EEE205

HW - 1+2

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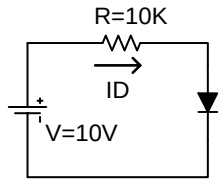
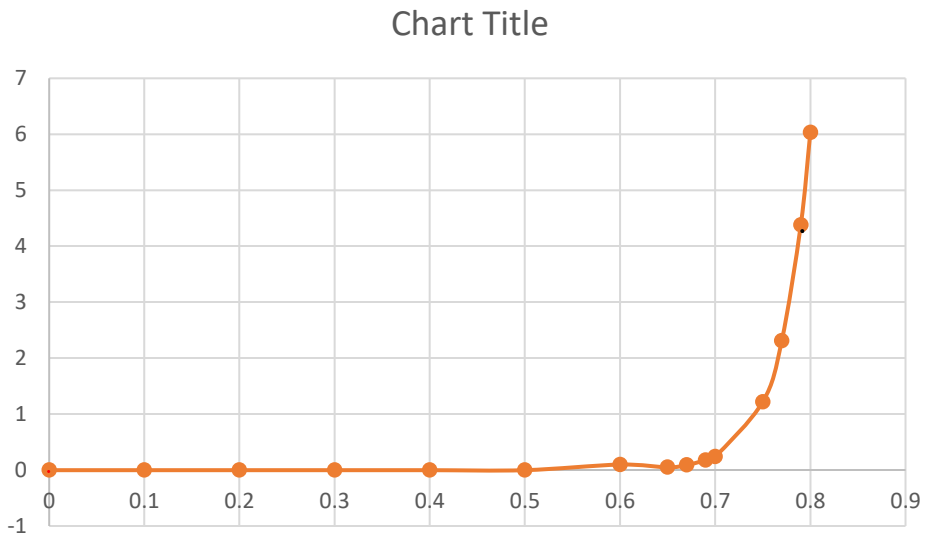
Section: 04

For the PN junction diode in the circuit, following table gives the value of voltages (V) across a PN junction diode and the corresponding current (mA) through it.

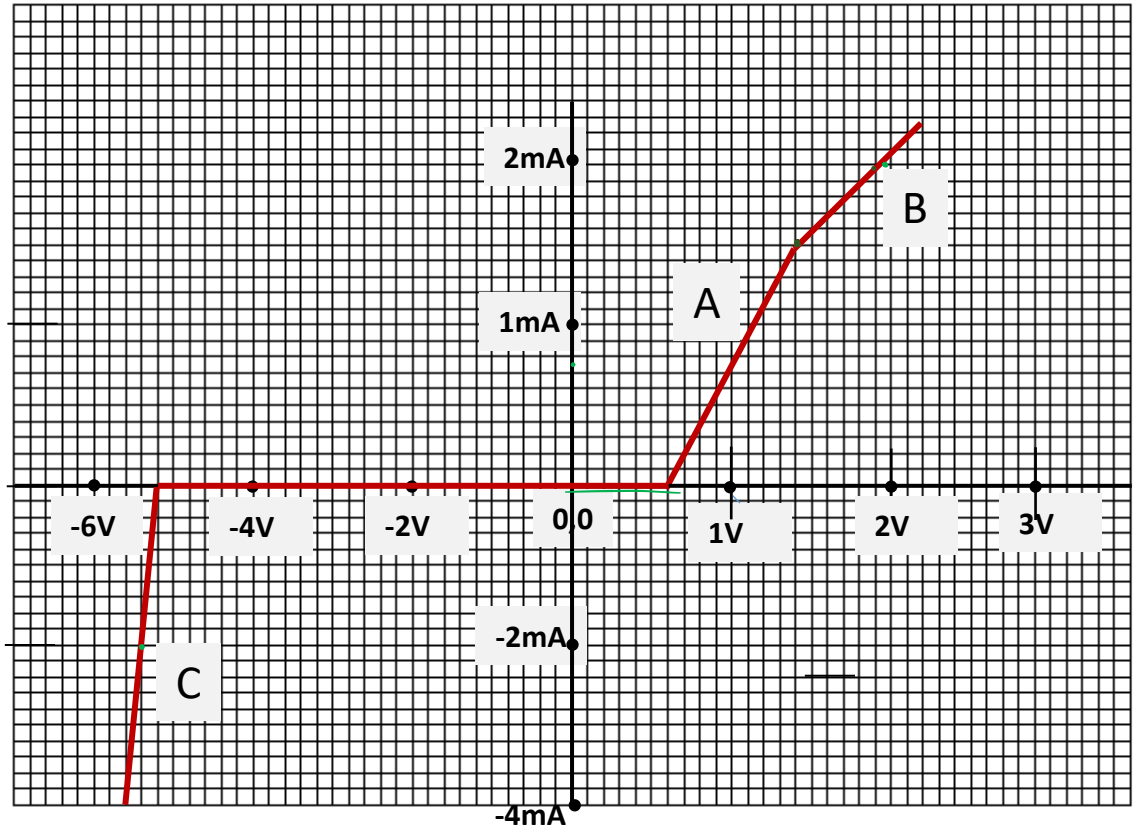
1. Draw the IV characteristics curve on graph paper.
2. Draw the piecewise linear IV characteristics curve on the same paper.
3. Determine V_{D0} and r_D from the curve.
4. Find Diode current ID flowing through the circuit.

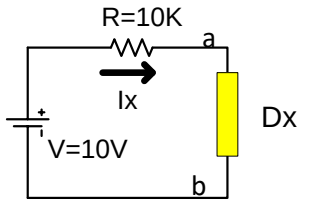
VD(V)	ID(mA)
0	0
0.1	0
0.2	0
0.3	0
0.4	0
0.5	0
0.6	0.1
0.65	0.05
0.67	0.09
0.69	0.18
0.7	0.24
0.75	1.22
0.77	2.31
0.79	4.38
0.8	6.03

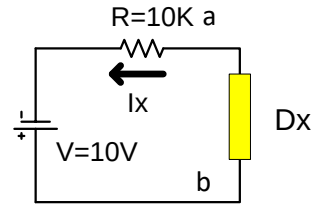




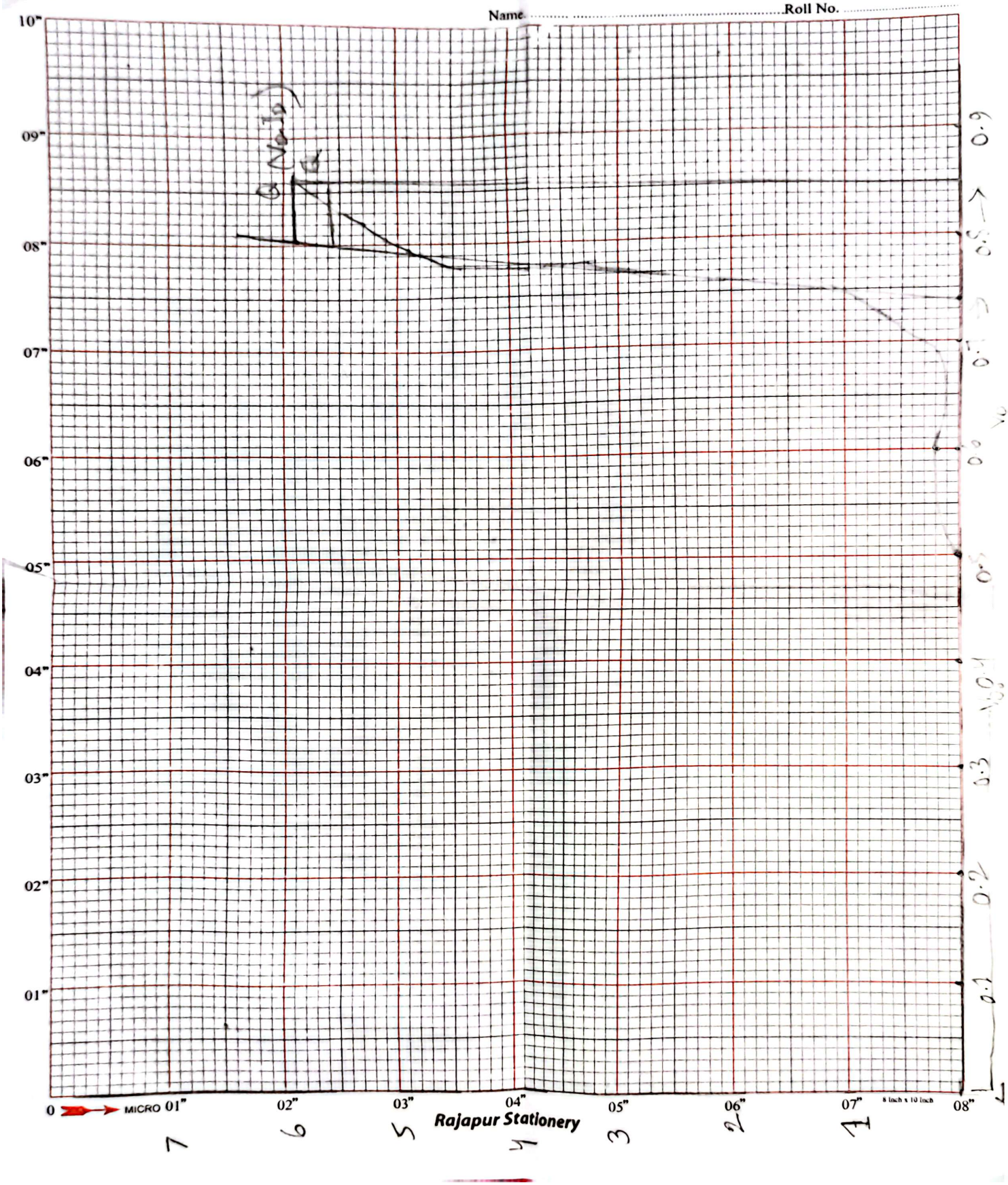
Find a circuit model for each line segment of the hypothetical Device X as shown in Fig.
Draw the circuit models identifying terminals *a* and *b* for each equivalent circuit.
Find the currents for each segment of the IV characteristics.







Name ..... Roll No. .....


10"
09"
08"
07"
06"
05"
04"
03"
02"
01"
0
MICRO 01"
02"
03"
04"
05"
06"
07"
08"
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Rajapur Stationery
8 Inch x 10 Inch

3] from the curve, using piecewise,

$V_{D_0} = 0.75\,V$.

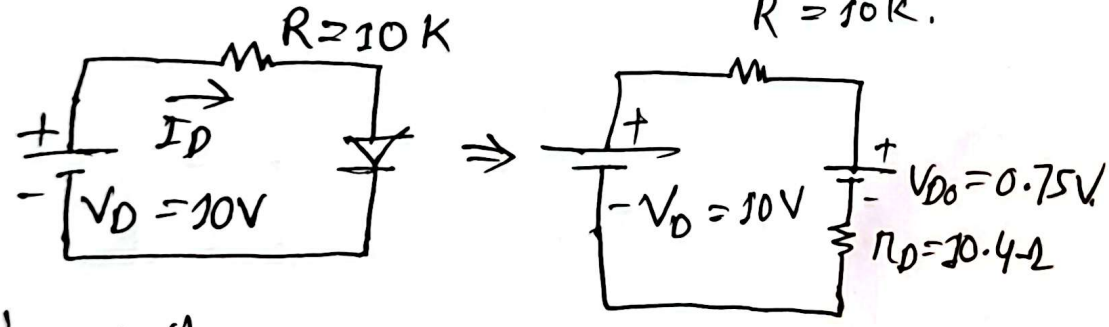
$$m = \frac{1}{r_D} \Rightarrow r_D = \frac{1}{m} = \frac{\Delta x}{\Delta y}$$

$$= \frac{0.8 - 0.75}{0.00603 - 0.00122}$$

$$= 10.4\,\Omega$$

$\therefore r_D = 10.4\,\Omega$ A

4]



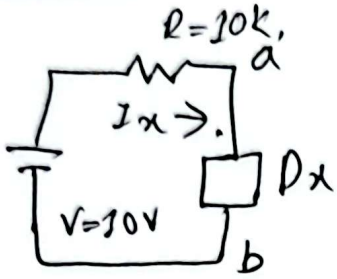
Applying KVL.

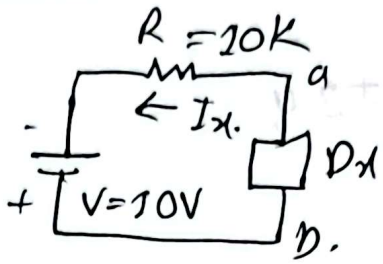
$$V_D - I_D R - V_{D_0} - I_D r_D = 0$$

$$\Rightarrow 10 - I_D R - 0.75 - I_D R r_D = 0$$

$$\Rightarrow I_D = \frac{9.25}{(10000 + 10.4)}$$

$$= 9.24 \times 10^{-6}\,A.$$



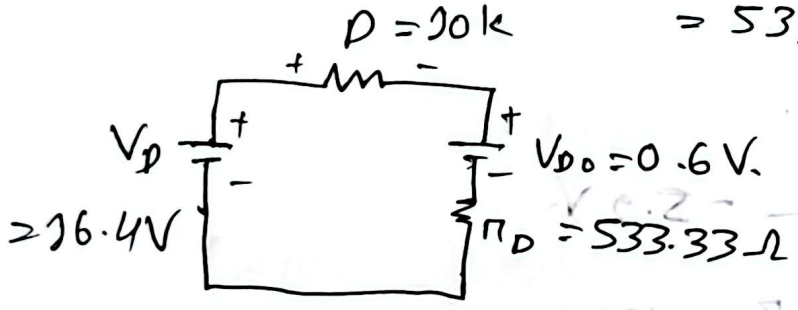


For segment A,

$V_{D0} = 0.6\,V$

$I_D = 1.5\,mA$

$$r_D = \frac{1}{m} \Rightarrow \frac{\Delta x}{\Delta y} = \frac{1.4 - 0.6}{1.5 \times 10^{-3}} = 533.33\,\Omega$$



$$V_D - I_D R - V_{D0} - I_D r_D = 0$$

$$\Rightarrow V_D = I_D R + V_{D0} + I_D r_D$$

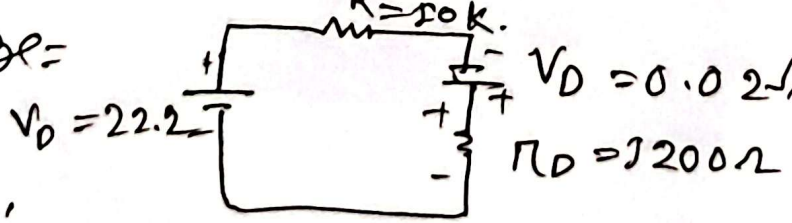
$$= (1.5 \times 10^{-3} \times 10000 + 0.6 + 533.33 \times 1.5 \times 10^{-3})$$

$$= 16.4\,V.$$

For segment B,

$V_{D0} = -0.1\,V, \quad I_D = 2\,mA.$

$$r_D = \frac{1}{m} = \frac{\Delta x}{\Delta y} = \frac{2 - 1.4}{0.002 - 0.0015} = 1200\,\Omega.$$



KVL:

$$V_D - I_D R + V_{D0} - I_D r_D = 0$$

$\Rightarrow V_D = 20 - 0.2 + 2.4$

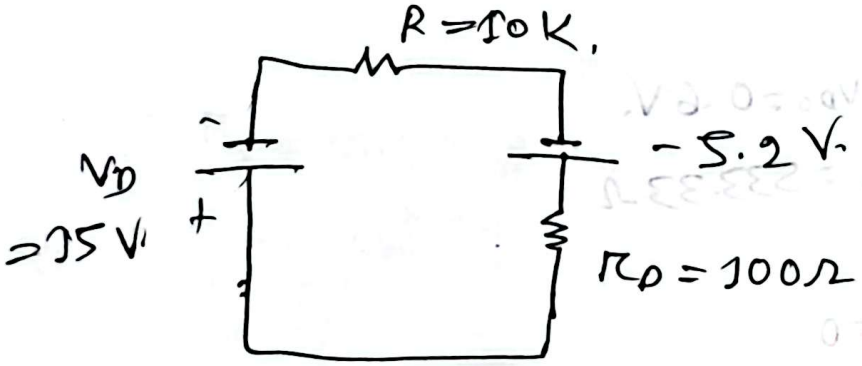
$V_D = 22.2\,V.$

Segment C,

$V_{D0} = -5.2\,V$, $I_D = -2\,mA$.

$$r_D = \frac{1}{m} = \frac{dx}{dy} = \frac{-5.4+5.2}{-2\times10^{-3}} = 100\,\Omega$$

$r_D = 100\,\Omega$



Applying KVL,

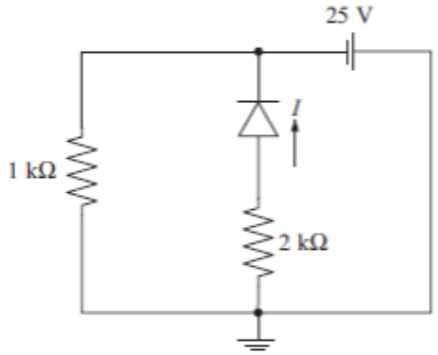
$$V_D + I_D r_D - V_{D0} - I_D R = 0$$

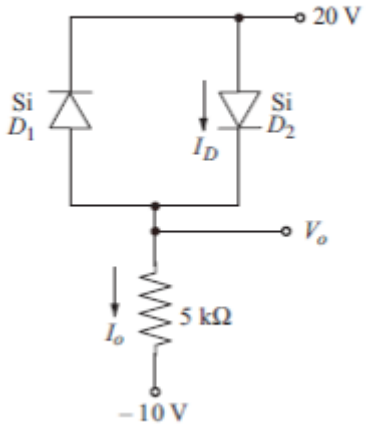
$$\Rightarrow V_D = V_{D0} - I_D(R + r_D)$$

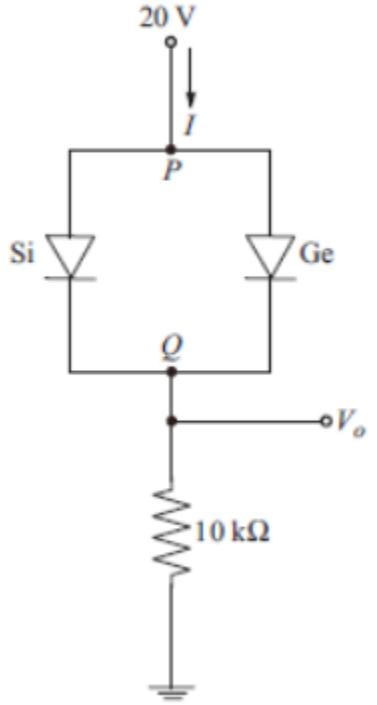
$$= -5.2\times10^{-3} + 2\times10^{-3}(10100)$$

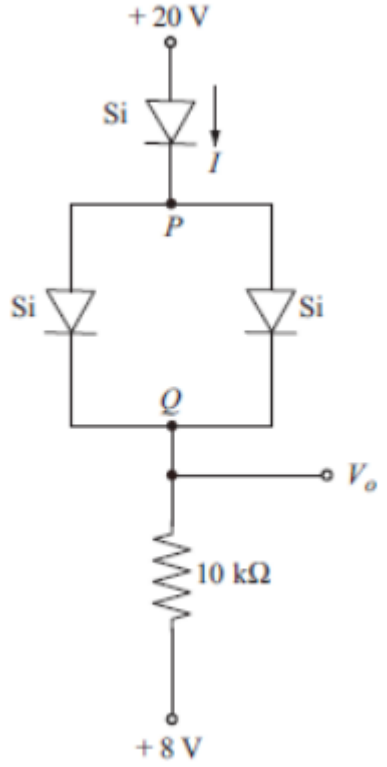
$$= 15\,V$$

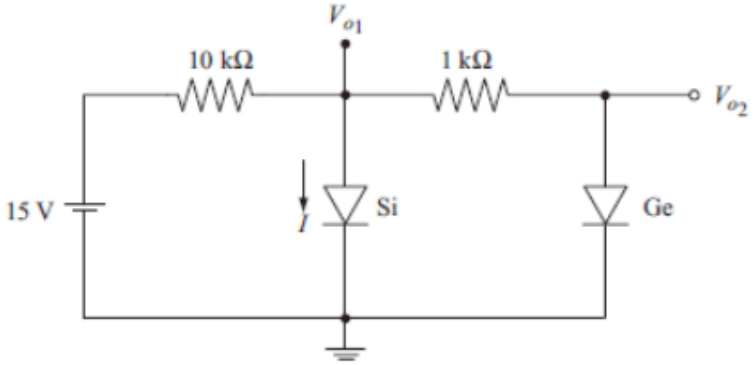
Determine the labelled currents and voltages in the circuits given below.

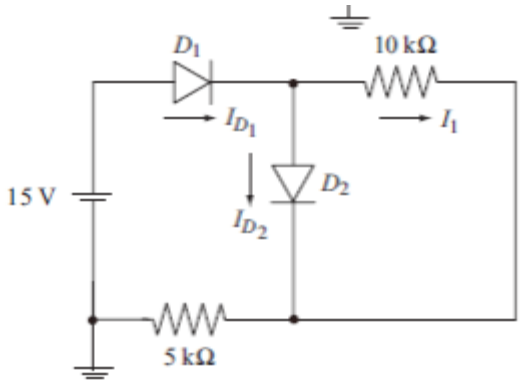


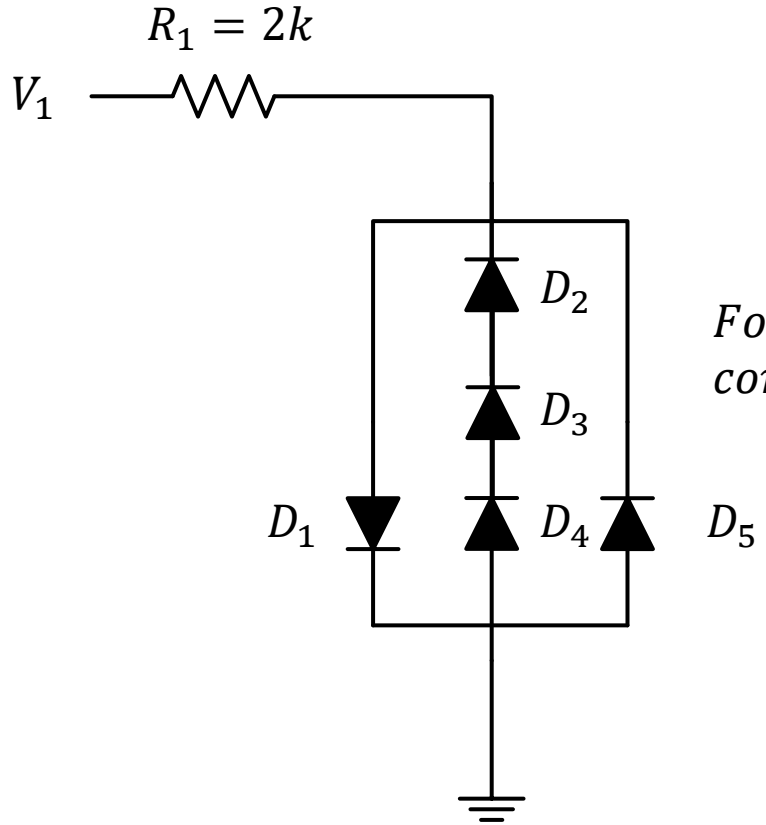




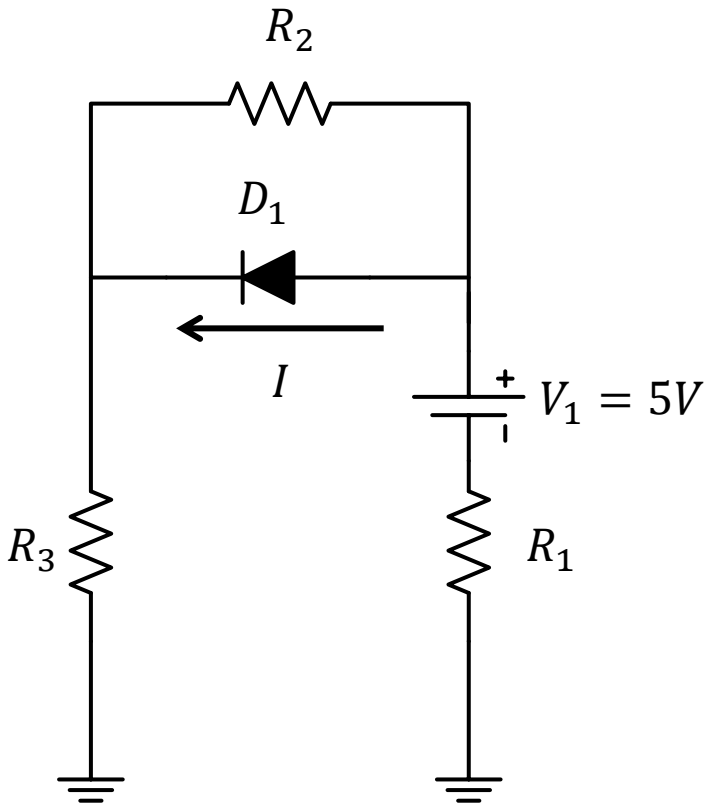








For V_1: $-2V, -3V, 0.7V, 2V$,
consider all the diodes are Si diode



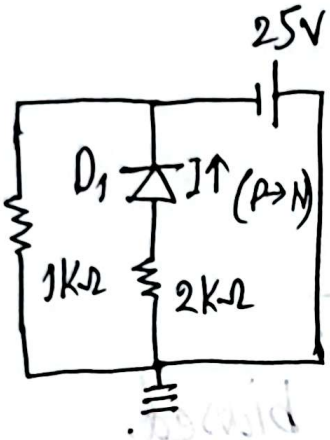
1. Determine the conduction state using a. on assumption, b. off assumption.
2. Determine I. consider Si diode.

$R_1 = 2k, R_2 = 0.5k, R_3 = 5k$

HW2

Answer to the Q. No-1

1]

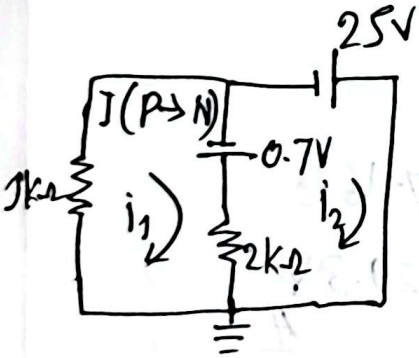


Here,

Diodes appear to be forward biased D_1

Let,

D_1 diode is on



for mesh-1,

$$i_1 \cdot -0.7 + 2(i_1 - i_2) = 0$$

$$\Rightarrow 3i_1 - 2i_2 = 0.7 \quad \ldots (i)$$

for mesh-2,

$$2(i_2 - i_1) + 0.7 - 25 = 0$$

$$\Rightarrow -2i_1 + 2i_2 = 24.3 \quad \ldots (ii)$$

from (i), (ii),

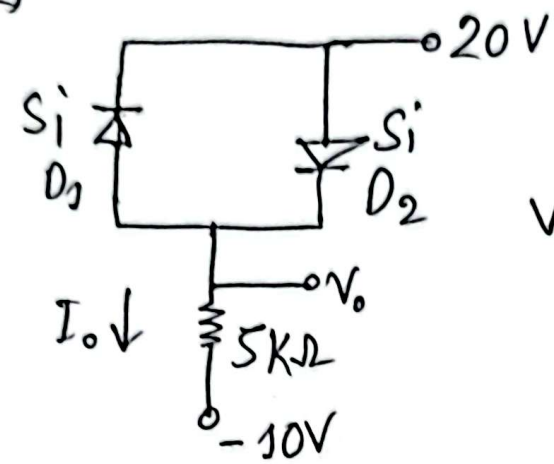
$i_1 = 25\,mA$, $i_2 = 37.15\,mA$

$I = (i_2 - i_1) = (37.15 - 25) = 12.15\,mA.$

D_1 is forward biased and it must be ON.

Ans

2)



For, D_1,

$V_D = V_P - V_N$

$= -10 - 20$

$= -30 < 0.7$

$\therefore D_1$ is reverse biased.

For, D_2,

$V_D = V_P - V_N$

$= 20 + 10$

$= 30\ V > 0.7V$

D_2 is forward Biased.

$\therefore V_D = V_{D0} + I_D R$

$\Rightarrow 30 = 0.7 + 5000 I_D$

$\therefore I_D = 0.00586\ A$ Ans

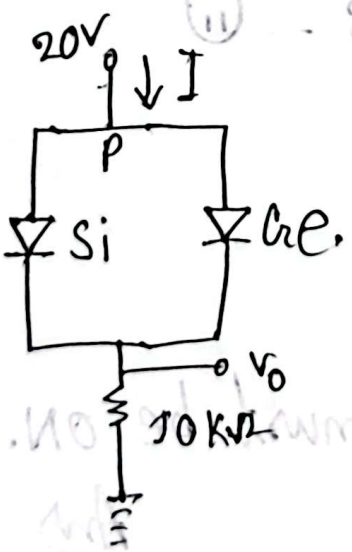
ABCD.

$-30 + 0.7 + V_0 = 0$

$V_0 = 29.3V$

A

3)



For Si,

$V_D = V_P - V_N$

$= 20 - 0$

$= 20V > 0.7.$

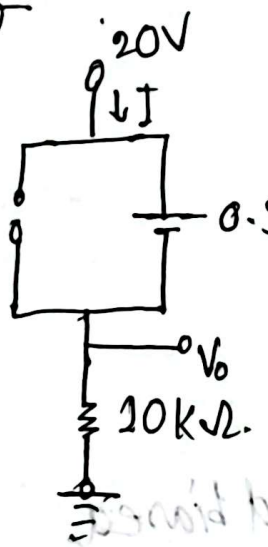
It is forward Biased and it will be ON.

For Ge,

$V_D = V_P - V_N = 20 - 0 = 20V > 0.3V.$

It is a forward Biased and it will be ON.

when we see multiple diodes are ON, the minimum voltages diodes remain ON and others will be off



$V_D = V_{D_o} + IR$

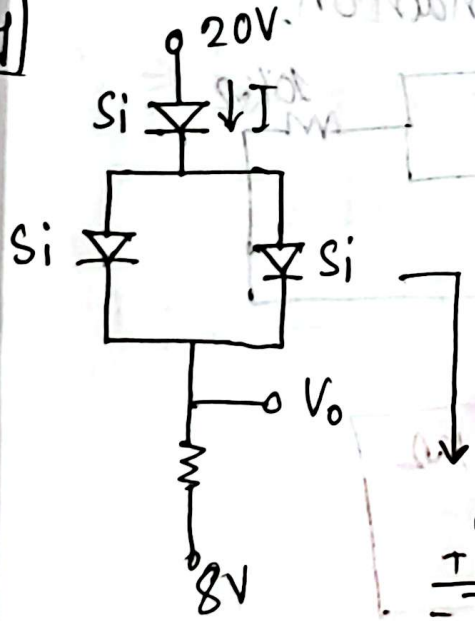
$\Rightarrow 20 = 0.3 + I \cdot 10000$

$I = 0.00197\,A$ Ans

$V_o = 10 \times 1.97$

$= 19.7V$ Ans

4]

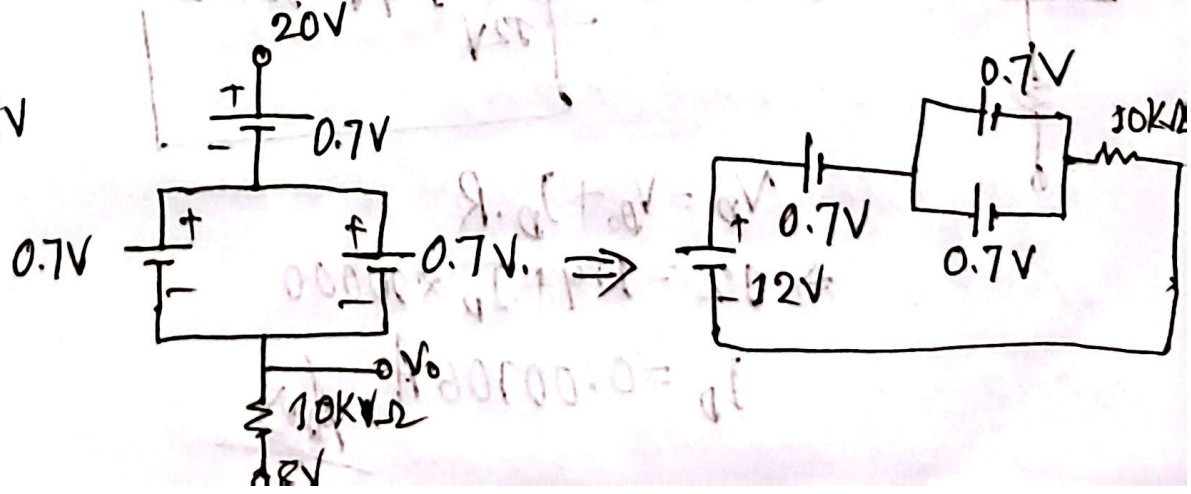


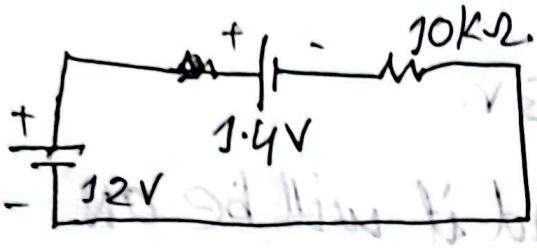
$V_D = V_P - V_N$

$= 20 - 8$

$= 12V > 0.7V.$

It is a forward biased. will remain ON.





$V_D = V_{D0} + I_D R$

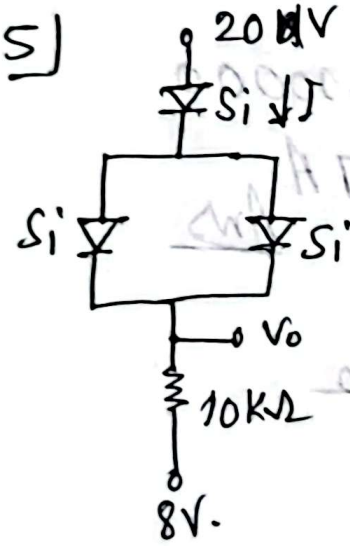
$\Rightarrow 12 = 1.4 + I_D \times 10000$

$I_D = 0.00706\ A$ Ans

$V_0 = 1.06 \times 10$

$= 10.6V.$

5]

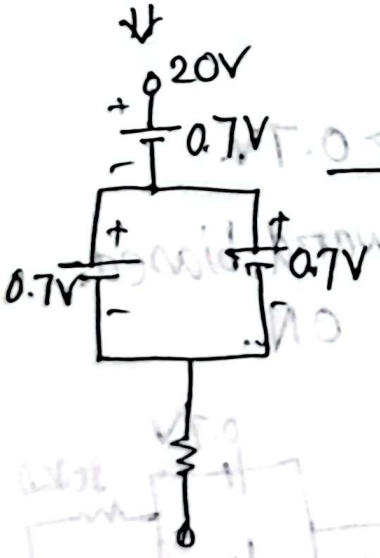


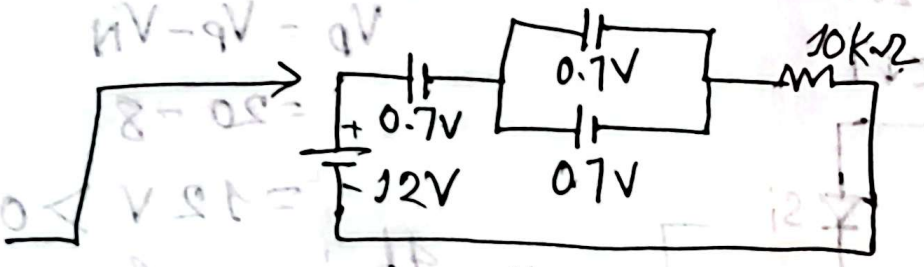
$V_D = V_P - V_N$

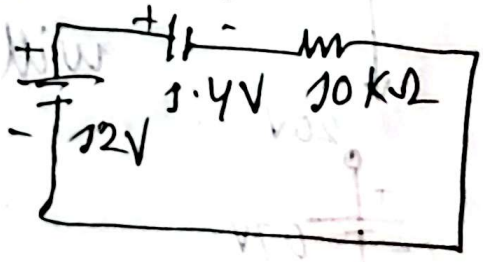
$= 20 - 8$

$= 12 > 0.7V.$

It is a forward biased, and it will remain on.





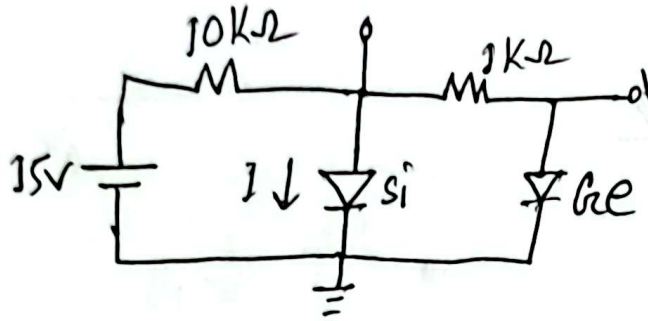


$V_D = V_{D0} + I_D \cdot R$

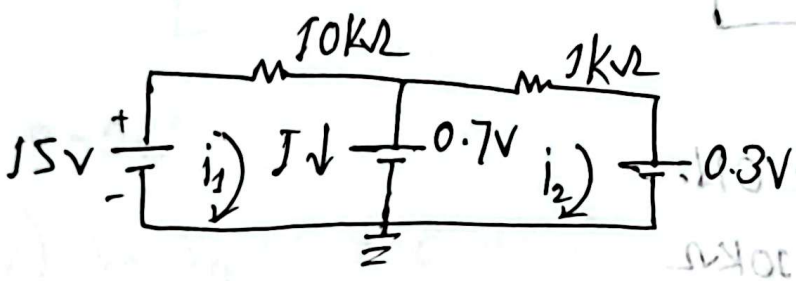
$\Rightarrow 12 = 1.4 + I_D \times 10000$

$I_D = 0.00706\ A$ Ans

5]



Let, All the diodes are on.



for mesh-1,

$$-15 + 10i_1 + 0.7 = 0$$

$$\Rightarrow i_1 = \frac{15 - 0.7}{10} = 1.43\,mA.$$

for mesh-2,

$$-0.7 + i_2 + 0.3 = 0$$

$$\Rightarrow i_2 = 0.4\,mA.$$

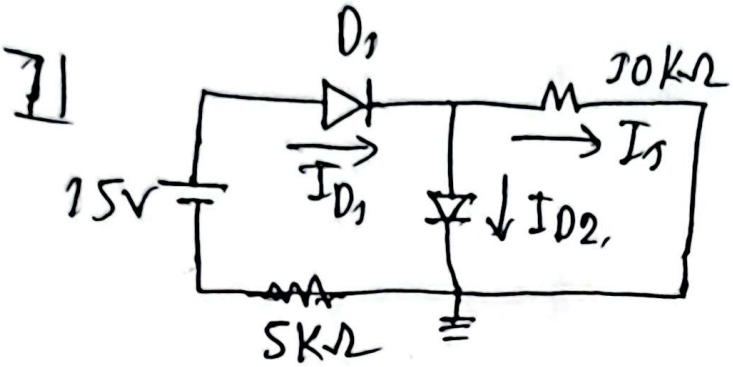
$$\therefore I = i_1 = 1.43\,mA.$$

I : P $\longrightarrow$ N : ON

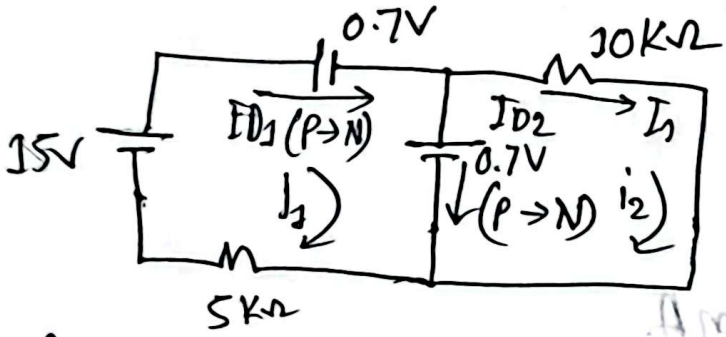
Ans

Refer to the eq. Note

7]



let, all diodes are ON.



for mesh-1,

$$5i_1 - 15 + 0.7 + 0.7 = 0$$

$$\Rightarrow i_1 = 2.72\,mA.$$

for mesh-2,

$$10\,i_2 - 0.7 = 0$$

$$\Rightarrow i_2 = 0.07\,mA.$$

$$I_{D1} = i_1 = 2.72\,mA.$$

$\therefore D_1 : I_{D1} = 2.72\,mA\ (P \to N)$

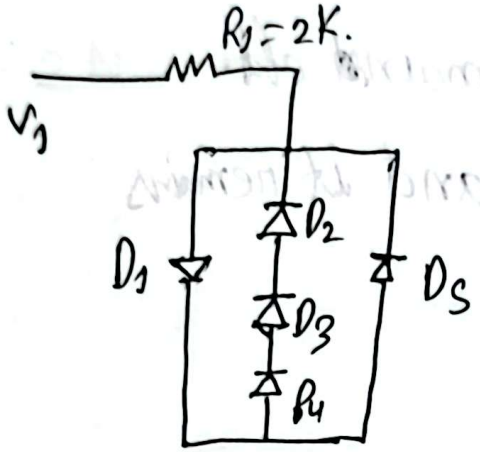
D_1 is forward biased. so it remained ON.

$$I_{D2} = (i_1 - i_2) = 2.65\,mA.$$

$D_2 :- I_{D2} = 2.65\,mA\ (P \to N)$

$\therefore I_5 = i_2 = 0.07\,mA$ D_2 also remained ON.

8)



for $V_1 = -2V$,

(D_1) $V_P - V_N = -2 - 0 = -2 < 0.7\,V$

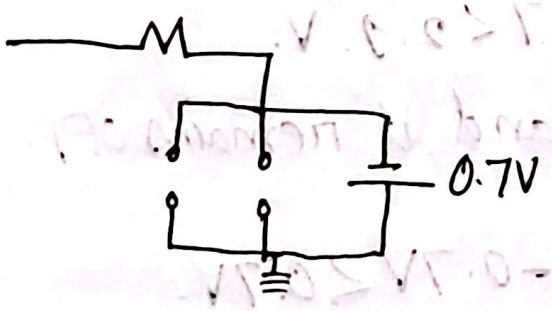
It is reversed biased and it remains off.

(D_2, D_3, D_4) $V_P - V_N = 0 + 2 = 2 < 2.1\,V$

It is reversed biased and it remains off.

(D_5) $V_P - V_N = 0 + 2 = 2 > 0.7\,V$

It is forward biased and it remains ON.



for $V_1 = -3V$,

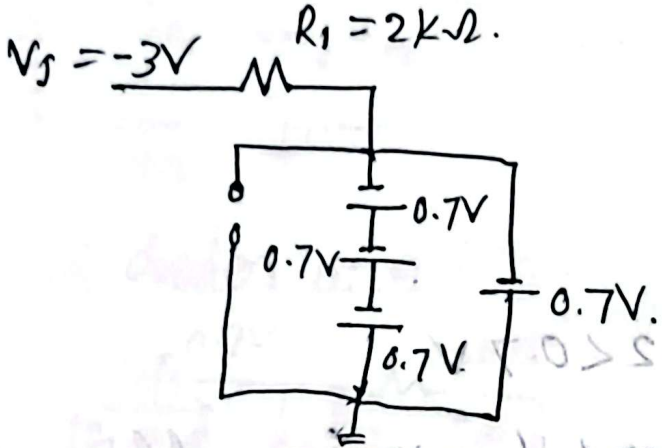
(D_1) $V_P - V_N = -3 - 0 = -3 < 0.7V$

(D_2, D_3, D_4) $V_P - V_N = 0 + 3 = 3 > 2.7V$

(D_5) $V_P - V_N = 0 + 3 = 3V > 0.7V$.

D_1 is reversed biased and it remains off

D_2, D_3, D_4, D_5 is forward biased and it remains ON.



for, $V = 0.7V$.

(D_1) $V_P - V_N = 0.7 - 0 = 0.7V$.

It is transition state.

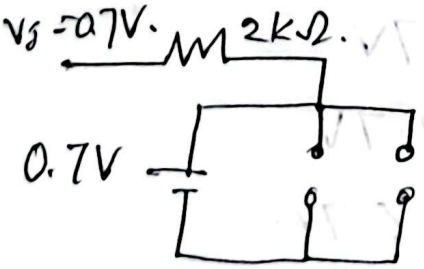
(D_2, D_3, D_4) $V_P - V_N = 0 - 0.7$

$= -0.7 < 2.1.V.$

It is reverse biased and it remains OFF

(D_5) $V_P - V_N = 0 - 0.7 = -0.7V < 0.7V.$

It is a reverse biased and it remains off.



for,
$V_1 = 2N$

$(D_1) \rightarrow V_P - V_N = 2 - 0 = 2\,V > 0.7\,V$

It is a forward biased. So it remained ON.

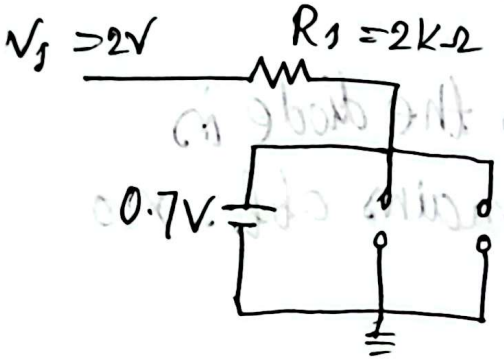
$(D_2, D_3, D_4) \rightarrow V_P - V_N = 0 - 2 = -2V < 2.7V$

It is a reversed biased. So it remain OFF

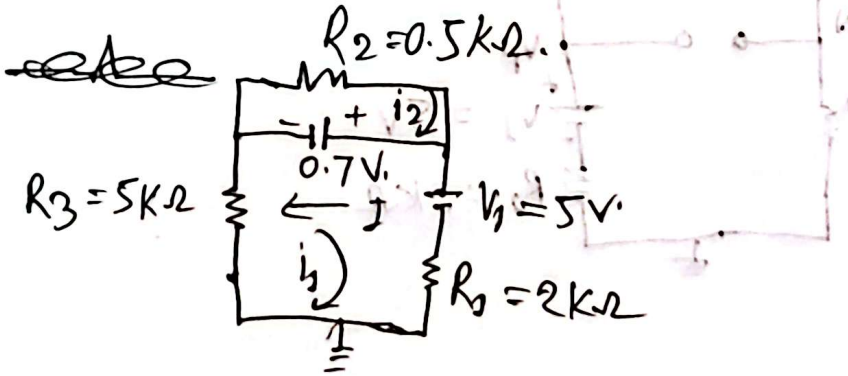
$(D_5) \rightarrow V_P - V_N = 0 - 2$

$= -2\,V < 0.7\,V$

It is a reversed biased and it remains off.



8] 1] a] let, all the diodes are ON.



for mesh-1,

$5i_1 - 0.7 + 5 + 2i_1 = 0$

$\Rightarrow 7i_1 = -4.3$

$i_1 = -0.614\,mA$

for mesh-2,

$0.7 + 0.5i_2 = 0$

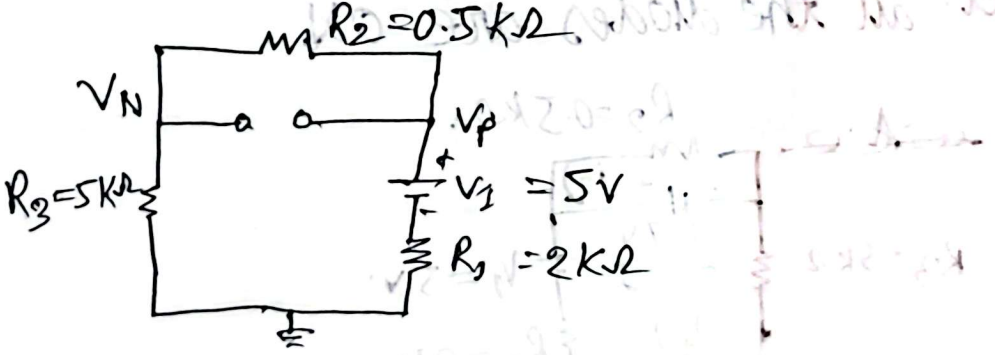
$\Rightarrow i_2 = -1.4\,mA$

$I = (i_2 - i_1) = (-1.4 + 0.614) = -0.786\,mA.$

D_1 ; $I = -0.786\,mA$ (N→P)

∴ Assumption is wrong as the diode is reversed biased. So it remains off. no current will be flow.

b] Assume that, all the diodes are off



$$V_P - V_N = V_{R_2} = I R_2 = \frac{5}{5+2+0.5} \times 0.5$$

$$V_P - V_N = 0.33V < 0.7V$$

It is a reverse biased. so it remained off no current will flow,

2] $I = 0\ A$ Ans