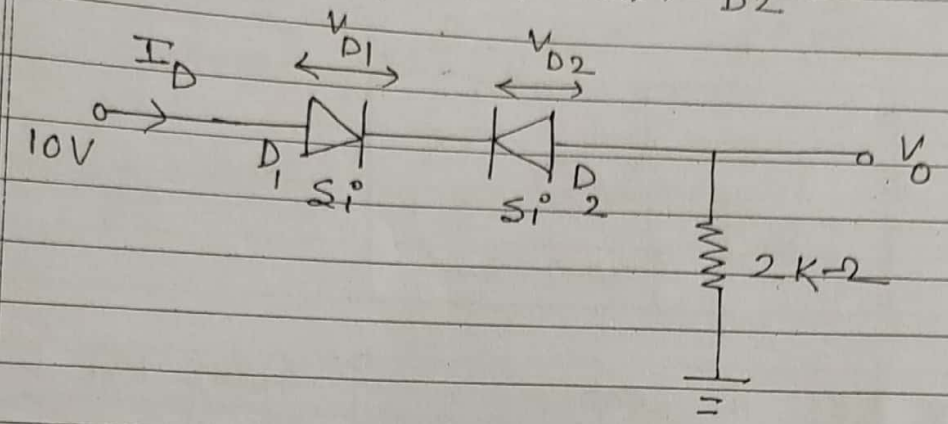
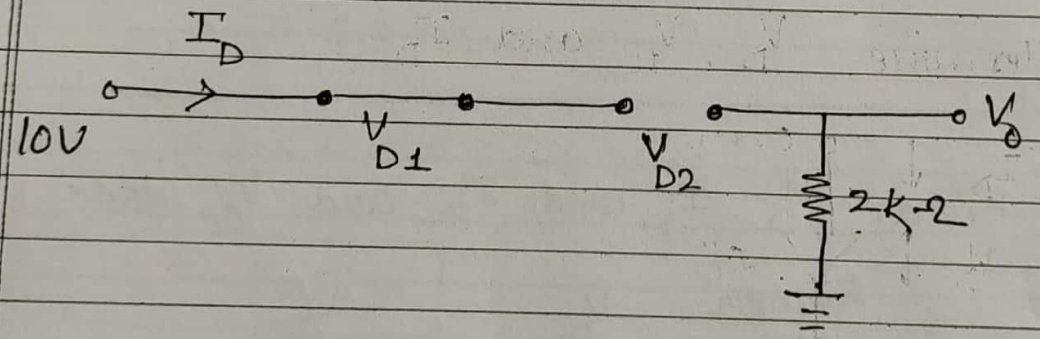
QNO 10 Calculate the V_0, V_{D1}, V_{D2} and I_D.



Soln D_1 — FB

D_2 — RB ∴ The equivalent ckt will be -



∴ $\boxed{I_D = 0}$

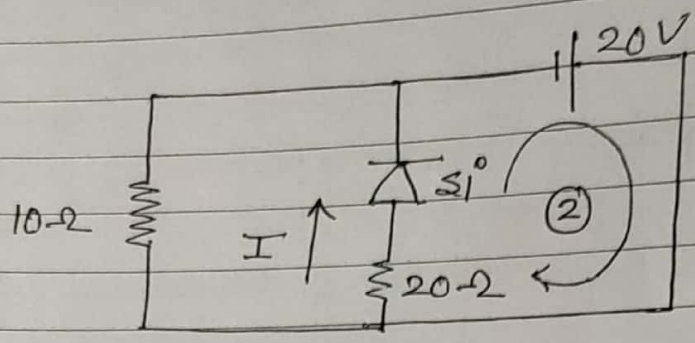
$\boxed{V_{D1} = 10V}$

$\boxed{V_{D2} = 10V}$

& $V_0 = I_D \times 2K\Omega$

$\boxed{V_0 = 0V}$ Ans

QNO 1) Determine I for the given ckt.



⇒ Apply KVL in Loop 2

$20 - 20I - 0.7 = 0$ OR

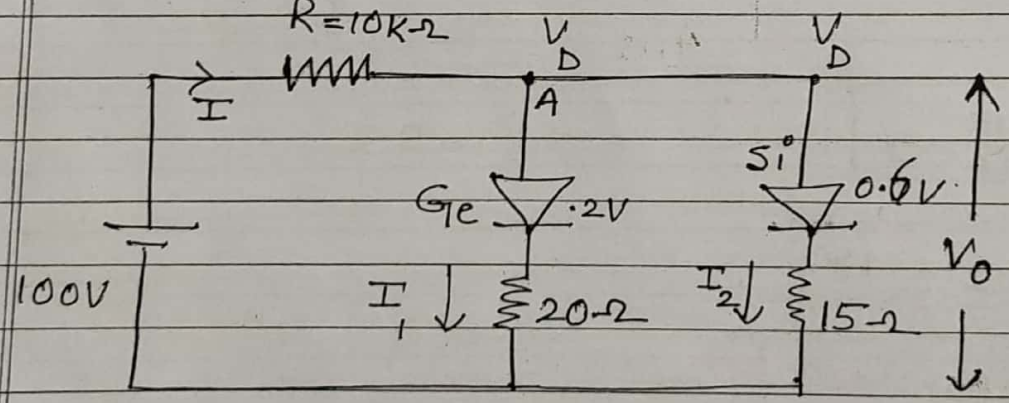
$I = 0.965\,A$ Ans

Apply KVL in Loop 1

$-20I - 0.7 - 10I = 0$

$I =$

QNO 2) Find V_D, I_1 and I_2, and V_0 also.



⇒ Apply KCL at point A.

$\Rightarrow \quad I = I_1 + I_2$

$\Rightarrow \quad \frac{100 - V_D}{10 \times 10^3} = \frac{V_D - 0.2}{20} + \frac{V_D - 0.6}{15\Omega}$

By solving $\quad \boxed{V_D = 0.5138V}$

$\Rightarrow \quad I_1 = \frac{V_D - 0.2}{20} = 15.69\,mA$

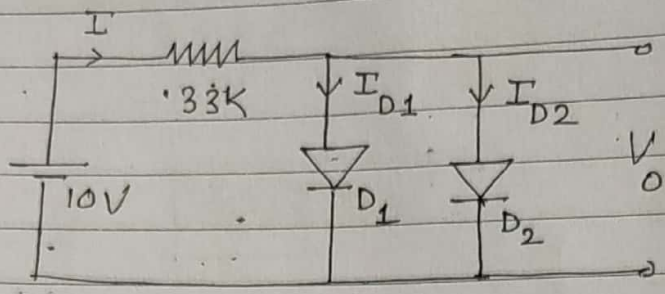
$I_2 = \frac{V_D - 0.6}{15} = -5.7466\,mA$ } Ans

$V_0 = 0.6 + 15\Omega \times I_2$

$= 0.6 + 15\Omega \times (-5.7466\,mA)$

$\boxed{V_0 = 0.51\,V}$ Ans

QNO13 Find V_o, I, I_{D1} and I_{D2}.



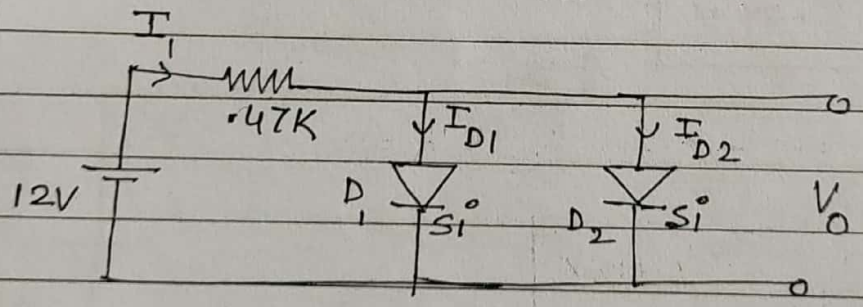
Sol^{n}: D_1 & D_2 will be F.Biased.

$$I = \frac{10V}{.33K} = 30.3\ mA$$

$$\therefore I_{D1} = I_{D2} = I/2 = 15.15\ mA \quad \underline{Ans}$$

$$\Rightarrow V_o = 10 - I \times .33K = 0.001\ V$$

QNO14 Find I_1, I_{D1}, I_{D2} and V_o.



Sol^{n} D_1 and D_2 will be Forward biased.

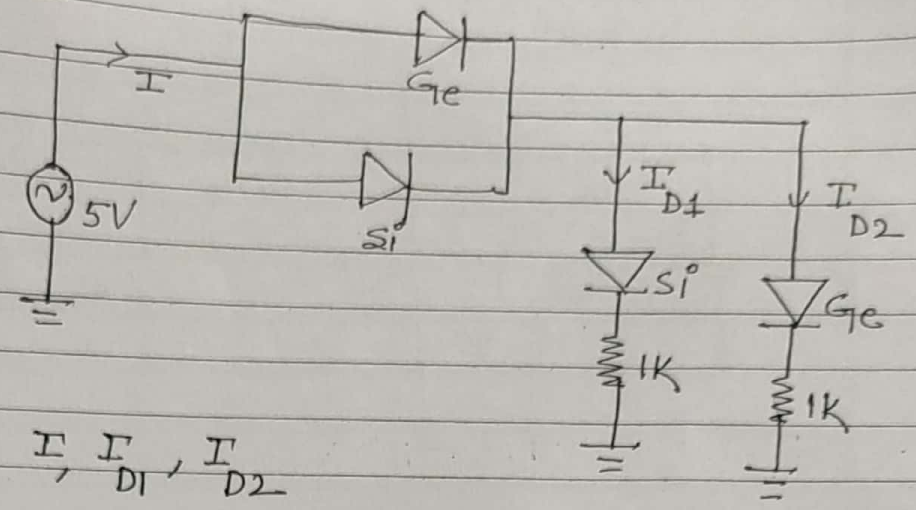
Apply KVL $\quad 12 - .47 I_1 - 0.7 = 0$

$$\boxed{I_1 = 24\ mA}$$

$$I_{D1} = I_{D2} = I_1/2 = 12\ mA, \quad \boxed{V_o = 0.7V}$$

Imp

QNO 15



Find I, I_{D1}, I_{D2}

Sol^{n}:- Ge diode will be FB.

⇒ Apply KVL

$$5 - 0.3 - 0.7 - I_{D1} \times 1K = 0$$

$$\boxed{I_{D1} = 4mA}$$

Similarly

$$5 - 0.3 - 0.3 - I_{D2} \times 1K = 0$$

$$\boxed{I_{D2} = 4.4mA}$$

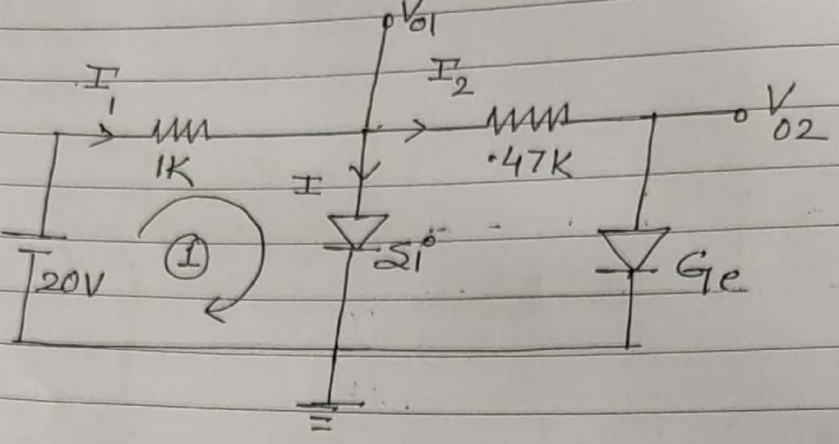
$$\therefore I = I_{D1} + I_{D2}$$

$$= 4 + 4.4$$

$$\boxed{I = 8.4\,mA}$$ Ans

MIMP

QNO 16 Find V_{01}, V_{02}, I_1 and I.



Sol^n

$V_{01} = 0.7V$

& $V_{02} = 0.3V$

⇒ Apply KVL in Loop 1 :-

$20 - I_1 - 0.7 = 0$

$I_1 = 19.3\ mA$

⇒ Now Apply KVL in Loop 2 :-

$-0.47 I_2 - 0.3 + 0.7 = 0$

$I_2 = .85\ mA$

⇒ $I = I_1 - I_2$

$= 19.3 - .85$ ⇒ $I = 18.45\ mA$

Ans

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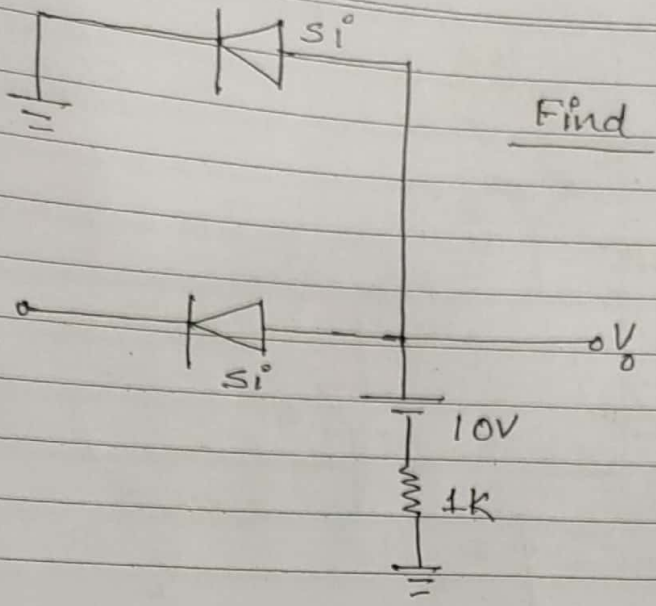
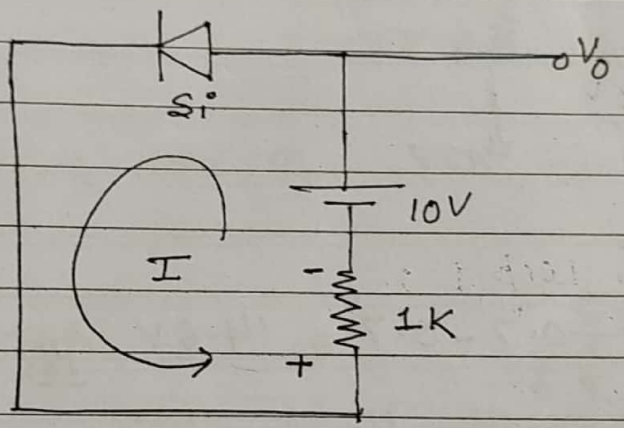
QNO17



Find V_0

Sol^n



$\Rightarrow$ KVL :- $10 - 0.7 - I \times 1K = 0$

$$I = 9.3mA$$

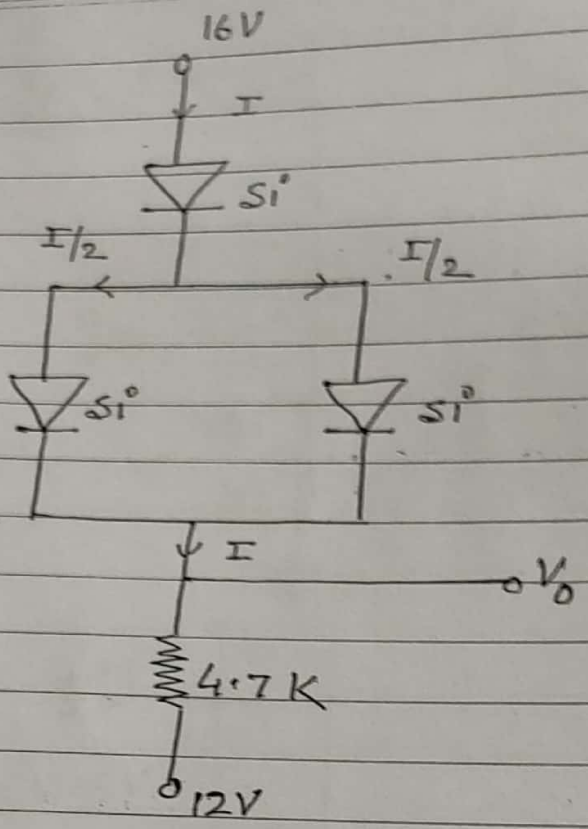
$\therefore$ $V_0 = 10 - 9.3mA \times 1K\Omega$

$$V_0 = 0.7\,V$$

Ans

Q NO 18

Find V_0



Sol:- $V_0 = 16 - 0.7 - 0.7 = 14.6\,V$ Ans

OR

⇒ Apply KVL

$16 - 0.7 - 0.7 - I \times 4.7 - 12 = 0$

$I = 0.55\,mA$

$\therefore V_0 = 4.7K \times 0.55mA + 12$

$= 2.585 + 12$

$V_0 = 14.6\,V$

Ans

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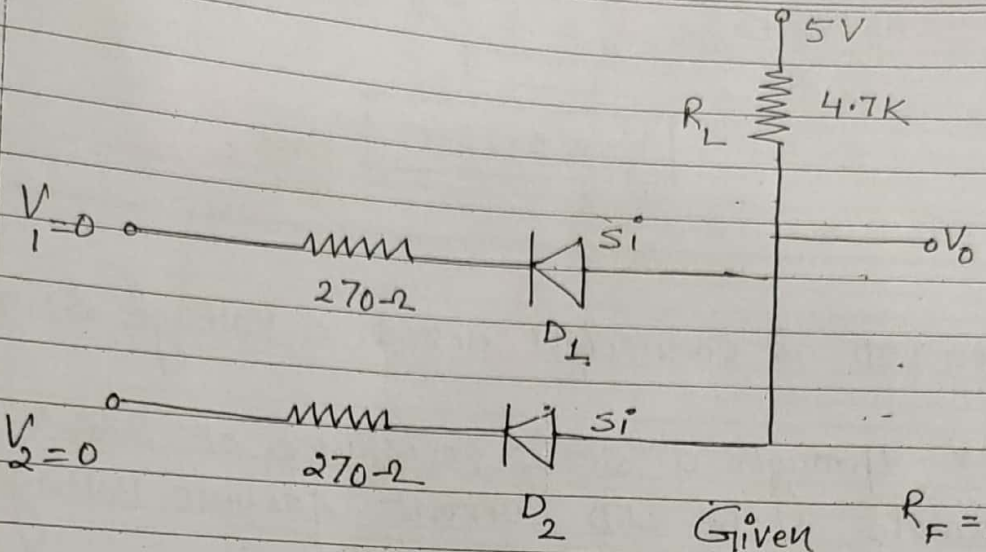
QN019



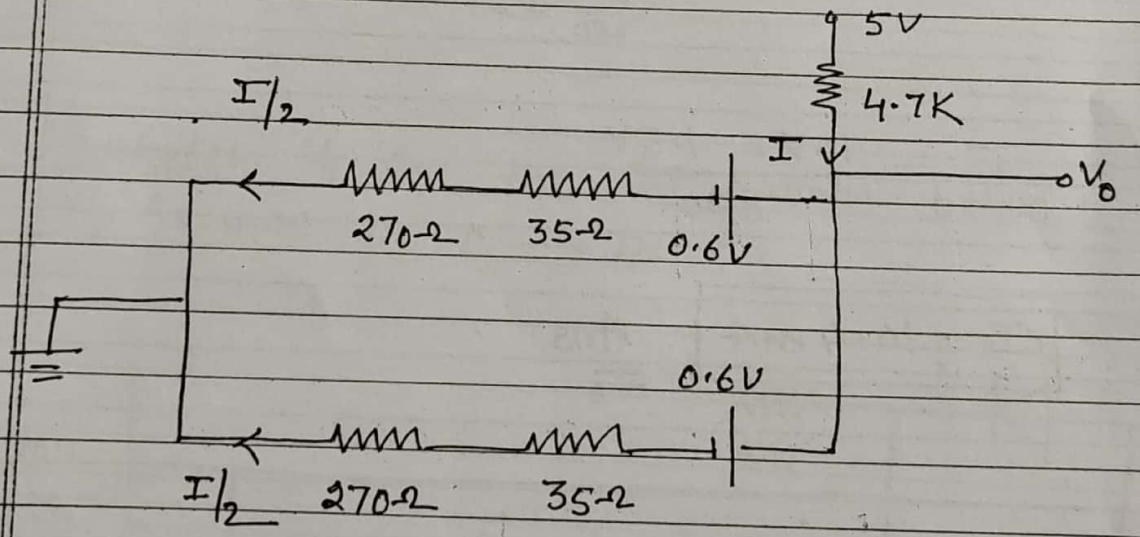
Given $R_F = 35\Omega$

$V_\gamma = 0.6V$

$R_r = \infty$

Sol^n

Diodes D_1 and D_2 $\rightarrow$ F.B ; Equivalent ckt will be -



$\Rightarrow$ Apply KVL in any L path :-

$$5 - 4.7I - 0.6 - 35 \times I/_2 - 270 \times I/_2 = 0$$

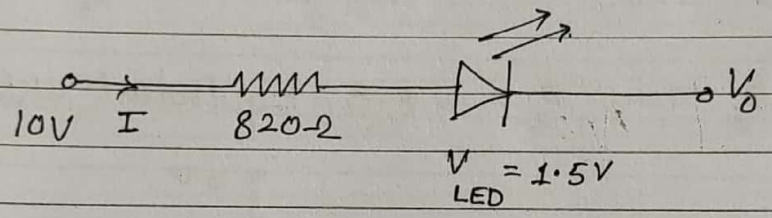
$$\boxed{I = 9 \times 10^{-4} A}$$

$\therefore$ o/p voltage $V_0 = 5 - 4.7 \times 9 \times 10^{-4} \times 10^{3}$

$$\boxed{V_0 = 0.730V}$$ Ans

QNo20 An LED is connected across a voltage source of 10V through a series resistance of 820Ω. Calculate the LED current. Assume voltage drop across an LED of 1.5V.

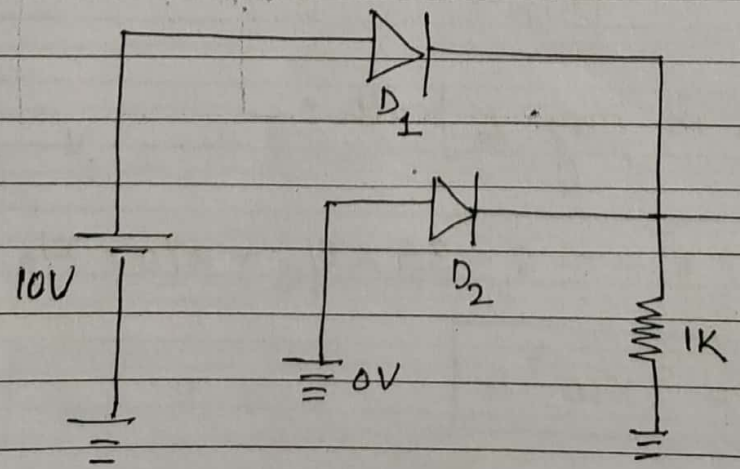
Sol^{n}



$$I = \frac{10V - 1.5V}{820}$$

$$\boxed{I = 10.4\,mA}$$ Ans

QNo21



Find I.
Assume diode to be practical.

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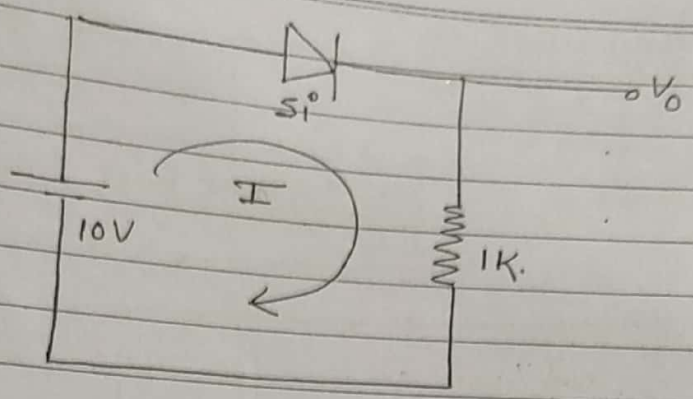
Sol^n



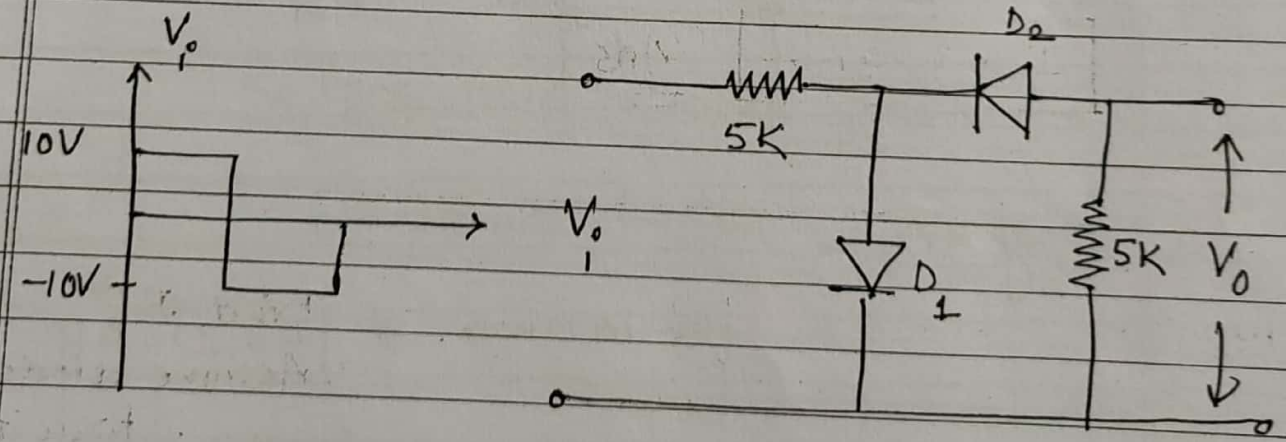
⇒ KVL $\quad 10 - 0.7 - I = 0$

$$\boxed{I = 9.3\,mA}$$

$$\therefore V_0 = 9.3\,mA \times 1K$$

$$\boxed{V_0 = 9.3\,V}$$ Ans

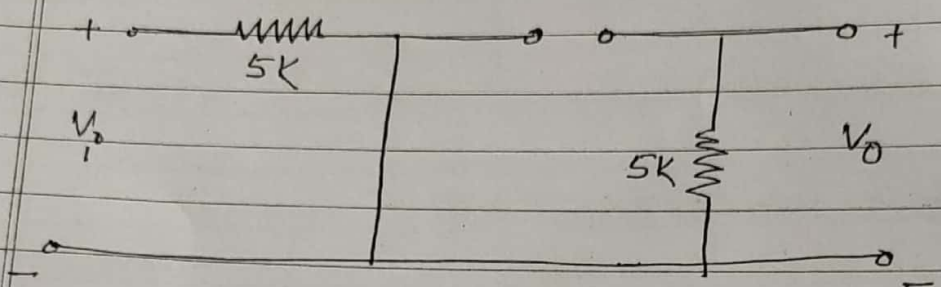
Q NO 22 Sketch V_0 For the Ckt shown below. Assume $D_1, D_2 \rightarrow$ Ideal.



2014 During (+ve) Half cycle

$D_1 \rightarrow FB$

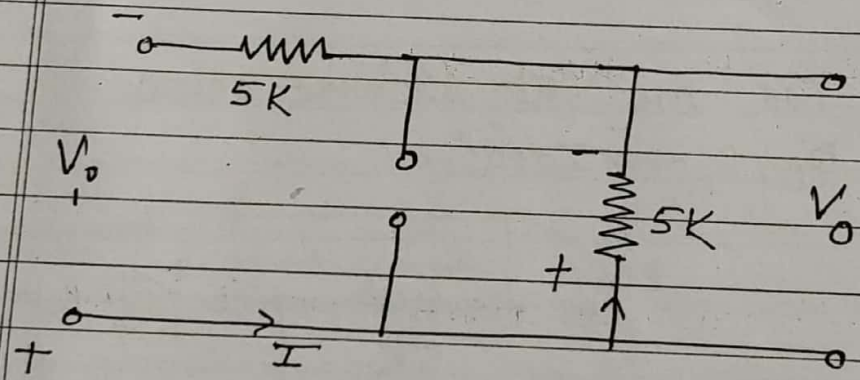
$D_2 \rightarrow RB$, $\therefore$ No Current will flow through R_L



$\therefore \boxed{V_o = 0}$

⇒ During (-ve) Half cycle :- D_1 – RB

$D_2 \rightarrow FB$

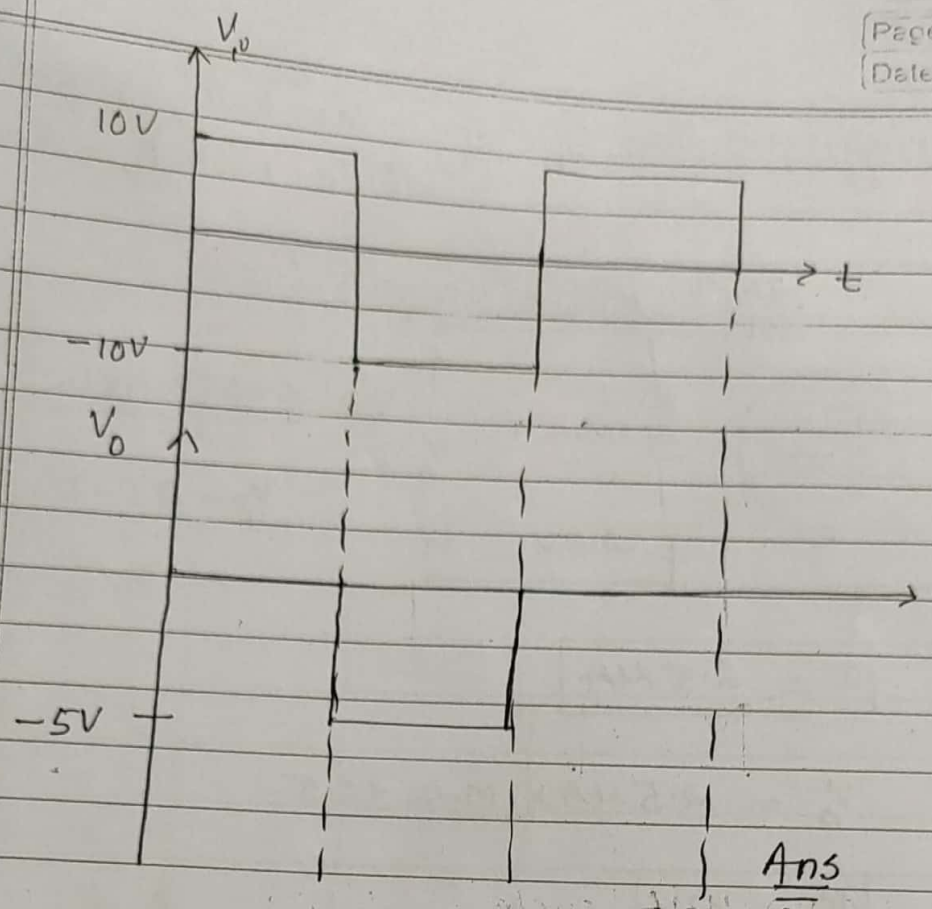


⇒ Apply KVL :- $V_i - 5I - 5I = 0$

$10 - 10I = 0 \Rightarrow \boxed{I = 1mA}$

$\therefore V_o = -5 \times 1mA$

$\boxed{V_o = -5V}$



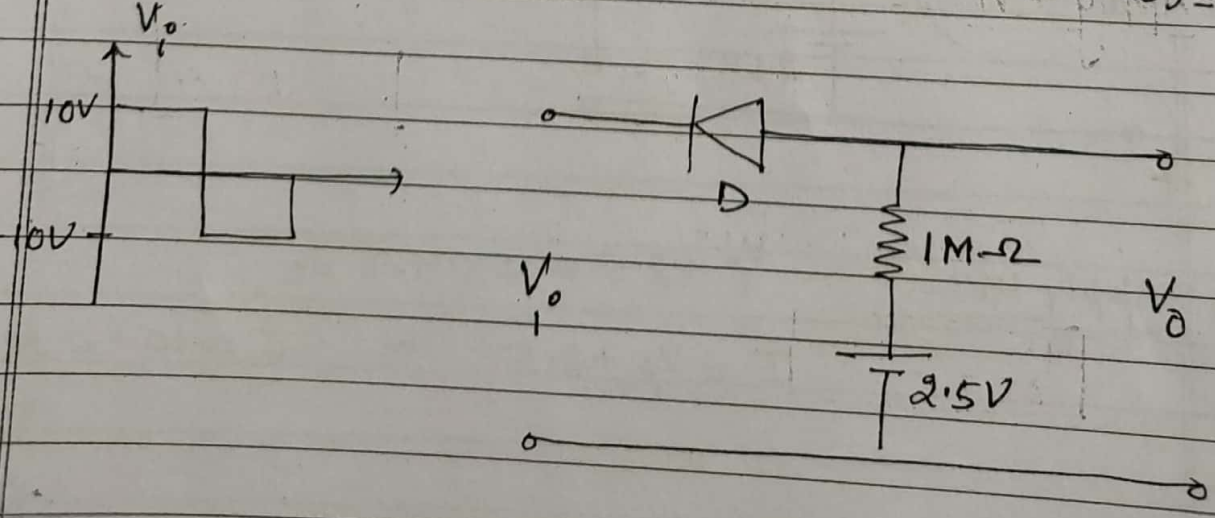
Ans

QN023 Sketch V_0 For the given ckt.

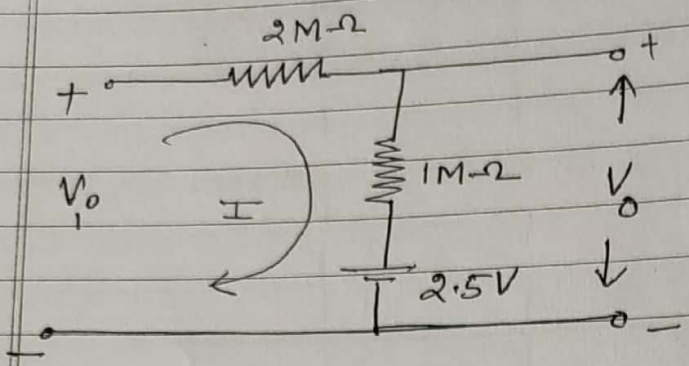
Given $V_\gamma = 0$

R_R (Resistance of diode when it is R.B) = 2 MΩ

R_F (Resistance of diode when it is F.B) = 0



2014 During (+ve) Half cycle :- D — R.B., ∴ Replace diode with $R_f = 2M\Omega$



Apply KVL

$V_0 - 2I - I - 2.5 = 0$

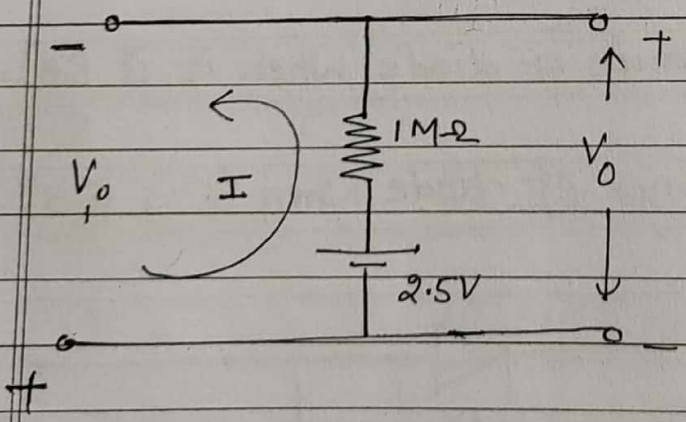
$\Rightarrow$ $\boxed{I = 2.5\mu A}$

$\Rightarrow$ $\therefore V_0 = 2.5\mu A \times 1M\Omega + 2.5$

$\boxed{V_0 = 5V}$

$\Rightarrow$ During (-ve) Half cycle :- D — FB

Replace diode with $\boxed{R_F = 0}$



$\Rightarrow$ Apply KVL $\quad V_0 + 2.5 - I \times 1M\Omega = 0$

$I = V_0 + 2.5 \quad \Rightarrow \quad I = 10 + 2.5$

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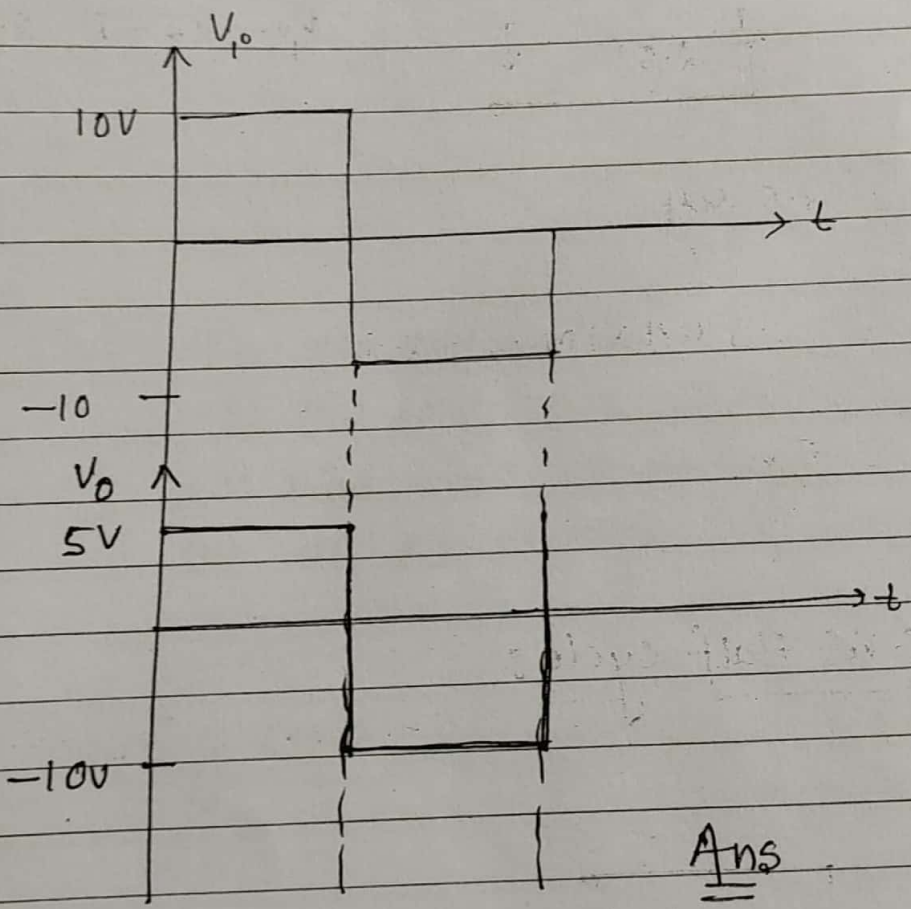
$$I = 12.5\ \mu A$$

$$\therefore \quad V_0 = -(1M\Omega \times 12.5\ \mu A) + 2.5V$$

$$V_0 = -10V$$



Ans

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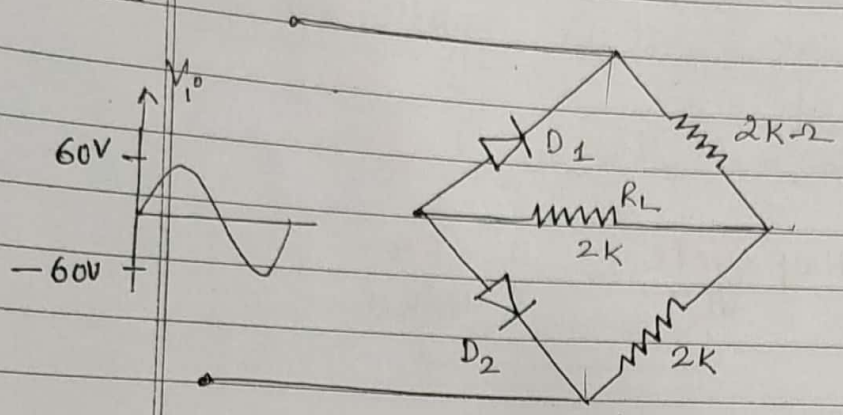
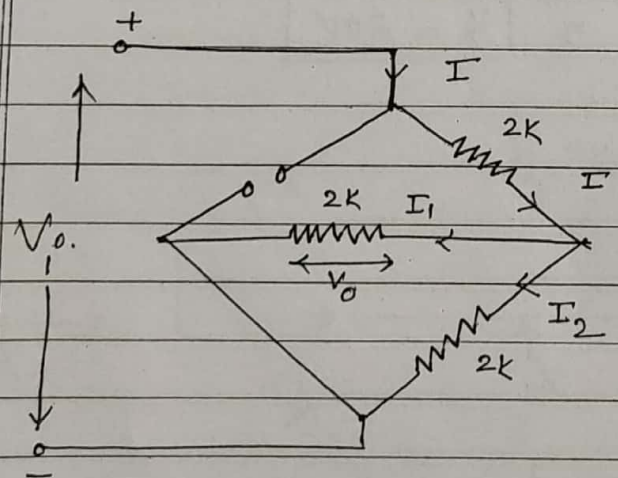
Numericals Based on Rectifiers

Q NO1 :



Find – (1) O/P voltage V_o
(2) PIV OF each diode
(3) Find rms o/p voltage
(4) dc o/p voltage

Sol^n :- During (+ve) Half cycle :- $D_1 \rightarrow RB$
$D_2 \rightarrow FB$



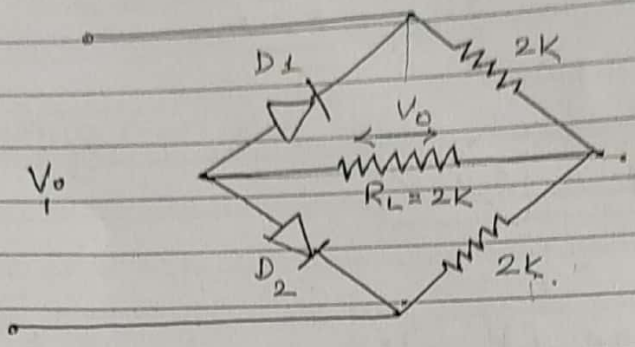
$$I = \frac{V}{R_{eq.}}$$

$$= \frac{60}{(2 \| 2) + 2K}$$

$$\boxed{I = 20\,mA}$$

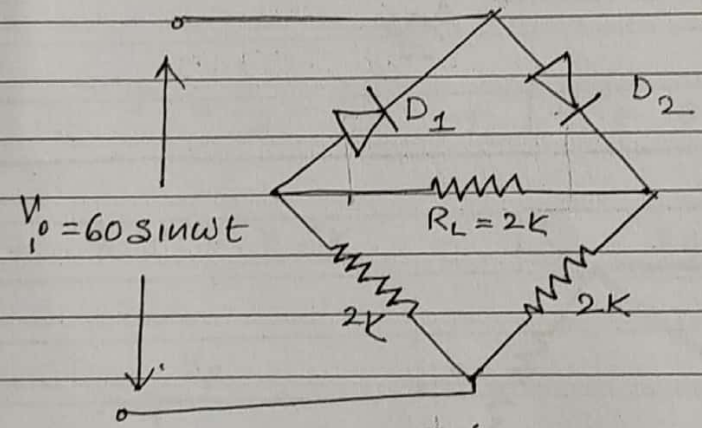
Find – V_o

Sol^n :- The given ckt can be re-drawn as :–



⇒ This is same as QNO–1.

QNO3



Find :- (1) sketch V_o

(2) PIV OF each diode

(3) V_{dc}

(4) V_{rms}

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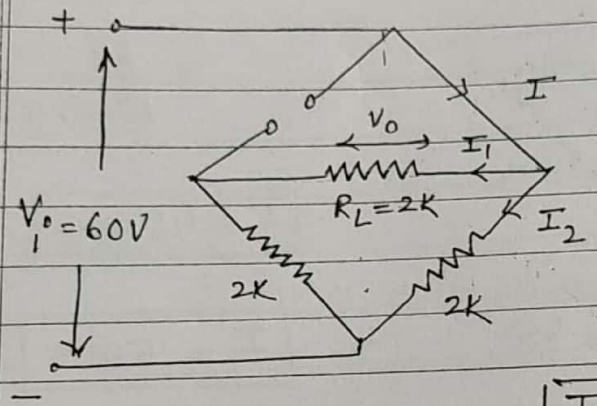
Step 1 During (+ve) Half cycle :-

$D_1 - RB$

$D_2 \rightarrow FB$



$$I = \frac{V}{R_{eq.}}$$

$$= \frac{60}{(2+2)\|2}$$

$$I = \frac{60}{4/3} = \frac{60 \times 3}{4}$$

$$\boxed{I = 45\,mA}$$

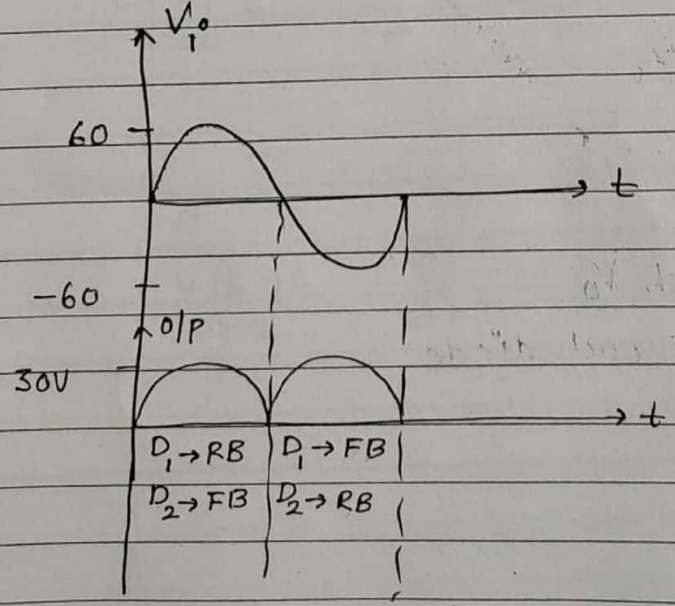
$\Rightarrow$ $\therefore I_1 = \frac{2}{2+2} \times 45$ (using Current divider Rule)

$$\boxed{I_1 = 15\,mA}$$

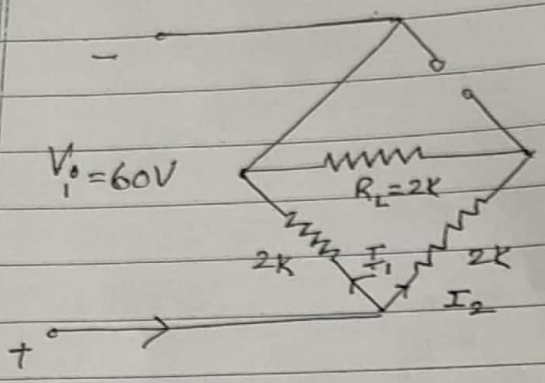
$\therefore V_o = I_1 \times R_L$

$= 2K \times 15\,mA$

$$\boxed{V_o = 30V}$$



Step2 During (-Ve) Half cycle :- $D_1 \rightarrow FB$, $D_2 \rightarrow RB$



$$\Rightarrow I = \frac{V}{R_{eq}}$$

$$= \frac{60}{(2+2) \parallel 2K}$$

$$\boxed{I = 45\,mA}$$

$$\therefore I_1 = \frac{2}{4+2} \times 45 \Rightarrow \boxed{I_1 = 15\,mA}$$

$$\Rightarrow \therefore V_0 = 15\,mA \times 2K$$

$$\boxed{V_0 = 30V}$$

(2) PIV :- PIV of each diode =

(3) V_{dc} :- $V_{dc} = \frac{2V_m}{\pi} = \frac{2 \times 30}{\pi} = 19.09V$

(4) V_{rms} :- $V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{30}{\sqrt{2}} = 21.21V$

Ans

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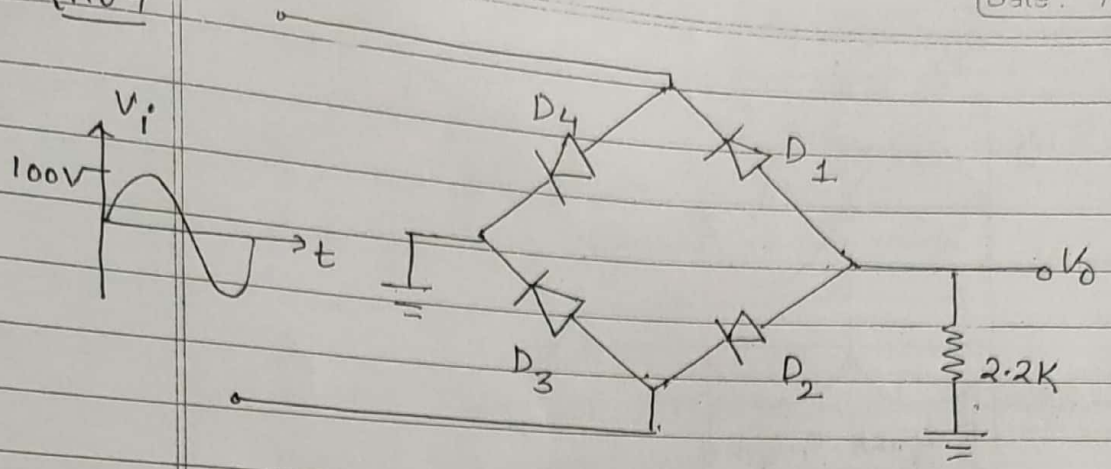
QNO4

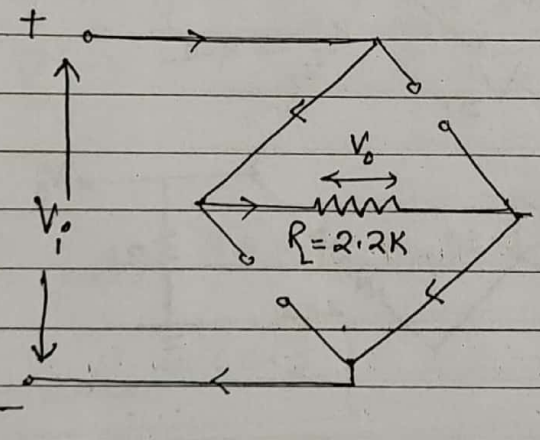


Find — ① V_0

② PIV OF each diode.

SOL^N:- During (+ve) Half cycle :- $D_1 \rightarrow RB$ $D_2 \rightarrow FB$

$D_3 \rightarrow RB$ $D_4 \rightarrow FB$



⇒ Apply KVL

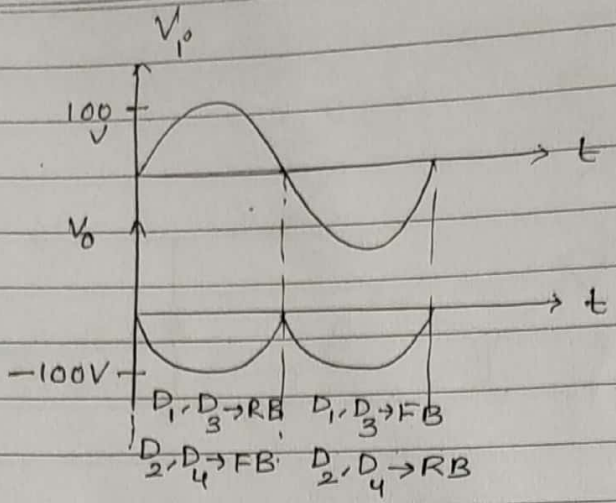
$V_i + V_0 = 0$

$V_0 = -V_i$

$\boxed{V_0 = -100V}$

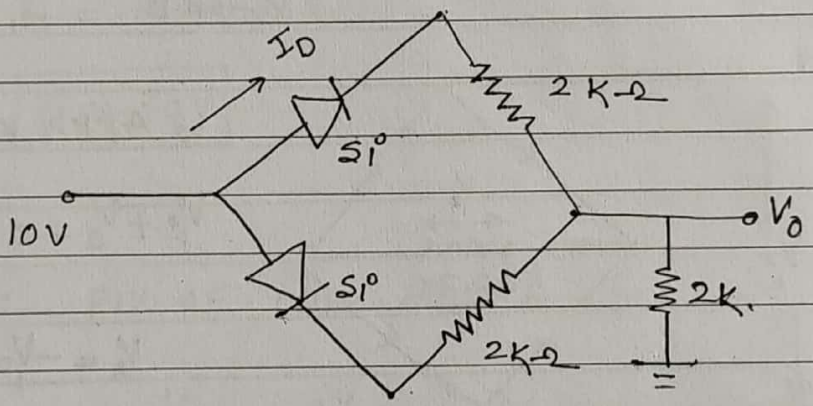
⇒ Similarly V_0, during (-ve) Half cycle

$\boxed{V_0 = -100V}$



⇒ PIV of each diode $= V_m = 100V$ Ans

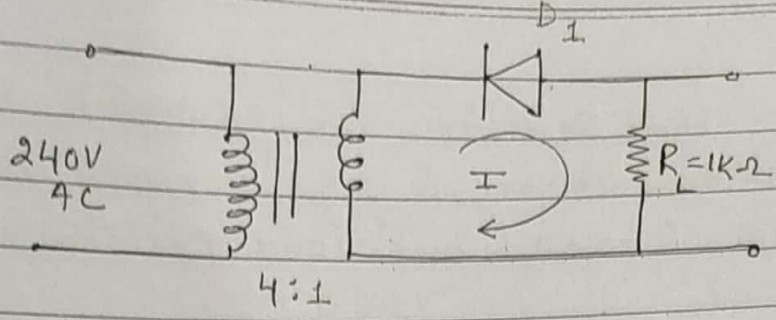
QNO5



Find ① V_o
② I_D

Sol^n:- The given ckt can be Re-drawn As :-

QNO6



Find the Value of Average Load voltage (V_{Ldc}) and sketch o/p waveform.

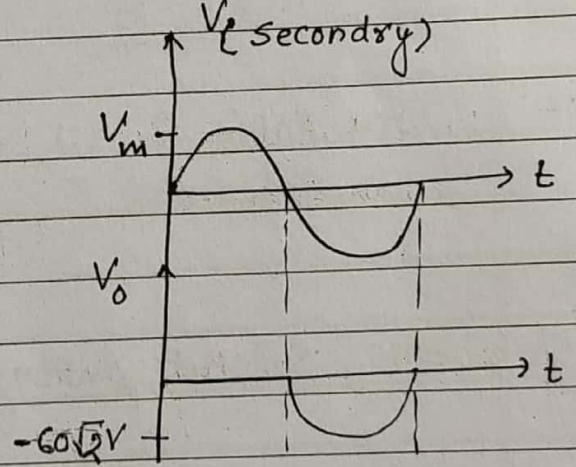
Sol^n:- We know $\boxed{\frac{V_1}{V_2} = \frac{N_1}{N_2}}$ ⇒ Where V_1 → Input AC rms value of voltage

V_2 → rms Value of Secondry voltage

⇒ $\frac{V_1}{V_2} = \frac{4}{1}$ ⇒ $\frac{240}{V_2} = \frac{4}{1}$ ⇒ $\boxed{V_2 = 60V}$ ↓ rms value

⇒ $V_{2(max)} = \sqrt{2} \times V_{2(rms)}$

$\boxed{V_{2(max)} = 60\sqrt{2}}$



⇒ $\therefore V_{Ldc} = -\frac{V_m}{\pi}$

$= -\frac{60\sqrt{2}}{\pi}$

$\boxed{V_{Ldc} = -27V}$ Ans

Q.NO7

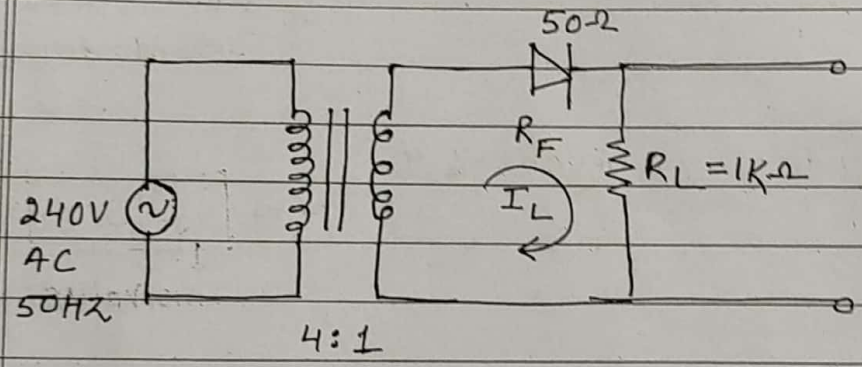
For Half Wave Rectifier, the Resistance of transformer secondry is 5Ω, Forward resistance of diode $R_F = 50\Omega$ and Load Resistance is 1KΩ.

Calculate – ① Average load Current and load Voltage

② RMS load Current and load Voltage

③ DC Load Power and AC Input power

④ Rectification Efficiency



Sol^n:- Turn Ratio is 4:1, therefore it is a stepdown transformer.

Given $R_S = 5\Omega$

∴ rms Secondry Voltage $V_{S(rms)} = \frac{N_2}{N_1} \times V_{1(rms)}$

$= \frac{1}{4} \times 240$

$= 60V$

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$\Rightarrow \quad \therefore \quad V_{S(max)} = \sqrt{2}\, V_{S(rms)}$

$= 60\sqrt{2}$

$= 84.8\ V$

$\Rightarrow$ Peak load current $= \dfrac{V_m}{R_F + R_S + R_L} = \dfrac{84.8}{5\Omega + 50\Omega + 1000\Omega}$

$$\boxed{I_m = 80.4\,mA}$$

① $\therefore \quad I_{Ldc} = \dfrac{I_m}{\pi} = \dfrac{80.4}{\pi} = 25.6\,mA$

② $V_{Ldc} = I_{Ldc} \times R_L = 25.6 \times 1K\Omega = 25.6\,V$

③ $I_{L(rms)} = \dfrac{I_m}{2} = \dfrac{80.4}{2} = 40.2\,mA$

④ $V_{L(rms)} = I_{L(rms)} \times R_L = 40.2 \times 1K\Omega = 40.2\,V$

⑤ DC Load Power :- $P_{Ldc} = V_{Ldc} \times I_{Ldc} = 25.6 \times 25.6$

$$\boxed{P_{Ldc} = 655.36\,mWatt}$$

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(6) AC Input Power :-

$$P_{ac} = I_{s(rms)}^2 \times (R_S + R_F + R_L)$$

$$= (40.2 \times 10^{-3})^2 \times (5 + 50 + 1000)$$

$$\boxed{P_{ac} = 1.7 \text{ Watt}}$$

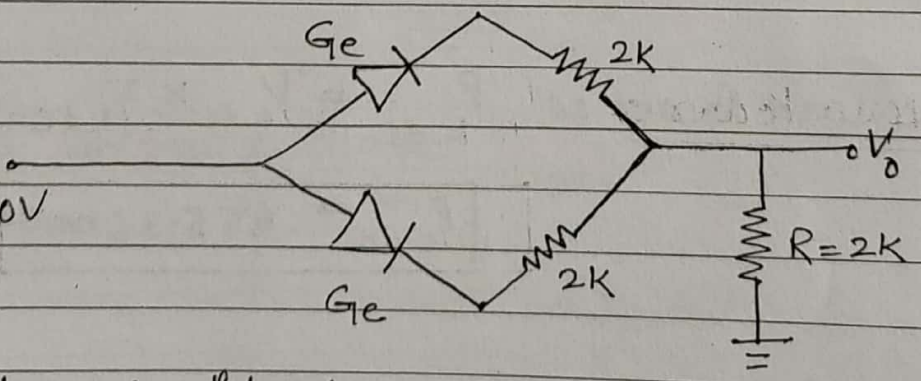
(7) Rectification Efficiency :-

$$\eta = \frac{P_{L\,dc}}{P_{L\,ac}} \times 100 = \frac{655.36 \times 10^{-3}}{1.7} \times 100$$

$$\boxed{\eta = 38.5\,\%}$$ Ans

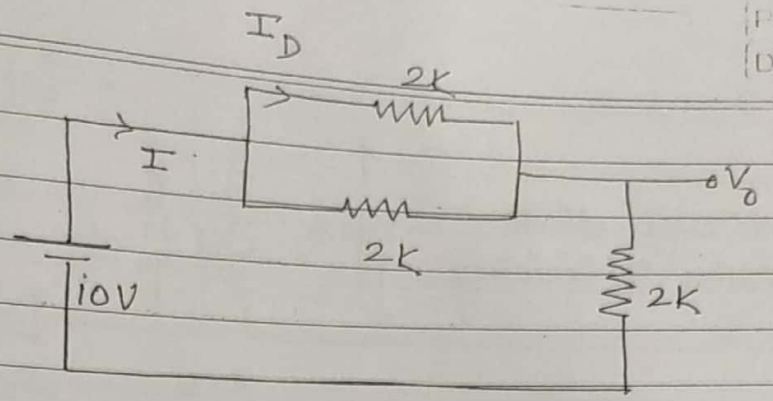
MP

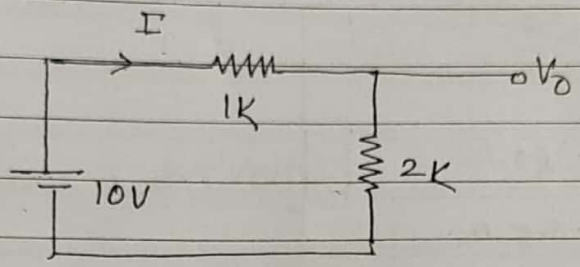
QNO8 Determine V_o and I_D for given CKt.



⇒ Diodes are ideal

Sol:-





$$I = \frac{V}{R_{eq.}} = \frac{10}{3K}$$

$$\boxed{I = 3.3\ mA}$$

$$\Rightarrow \quad \therefore \quad I_D = \frac{I}{2} = \frac{3.3}{2} = 1.66\ mA$$

$$\Rightarrow \quad V_o = 2K \times I = 2K \times 3.3$$

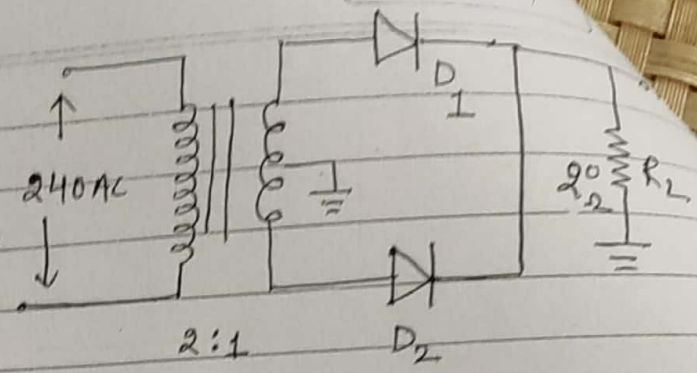
$$\boxed{V_o = 6.6V}$$

Ans

QNO9 A Full Wave Rectifier with a Centre tapped transformer supplies a dc current of 100 mA to a load resistance of $R = 20\Omega$. The secondry resistance of transformer is 1Ω. Each diode has a Forward resistance of 0.5Ω. Determine—

(1) rms Value of Signal Voltage across each half of Secondry
(2) DC Power supplied to load
(3) AC Power Input to rectifier

4. PIV of each diode
5. Conversion Efficiency.



20th :- Given $\frac{N_1}{N_2} = \frac{2}{1}$

$R_L = 20\,\Omega$

$R_F = 0.5\,\Omega$

$R_S = 1\,\Omega$

& $I_{Ldc} = 100\,mA$

⇒ We know $I_{Ldc} = \frac{2I_m}{\pi}$

$I_m = \frac{\pi \times I_{Ldc}}{2} = \frac{\pi \times 100\,mA}{2}$

$\boxed{I_m = 157\,mA}$

⇒ We know $I_m = \frac{V_m}{R_S + R_F + R_L}$

$\therefore V_m = I_m \cdot (R_S + R_F + R_L) = 157 \cdot (0.5 + 1 + 20)$

$V_m = I_m (R_S + R_F + R_L)$

$V_m = 157 \times (0.5+1+20)$

$$\boxed{V_m = 3.3755\ V}$$

$\Rightarrow \quad \therefore V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{3.3755}{\sqrt{2}}$

(1) $$\boxed{V_{rms} = 2.4\ \text{Volts}}$$

(2) DC Power :- $P_{dc} = I_{Ldc}^2 \times R_L$

$= (100 \times 10^{-3})^2 \times 20\,\Omega$

$$\boxed{P_{dc} = 0.2\ \text{Watts}}$$

(3) AC I/P Power :- $P_{ac} = \frac{V_{rms}^2}{R_S + R_F + R_L}$

$= \left(\frac{V_m}{\sqrt{2}}\right)^2 \times \frac{1}{(R_S+R_F+R_L)}$

$= \left(\frac{3.3755}{\sqrt{2}}\right)^2 \times \frac{1}{(20+1+5)}$

$$\boxed{P_{ac} = 0.2649\ \text{Watt}}$$

(4) PIV of each diode $= 2V_m = 2 \times 3.3755$

$= 6.75\,V$

(5) Conversion Efficiency :-

$$\eta = \frac{P_{Ldc}}{P_{Lac}} \times 100 = \frac{0.2}{0.2649} \times 100$$

$$\boxed{\eta = 75.58\ \%}$$

Ans