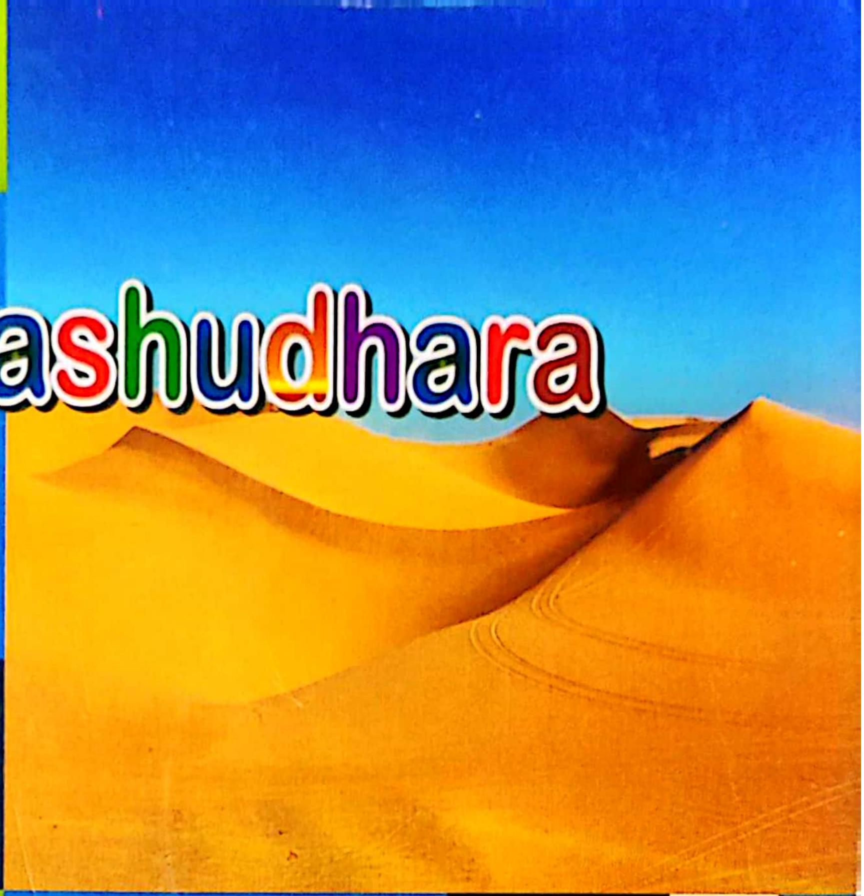


Bashudhara

Name : Sadman

Institute : 01121592

Subjects : Electronic

Roll No : Section : C

W
28.5.23

Electronics

types of material based on conductivity :→

(I) Conductor (metal)

(II) Insulator (Air / Glass / wood, ruber, plastic)

(III) Semiconductor

Differences between electrical circuit & Electronic Circuit.

⇒ Electronic & Electronic Circuit has decision making capability.

Electrical circuit has no decision making capability.

1st chapter

Assignment-1 (submission next week sunday)

(Fall-22 - spring 23)

* mid final ques print আসবে হবে।

Characteristic of Semiconductor :-

(i) Semiconductors can be elemental or compound

(ii) Elemental semiconductors have four valance electrons & they form co-valent bond.

(iii) Si & Ge etc are elemental semiconductors.

(iv) Compound semiconductors are GaAs, GaP, GaN etc.

Types of semiconductor :-

(i) Intrinsic (pure semiconductor)

(ii) Extrinsic (doped)

- → p-type
- → n-type

$V \propto I$

$V = IR$

$I = \frac{V}{R}$

C.W
31.5.23

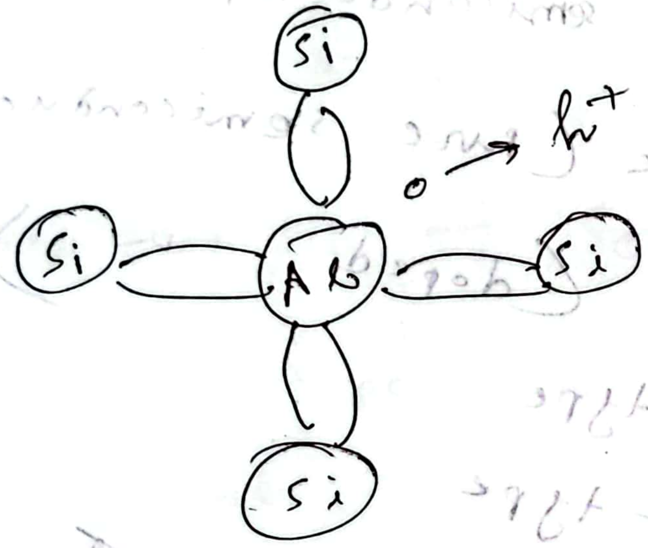
Electronics

p-type semiconductor :→ → (foreign particle)

$0 = -1.6\times10^{-19}\,C + 1.6\times10^{-19}\,C$ III → B, Al, Ga

$= e^- + h^+$

IV → (host)



$h^+ \gg e^-$

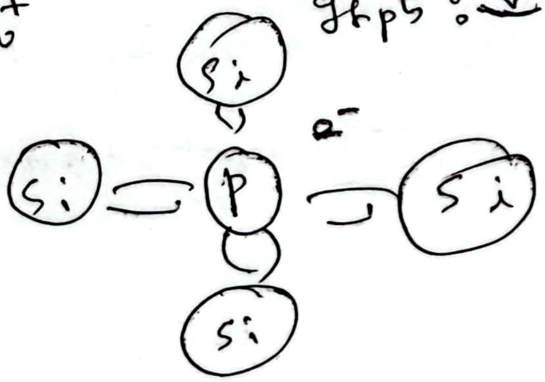
majority carrier → h^+

minority carrier → e^-

n-type :→

$e^- \gg h^+$

grp5 : V → N, P, As



majority : e^-

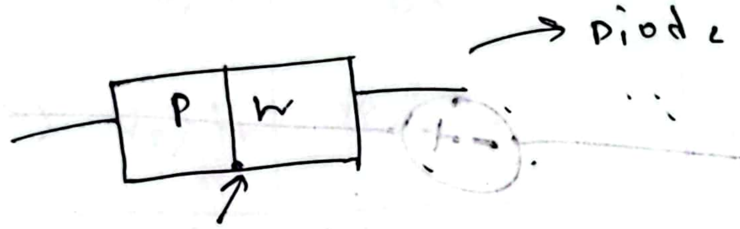
minority : h^+

P.T.O

Intrinsic semiconductor: $e^- = h^+$

so majority, minority carrier not available.

Diode :→ / p-n junction :→



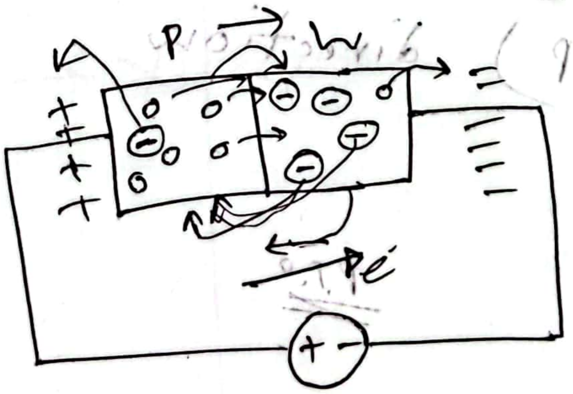
forward biasing :→

(i) V_S (+) ~ P (p)

(ii) majority :→ ✓ (moving)

$I_D \uparrow$ (p → n)

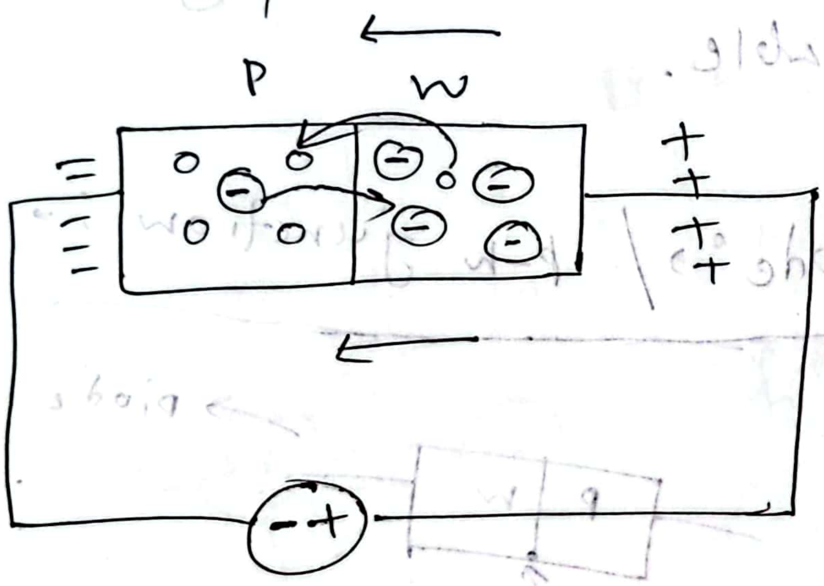
(iii) minority :→ X (not moving)



P.T.O

Reverse biasing :

(i) vs (+) → p (−) (n)



(ii) majority : ✗ (not moving)

(iii) minority : ✓ (moving)

$I_D \approx 0$ but $I_D \neq 0$

($n \rightarrow p$) direction

P.T.O

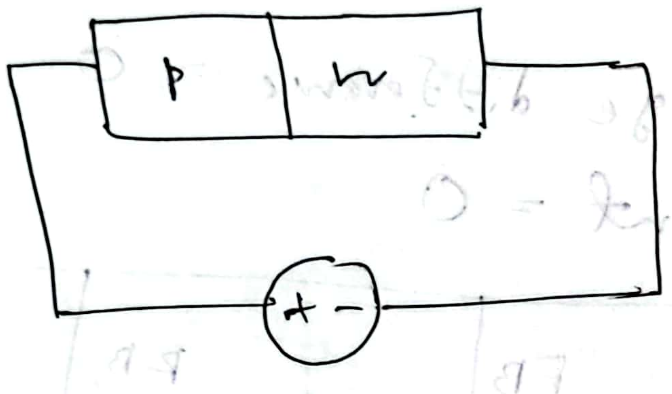
bias → force

No bias :→

→ voltage difference = 0

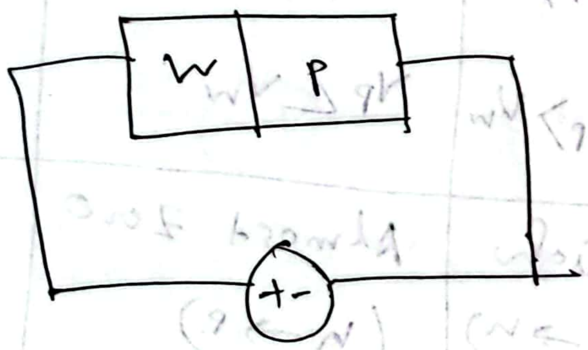
Current = 0

	FB	RB	NB
(i) V_D → $V_D = (V_P - V_N)$	$V_D > 0$ $V_P > V_N$	$V_D < 0$ $V_P < V_N$	$V_D = 0$ $V_P = V_N$
(ii) I_D →	high (p → n)	Almost zero (n → p)	$I_D = 0$
(iii) majority →	✓	✗	✗
(iv) minority →	✗	✓	✗



V_D

#

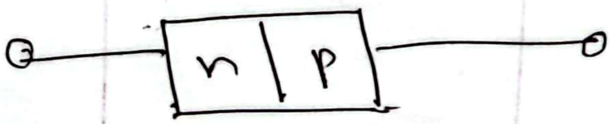


V_D

→ $V_D = 10V$ → Reverse bias

→ $V_D = -10V$ → forward "

#



(a) $+5V$ $\quad$ $+5V$ → No bias

(b) $+5V$ $\quad$ $-5V$ → reverse

(c) $-5V$ $\quad$ $+5V$ → forward

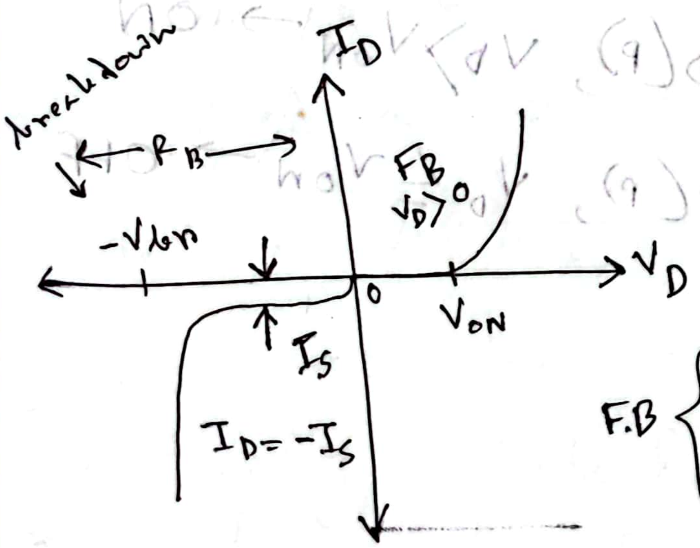
Class test : 1 (Sunday)

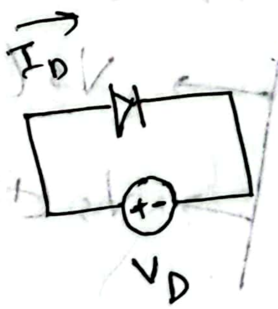
Assignment : 2 (Sunday)

C.W
4.6.23

Circuit symbol of Diode

I-V curve of diode :⇒





F.B $\begin{cases} \text{OFF} \rightarrow V_D \leq V_{ON} \ ; \ I_D = 0 \\ \text{ON} \rightarrow V_D > V_{ON} \ ; \ I_D \neq 0 \end{cases}$

V_{ON} = Turn on voltage

$V_T = \frac{KT}{Q}$

K = Boltzmann constant
$= 1.38 \times 10^{-23}$ J/kelvin

T = Temperature in kelvin
= Degree + 273

$I_D = I_S \, e^{\frac{V_D}{nV_T}}$; $V_D > V_{ON}$

I_S = Reverse Saturation Current

n = Ideality factor

V_T = Thermal voltage.

q = charge of an electron

$= 1.6 \times 10^{-19}$ C

Reverse bias:→

→ $V_s(+) \sim D(n)$, $|V_D| < |V_{br}|$

→ RB

→ $V_s(+) \sim D(n)$; $|V_D| \geq |V_{br}|$

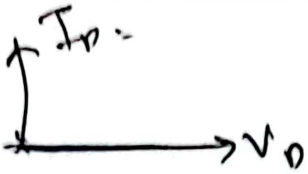
→ Breakdown

Forward bias:→

→ $V_s(+) \sim D(P)$, $V_D > V_{ON}$ → ON

→ $V_s(+) \sim D(P)$, $V_D \leq V_{ON}$ → OFF

C.W



Electronics

F.B

$I_D = 0 \; ; \; V_D \leq V_{ON}$

$I_D = I_s e^{\frac{V_D}{nV_T}} \quad V_D > V_{ON}$

R.B

$I_D = \infty \quad |V_D| \geq |V_{br}|$

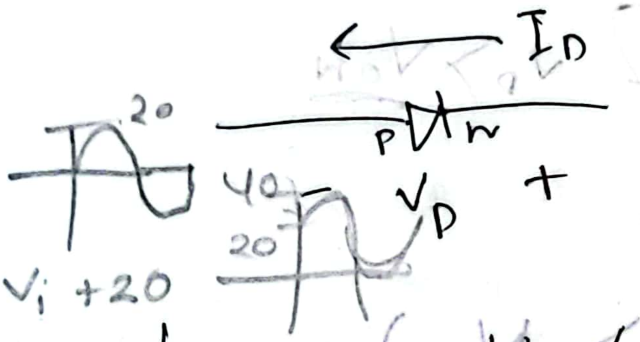
$I_D = -I_s \quad |V_D| < |V_{br}|$

A voltage ~~on~~ of ~~one point 2 volt~~ the following voltage is applied a accross a diode whose turn on voltage & break down voltage are 2 volt & 5 volt respectively. Calculate diode current if $n = 1$ and $I_s = 100$ nA.

(a) $V_D = 1$ volt (c) $V_D = -10$ volt

(b) $V_D = 10$ volt (d) $V_D = -1$ volt

Assume the temperature to be 27° Centigrade in all cases.

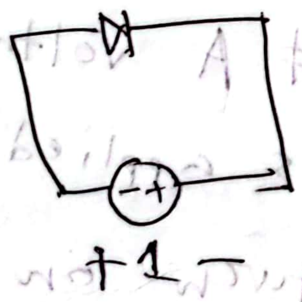


$V_o = V_i + 20$

$|V_D| < |V_{br}|$

(a) $V_D = 1$ volt (R.B)

$I_D = -I_S = I_S = 100$ nA



$y = 2 + 2$

(b) $V_D = 10$ (R.B)

$|V_D| > |V_{br}|$

$I_D = \infty$

(c) $V_D = -5$ V (f.B) $5 > 2$

$V_T = \frac{KT}{q}$

$I_D = -I_s e^{\frac{V_D}{nV_T}}$ $= \frac{1.38\times10^{-23}\times300}{1.6\times10^{-19}}$

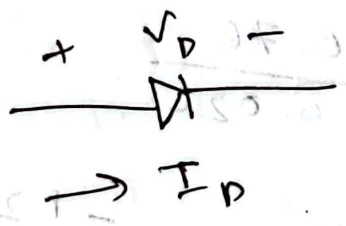
$= -I_s \cdot 6.93\times10^{83}$

$= -6.93\times10^{85}$ nA $= 0.0259V$

(a) $V_D = -1\ V$ (RB) $1 < 2$

$I_D = 0$

The current $I_D = 5\ mA$. flows through the following diode for $V_D = 0.76\ V$ at $30°$ centegrade.



Assuming the ideality factor, n to be unity and the V_{ON} to be $0.75\ V$ at $30°$ centigrade. Calculate the reverse saturation current.

P.T.O

$V_D > V_{ON}$

$$\Rightarrow I_D = I_S \, e^{\frac{V_D}{nV_T}}$$

$$V_T = \frac{1.38\times10^{-23} \times 303}{1.6\times10^{-19}}$$

$= 0.026$

$$\Rightarrow I_S = \frac{I_D}{e^{\frac{V_D}{nV_T}}}$$

$$= \frac{5}{e^{\frac{0.76}{0.026}}}$$

$$= 1.009\times10^{-12} \text{ mA}$$

effect of temperature on Turn ON voltage.

T ↑ Von ↓

T ↓ Von ↑

$2.5\,mV \,|\, 1^\circ C$

The turn on voltage of GaAs diode is 1.2 volt at room temperature. Calculate the new value of V_{ON} if the temperature is increased by 10° centegrade.

$\Rightarrow V_{ON} = 1.21 - 2.5 \times 10 \times 10^{-3}$

$= 1.175\ V$

Effect of temperature on I_s.

$T \uparrow \quad I_s \uparrow$

$T \downarrow \quad I_s \downarrow$

P.T.O

I_s = 1 nA in 10° centegrade calculate I_s at 70° centegrade.

10° C ⟶ 1 nA

20° C ⟶ 2 nA

30° C ⟶ 4 nA

40° C ⟶ 8 nA

50° C ⟶ 16 nA

60° C ⟶ 32 nA

70° C ⟶ 64 nA

~~The~~ calculate the diode current I_D at 343 k for the same value of V_D.

30° C ⟶ 0.76 v (V_D)

V_{ON} ⟶ 0.75 v, I_D = 2 mA

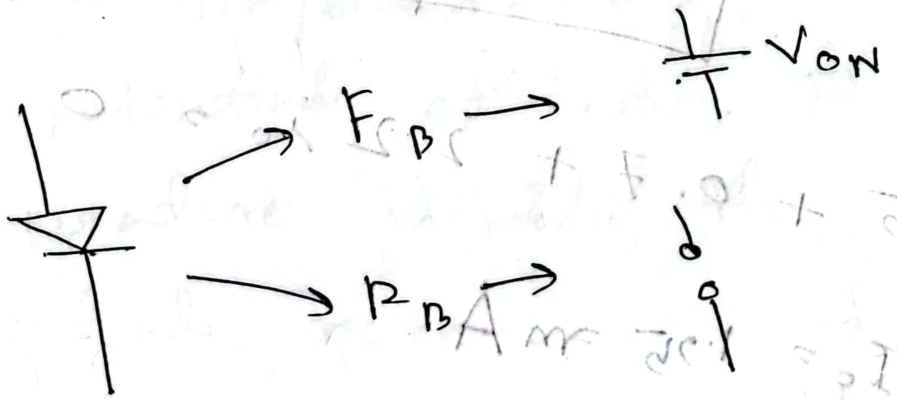
Assignment-2 ques 1 solve (fall 22 - spring 23)

CT:2 (Today class)

Sunday 11.6.23

Chapter-2

equivalent ckt of diode :-



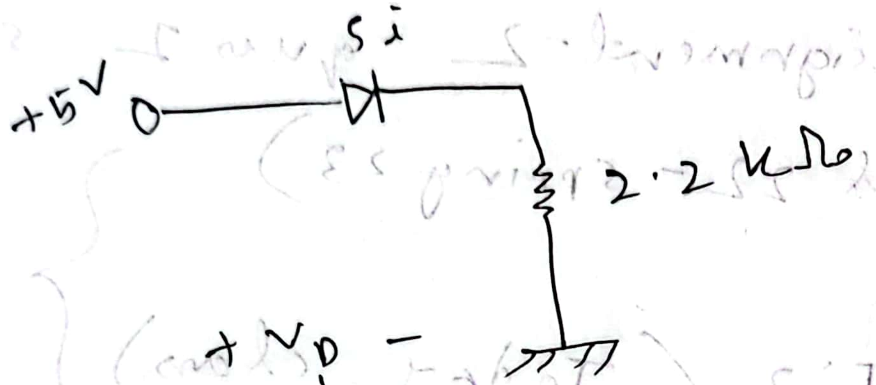
Von

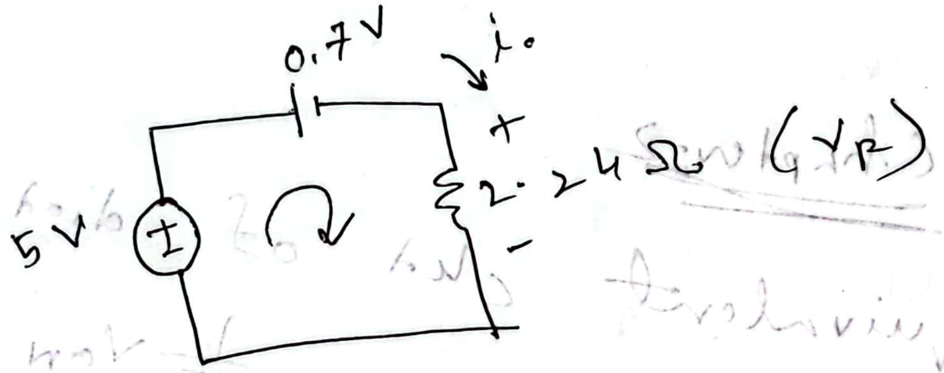
Ge → 0.3 V

Si → 0.7 V

GaAs → 1.2 V

#





$-5 + 0.7 + 2.2\, i_o = 0$

$\Rightarrow I_o = 1.95$ mA

$V_R = (2.2 \times 1.95)$ V

$V_D = 0.7$ V

7.6.23

Mid - Spring - 22

Electronics

(a)

2 nA → 10 °C

4 nA → 20 °C

8 nA → 30 °C

16 nA → 40 °C

32 nA → 50 °C

(b) Yes, temperature affect the turn on potential of diodes. If the temperature increases, the turn on potential decreases and if the temperature decreases, the turn on potential increases.

T ↑ V_{ON} ↓

T ↓ V_{ON} ↑

(c)

(i) $I_D = I_S e^{\frac{V_D}{nV_T}}$

$V_T = \frac{1.38 \times 10^{-23} \times 308}{1.6 \times 10^{-19}}$

$= 0.0266\ V$

$\Rightarrow e^{\frac{V_D}{nV_T}} = \frac{I_D}{I_S}$

$= \frac{5 \times 10^{-3}}{6 \times 10^{-9}}$

$\Rightarrow e^{\frac{V_D}{nV_T}} = 8.33 \times 10^5$

$\Rightarrow \frac{V_D}{0.0266} = \ln(8.33 \times 10^5)$

$\Rightarrow V_D = 13.633 \times 0.0266$

$= 0.36\ V$

(ii) $\frac{V_D}{0.0266} = \ln(0)$

$\Rightarrow V_D = \alpha$

(iii) $\frac{V_D}{0.0266} = \ln(-1)$

$\Rightarrow V_D = \alpha$

$\downarrow$ hole $\uparrow T$

$\uparrow$ hole $\downarrow T$

Spring 2023

(a) $V_D > V_{ON}$ $\longleftarrow$ $V_D = 0.76\ V$

$$I_D = I_s e^{\frac{V_D}{nV_T}} \longleftarrow I_D = 5\,mA$$

$n = 1$

$$\Rightarrow I_s = \frac{5\,mA}{e^{\frac{0.76}{0.026}}}$$

$$V_T = \frac{1.38\times10^{-23}\times 303}{1.6\times10^{-19}}$$

$= 0.026V$

$= 1.0097\times10^{-12}\ mA$

(b)

$303 \longrightarrow 1.0097\times10^{-12}\ mA$

$313 \longrightarrow 2.02\times10^{-12}\ mA$

$323 \longrightarrow 4.04\times10^{-12}\ mA$

$333 \rightarrow 8.08\times10^{-12}\ mA$

$343 \rightarrow 1.616\times10^{-11}\ mA$

$$\therefore I_D = 1.616\times10^{-11}\times e^{\frac{0.76}{0.0296}}$$

$= 2.287\ mA$

Ans

$$V_T = \frac{1.38\times10^{-23}\times 343}{1.6\times10^{-19}}$$

$= 0.0296\ V$

(c) $30^{\circ}C \longrightarrow 1.0097 \times 10^{-12}$ mA

$20^{\circ}C \longrightarrow 5.05 \times 10^{-13}$ mA

$10^{\circ}C \longrightarrow 2.53 \times 10^{-13}$ mA

$$V_T = \frac{1.38 \times 10^{-23} \times 283}{1.6 \times 10^{-19}}$$

$= 0.024$ V

$\therefore I_D = 2.53 \times 10^{-13} \times e^{\frac{0.76}{0.024}}$ mA

$= 14.315$ mA Ans

~~Fall-2022~~ ~~1(a)~~

~~1(b)~~

$V_{ON} = 2V, \quad V_{br} = 5V$

I. $V_D = 1\ V$ (Reverse bias)

$|V_D| < |V_{br}|$ (breakdown)

$I_D = -I_S = I_S$

II. $V_D = -2V$ (forward bias)

$V_D < V_{ON}$ [OFF situation]

$I_D = 0$

III. $V_D = 10\ V$ (Reverse bias)

$|V_D| > |V_{br}|$, $I_D = \alpha$

IV. $V_D = -10\ V$ (forward bias)

$V_D > V_{ON}$ [ON situation]

$I_D = -I_S\, e^{\frac{V_D}{nV_T}}$

$\cancel{= -I_S\, e^{\frac{10}{0.043}}}$

$\cancel{V_T}$

$\cancel{1.38\times10^{-23}\times 313}$

$\cancel{1.6\times10^{-19}}$

$\cancel{0.043}$

Summer-2022

1/ (a)

Case: 1

$V_D = V_A - V_B = 10 - 5$

$= 5\ V$ (forward bias)

$V_D > V_{ON}$ (ON)

2/

$V_D = 5 - 10 = -5\ V$ (Reverse bias)

$|V_D| > |V_{br}|$

3/

$V_D = -5 - 2 = -7\ V$ (Reverse bias)

$|V_D| > |V_{br}|$

4/

$V_D = -3 - (-5) = 2\ V$ (forward bias)

$V_D < V_{ON}$ (OFF)

(b)

$V_D = 5\,V$

$I_s = 10\,nA$

$V_T = \dfrac{1.38\times10^{-23} \times 298}{1.6\times10^{-19}}$

$= 0.026\,V$

$I_D = I_s\, e^{\frac{V_D}{nV_T}}$

$= 10\, e^{\frac{5}{0.026}}$

$= 3.298\times10^{84}\,nA$

(c) If $T\uparrow$ ON $\downarrow$

$25^\circ \longrightarrow 10\,nA$

$35^\circ \longrightarrow 20$

$45^\circ \longrightarrow 40$

$55^\circ \longrightarrow 80$

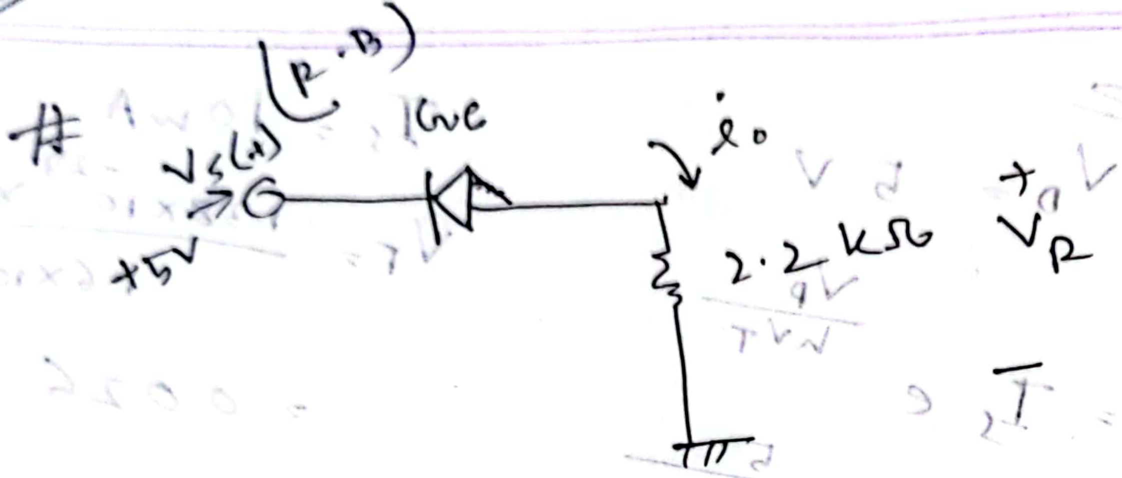
$65 \longrightarrow 160$

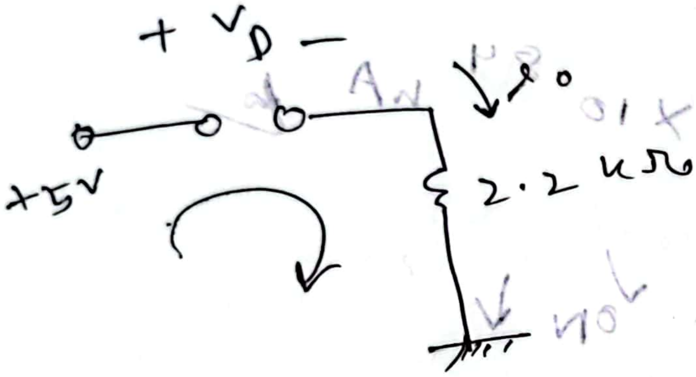
$75 \longrightarrow 320\,nA$ $\quad T\uparrow\; I_s\uparrow$

C.W
11.6.23

Electronics

#





$i_o = 0$

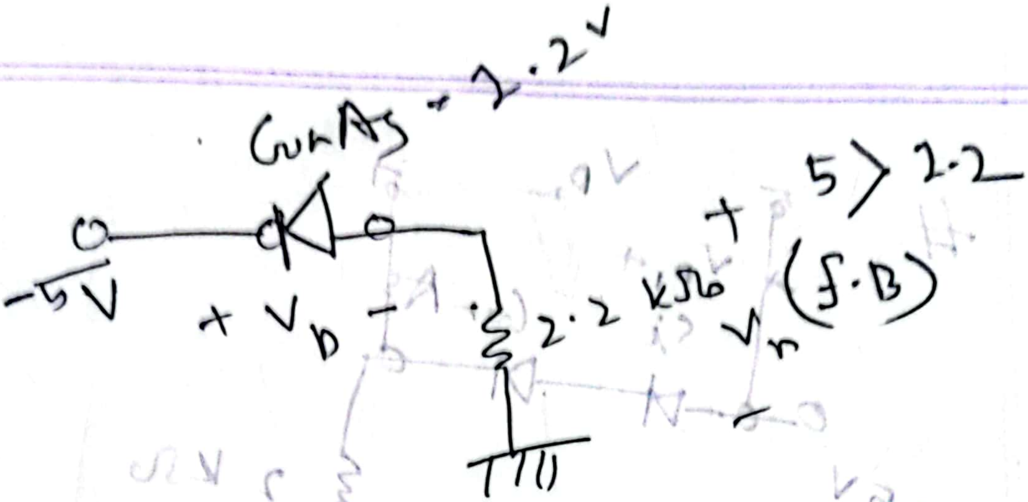
$V_R = 2.2 \times i_o = 0$

$-5 + V_D + 2.2 I_o = 0$

$\Rightarrow V_D = 5$

P.T.O.

#



$$+5 - 1.2 + 2.2\, i_0 = 0$$

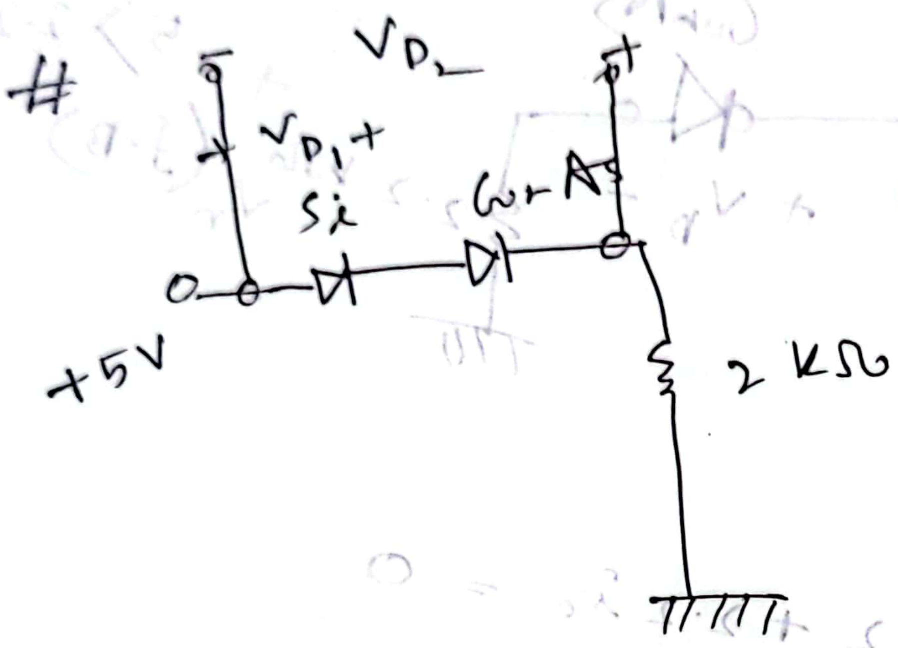
$$\Rightarrow i_0 = -1.72 \text{ mA}$$

$$V_R = 2.2 \times (-1.72) = -3.8 \text{ V}$$

$$V_D = -1.2 \text{ V}$$

P.T.O

#



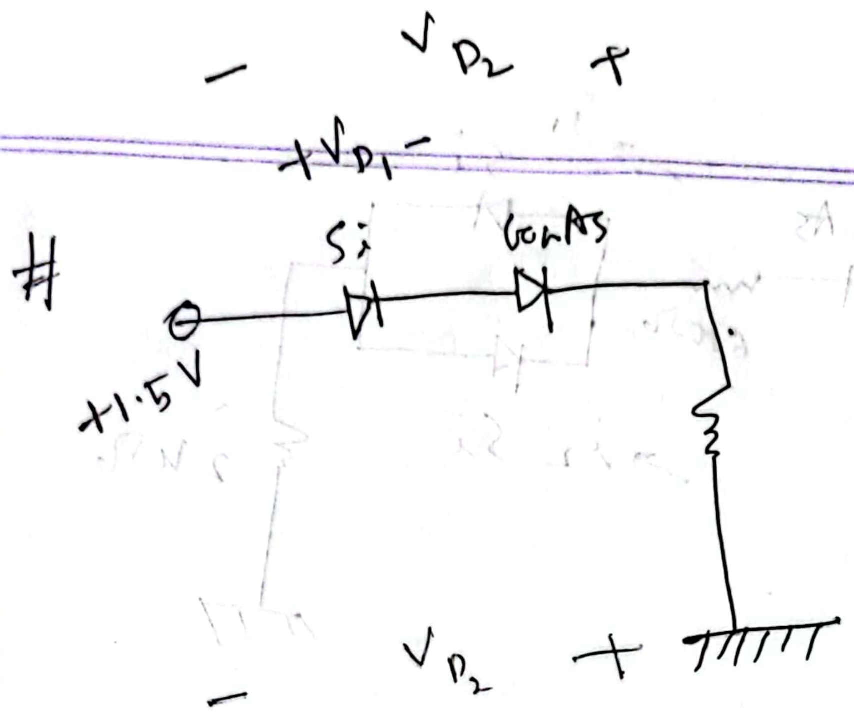
$$-5 + 0.7 + 1.2 + 2 i_0 = 0$$

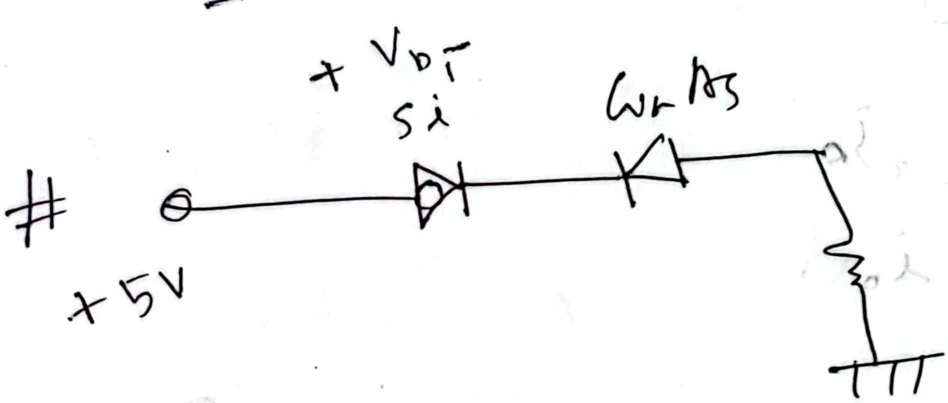
$$V_{D_1} = 0.7 \text{ V}$$

<u>for V_{D_2}</u>

$$-V_{D_2} - 0.7 - 1.2 = 0$$

$$\Rightarrow V_{D_2} = -1.9 \text{ V}$$



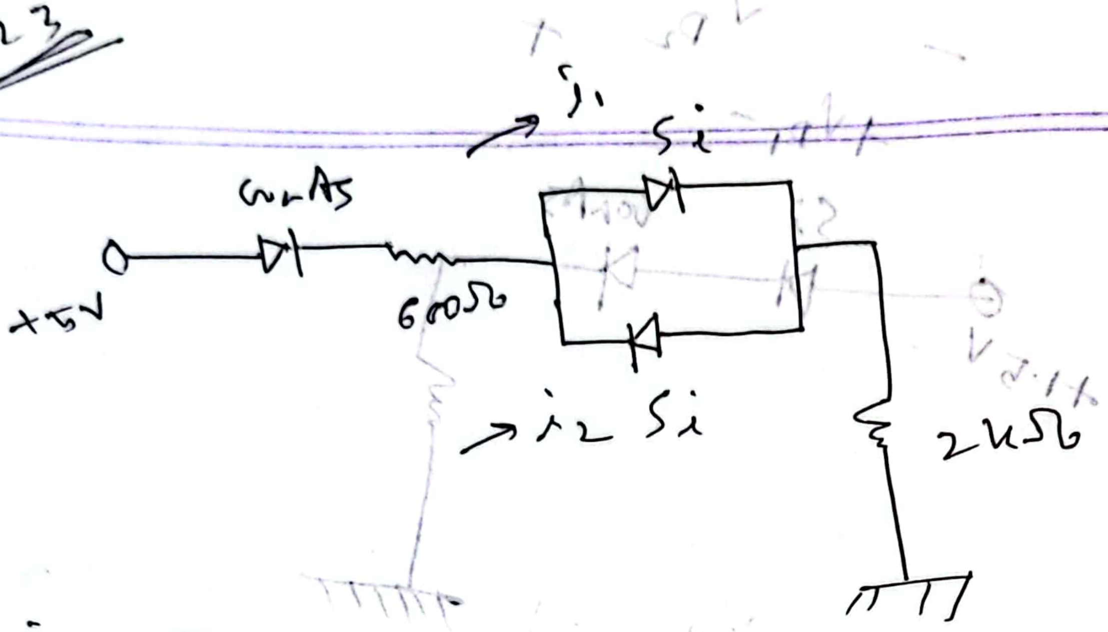


$i_0 = 0$

$$-5 - V_{D_2} + 2I_0 = 0$$

$$\Rightarrow V_{D_2} = 5V$$

CW 14.6.23



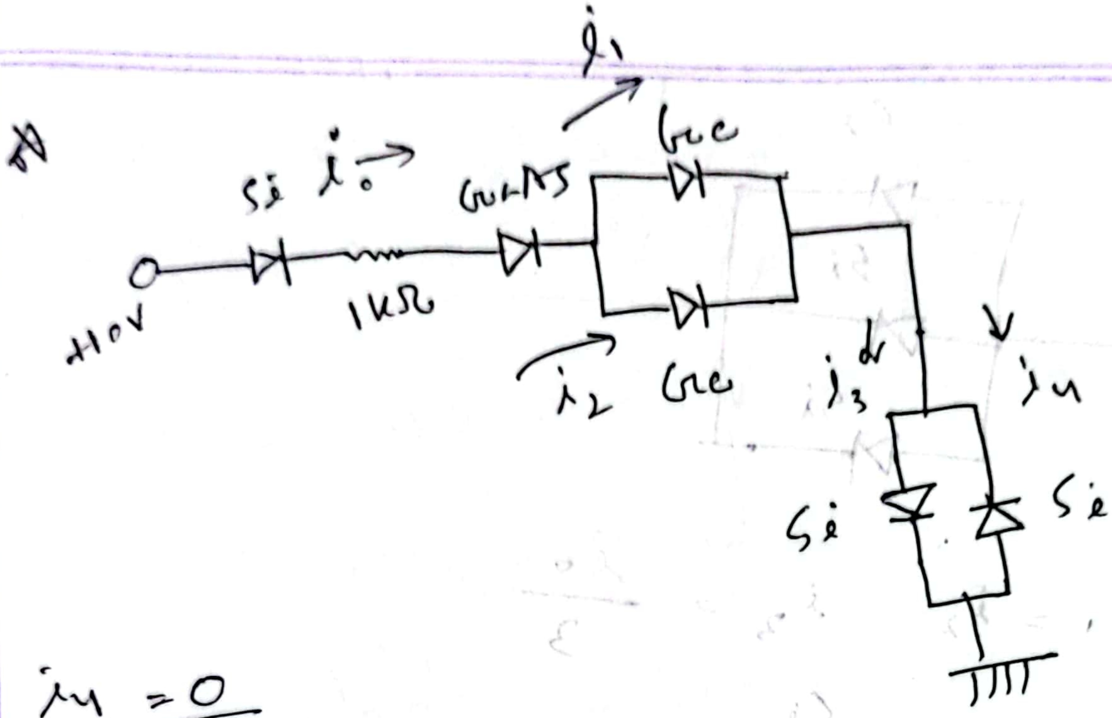
$i_2 = 0$

$i_1 + i_2 = i_0$

$\Rightarrow i_1 = i_0$

$-5 + 1.2 + 0.6\, i_0 + 0.7 + 2\, i_0 = 0$

P.T.O.



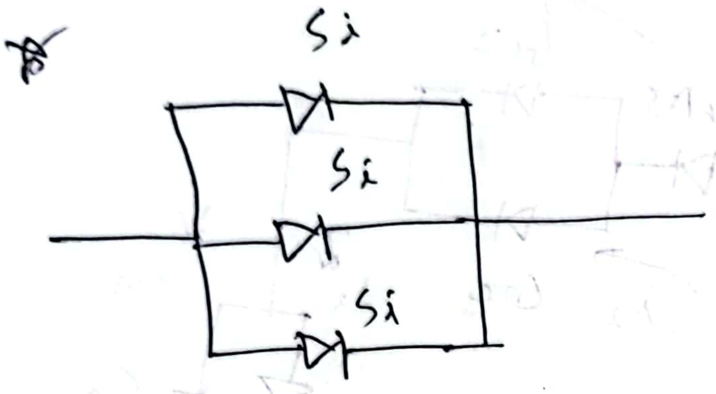
$i_4 = 0$

$i_3 = i_0$

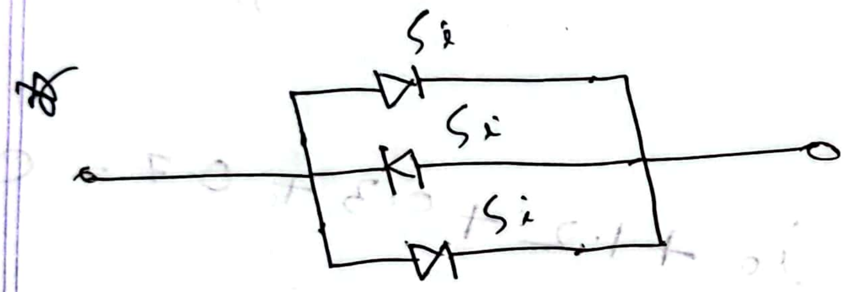
$-10 + 0.7 + i_0 + 1.2 + 0.3 + 0.7 = 0$

$\Rightarrow i_0 = 7.1\ mA$

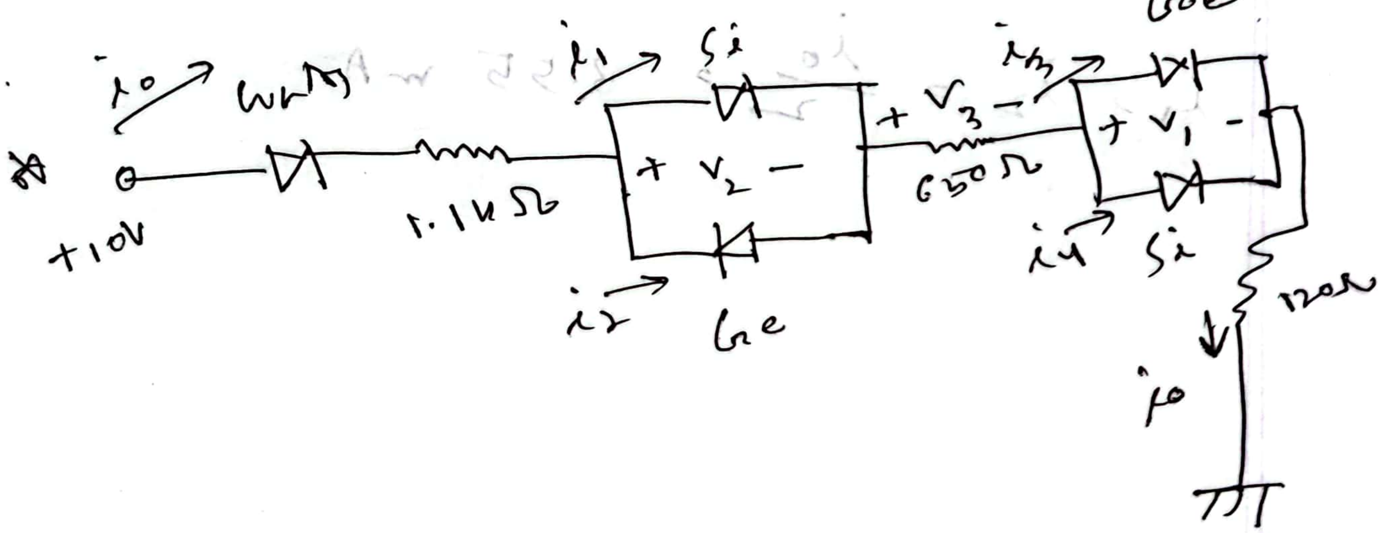
$i_1 = i_2 = \frac{i_0}{2} = 3.55\ mA$



$\Rightarrow i_1 = i_2 = i_3 = \dfrac{i_0}{3}$



$\Rightarrow i_2 = 0, \quad i_1 = i_3 = \dfrac{i_0}{2}$



$\Rightarrow i_2 = 0 \quad , \quad i_4 = 0 \quad , \quad i_3 = i_0$

$i_1 = i_0$

$-10 + 1.2 + 1.1\, i_0 + 0.7 + 0.65\, i_0 + 0.3 +$

$0.12\, i_0 = 0$

$\Rightarrow \cancel{\#} \quad 1.87\, i_0 = 7.8$

$\Rightarrow i_0 = 4.17 \text{ mA}$

Ge < Si

if two parallel connected diode are forward biased and the diodes are different than, ~~the~~ which diodes voltage value is small that will be counted & the biger value voltage diode will be vanished.

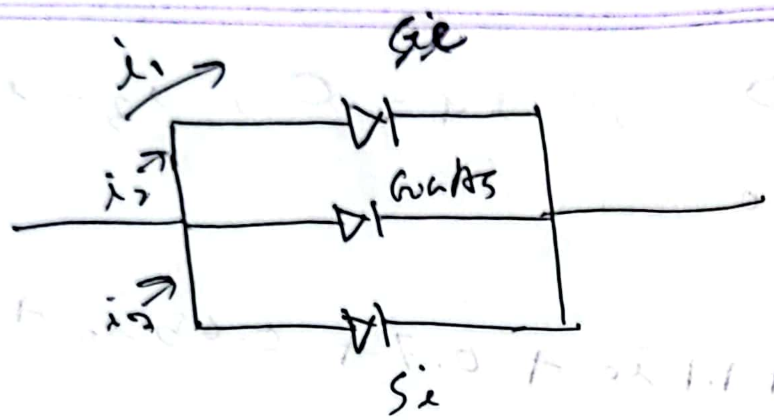
$V_1 = 0.3 V$

$V_2 = 0.7 V$ P.T.O

$V_3 = IR = 4.17 \text{ mA} \times 0.65 \text{ k}\Omega$

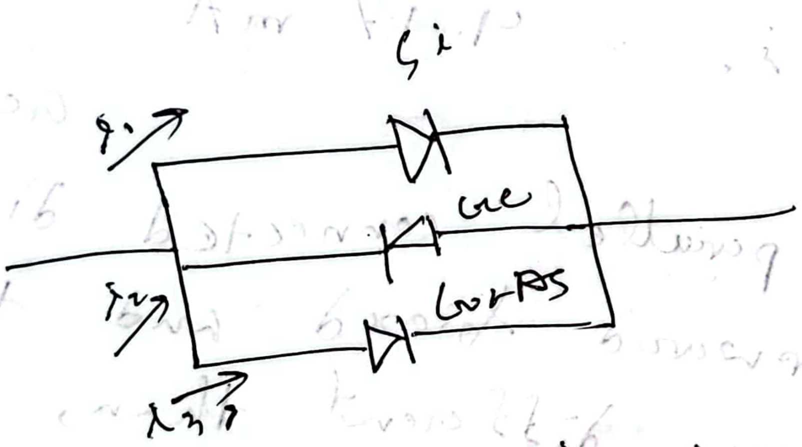
$= 2.7105 \text{ V}$

*

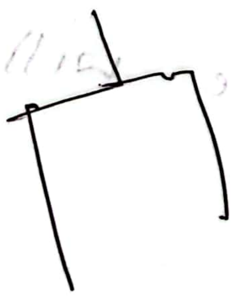


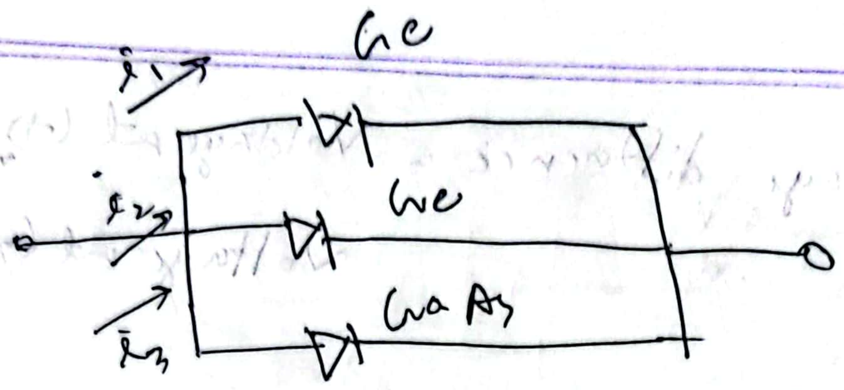
⇒ $i_2 = 0$, $i_3 = 0$, $i_1 = i_0$

*

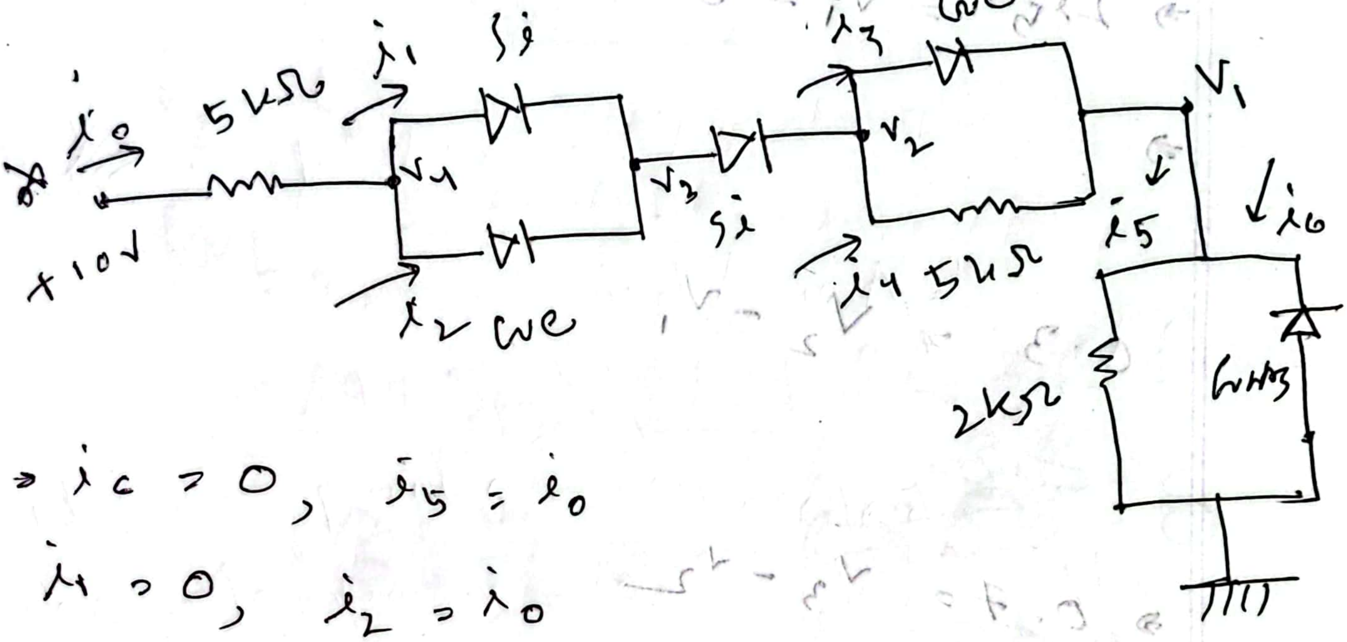


⇒ $i_2 = 0$ $i_1 = i_0$, $i_3 = 0$





$\Rightarrow i_3 = 0, \quad i_1 = i_2 = \frac{i_0}{2}$



$\Rightarrow i_6 = 0, \quad i_5 = i_0$

$i_1 = 0, \quad i_2 = i_0$

$-10 + 5i_0 + 0.3 + 0.7 + 0.3 + 2i_0 = 0$

$\Rightarrow 7i_0 = 8.7$

$\Rightarrow i_0 = 1.24 \text{ mA}$

$i_0 = i_3 + i_4$

$\Rightarrow i_3 = i_0 - i_4 = 1.18 \text{ mA}$

$V = iR$

$\Rightarrow i_4 = \frac{V}{R}$

$= \frac{0.3}{5}$

$= 0.06 \text{ mA}$

Voltage difference = Voltage at $(+)_{ve}$ node − Voltage at $(-)_{ve}$ node

$V_{2k\Omega} = V_1 - 0$

$\Rightarrow 2i_5 = V_1 - 0$

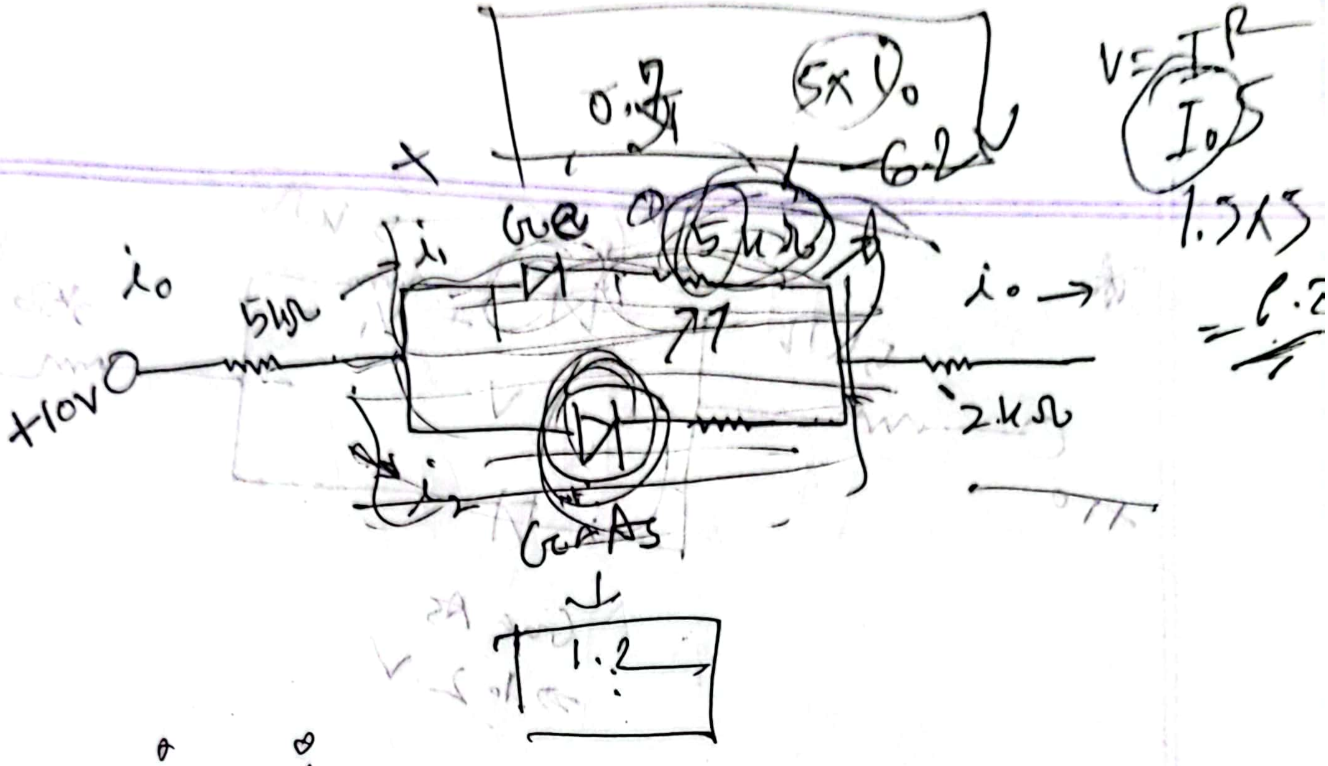
$\Rightarrow$

$0.3 = V_2 - V_1$

$\Rightarrow 0.7 = V_3 - V_2$

$\Rightarrow 0.3 = V_4 - V_3$ or $V_{5\Omega} = 10 - V_4$

$\Rightarrow 5i_0 = 10 - V_4$



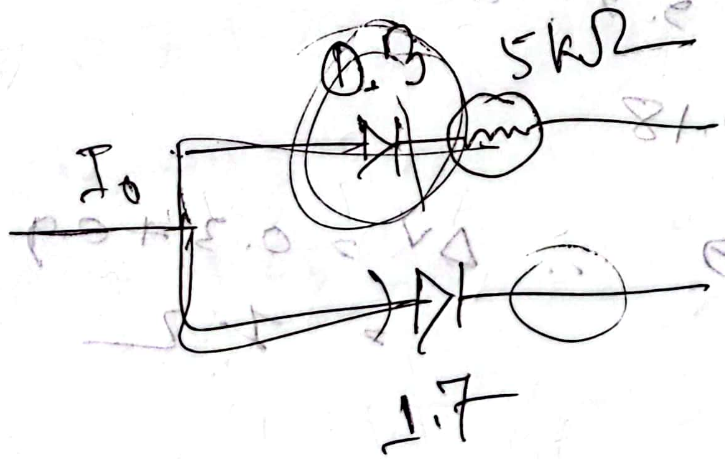
$i_2 = i_0$

KVL -

$-10 + 5i_0 + 1.2 + 2i_0 = 0$

$\Rightarrow 7i_0 - 8.8 = 0$

$\Rightarrow i_0 = \frac{8.8}{7} = 1.25$



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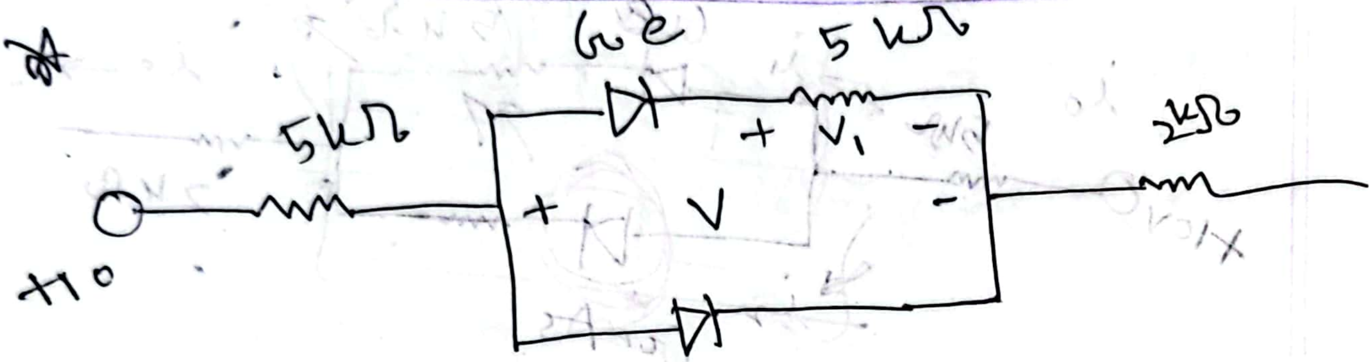


GaAs
$\Rightarrow 1.2\,V$

~~$i_0 = -10 +$~~

$-10 + 5 i_0 + 1.2 + 2 i_0 = 0$

$\Rightarrow 7 i_0 = 8.8$

$\Rightarrow i_0 = 1.257 \text{ mA}$

$-10 + 5 i_0 + 0.3 + 5 i_2 + 2 i_0 = 0$

$\Rightarrow 7 i_0 + 5 i_2 = 9.7$

$\Rightarrow 5 i_2 = 9.7 - 8.799 = 0.901$

$\Rightarrow i_2 = 0.18$

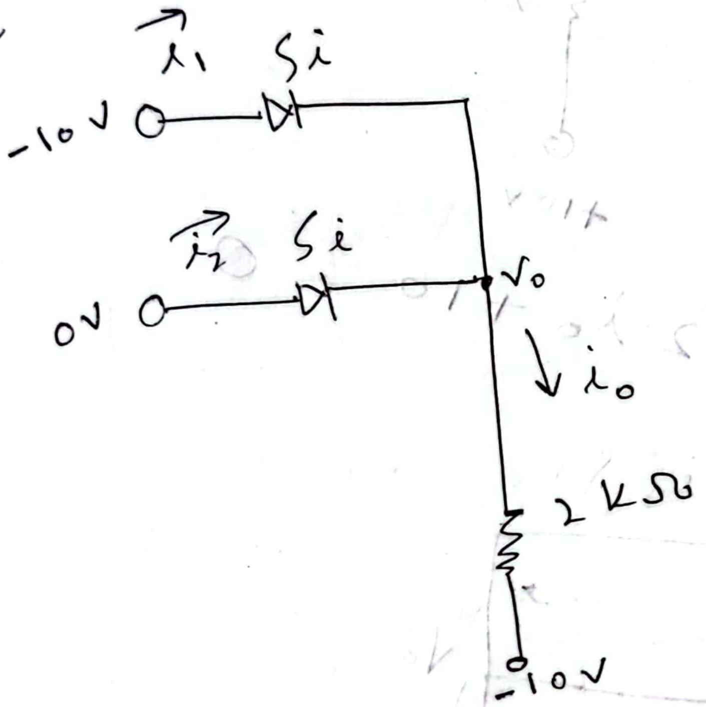
$V_1 = 0.9 \quad \therefore \Delta V = 0.3 + 0.9$

$= 1.2$

Chapter 2

5, 8, 11, 12, 13, 14, 22, 23, 24, 25, 26, 27, 28, 29

18-6-23

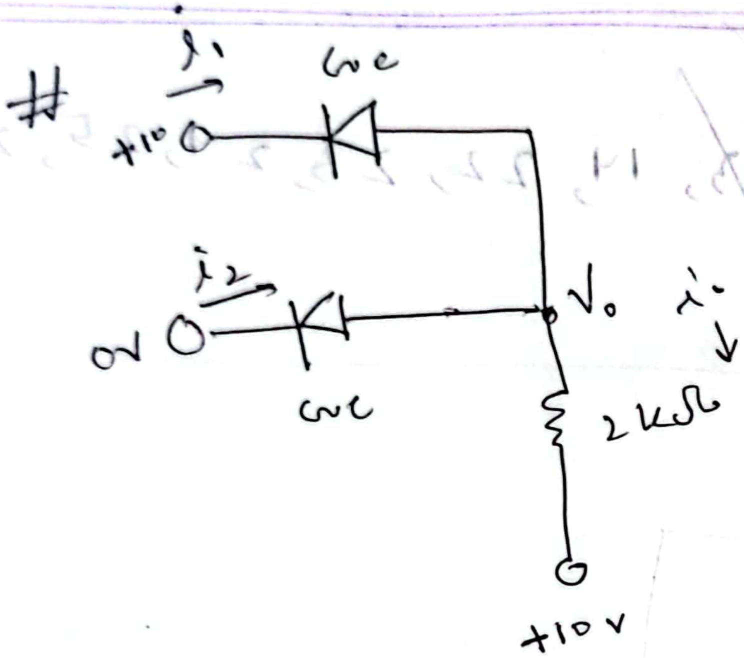


$0-(-10) = 10V$

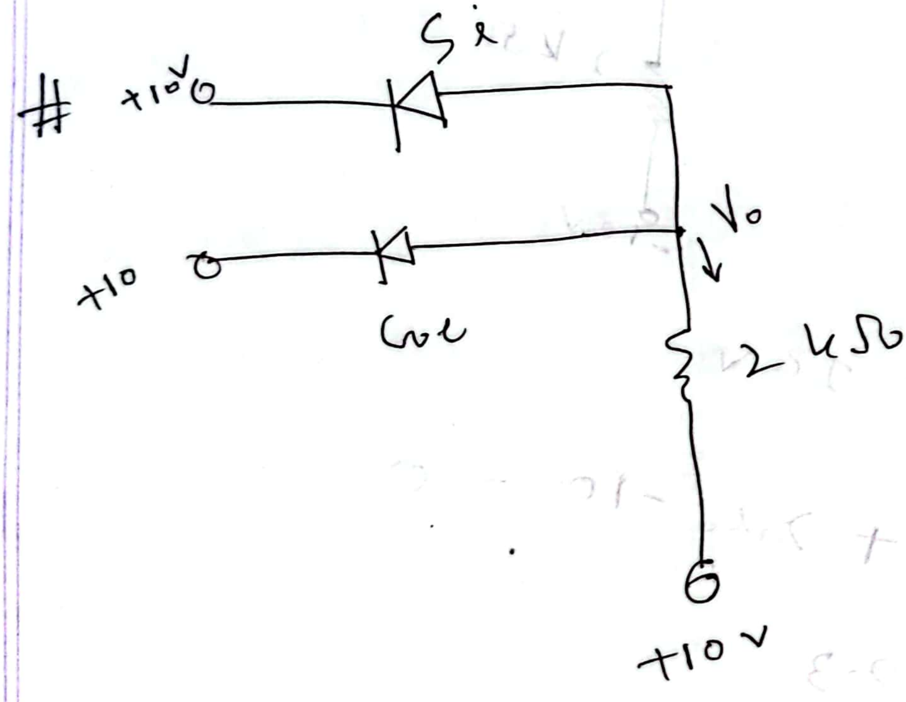
$0 + 0.7 + 2i_o - 10 = 0$

$\Rightarrow 2i_o = 9.3$

$\Rightarrow i_o = 4.65\ mA$



$$-10 - 0.3 + 2 i_o + 10 = 0$$



$$V_{2k\Omega} = V_o - (+10\,V)$$

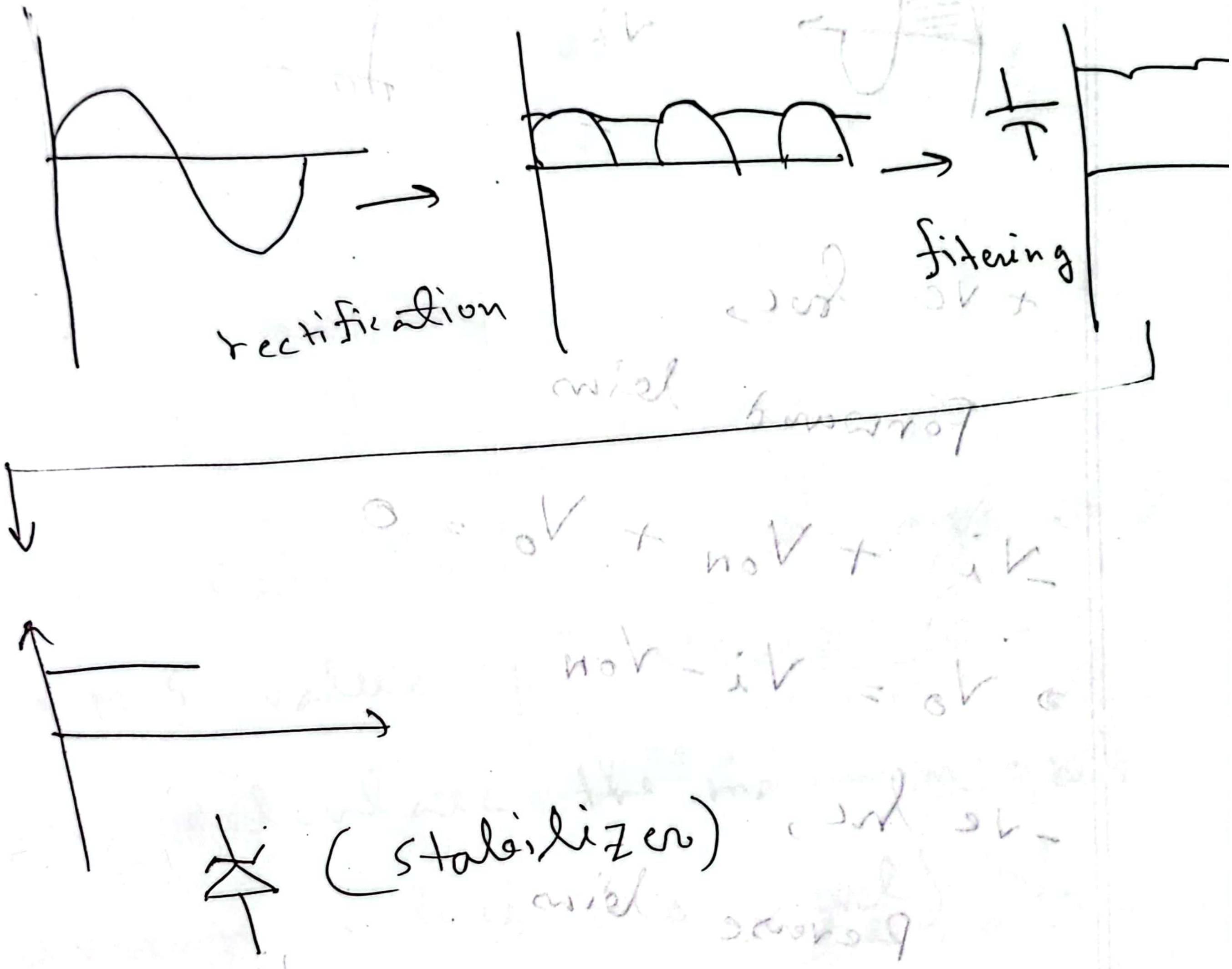
$$\Rightarrow 0 = V_o - 10$$

$$\Rightarrow V_o = 10\,V$$

C.W 18.6.23

Electronics

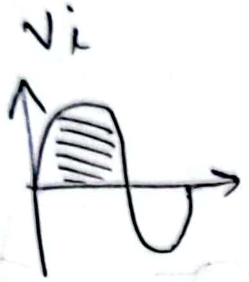
Rectifier Circuit

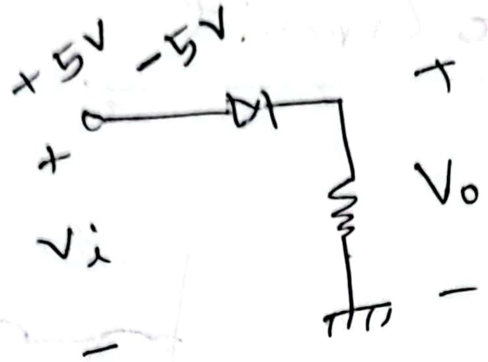


1.W

Half wave rectifier

Electronics





+ve half,

Forward bias

$$-V_i + V_{ON} + V_o = 0$$

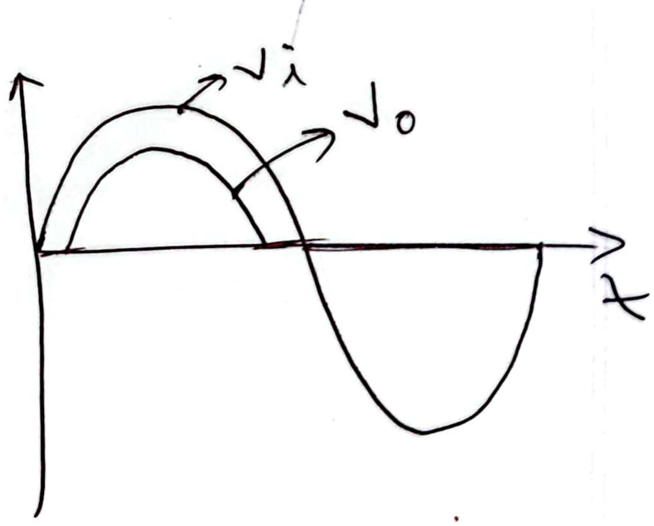
$$\Rightarrow V_o = V_i - V_{ON}$$

-ve half,

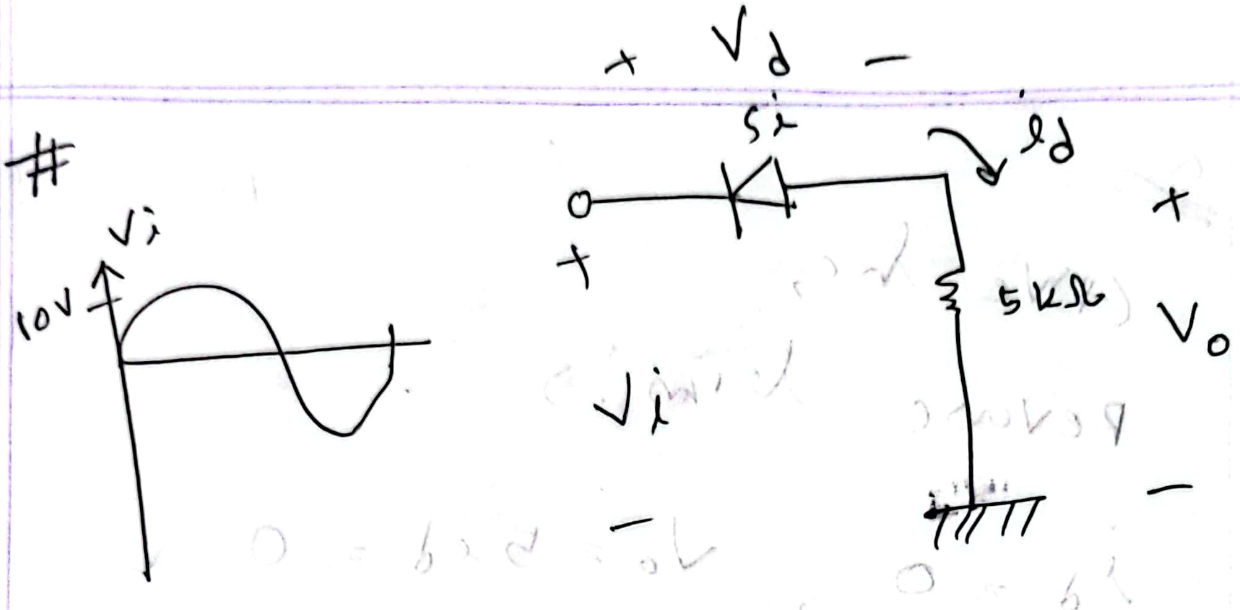
Reverse bias

$i = 0$

$V_o = iR = 0$



#



Qa: Derive the expression of V_o, V_d, i_d & sketch them.

Qb: Calculate the average and R.M.S values of V_i

Qc: Calculate the maximum and average values (dc level) V_o

Qd: Calculate P.I.V of the diode and comment on the breakdown voltage of it.

a

(+)ve hc,

Reverse bias :→

$i_d = 0$, $V_o = 5 i_d = 0$

$-V_i + V_d + V_o = 0$

$\Rightarrow V_d = V_i$

(−)ve hc,

Forward bias;

$-V_i - 0.7 + V_o = 0$

$\Rightarrow V_o = V_i + 0.7$

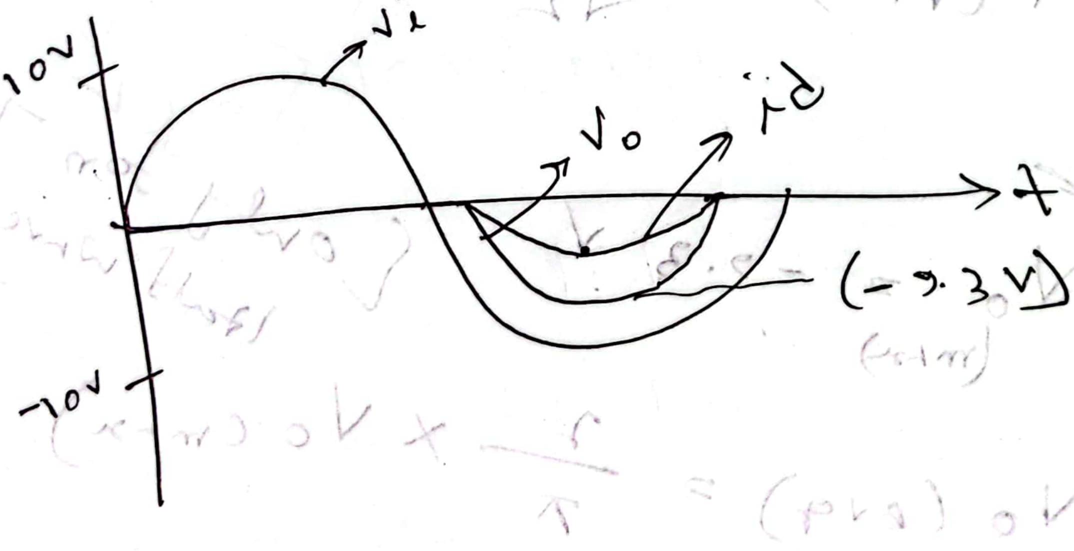
$\Rightarrow i_d = \frac{V_o + 1}{5}$ mA

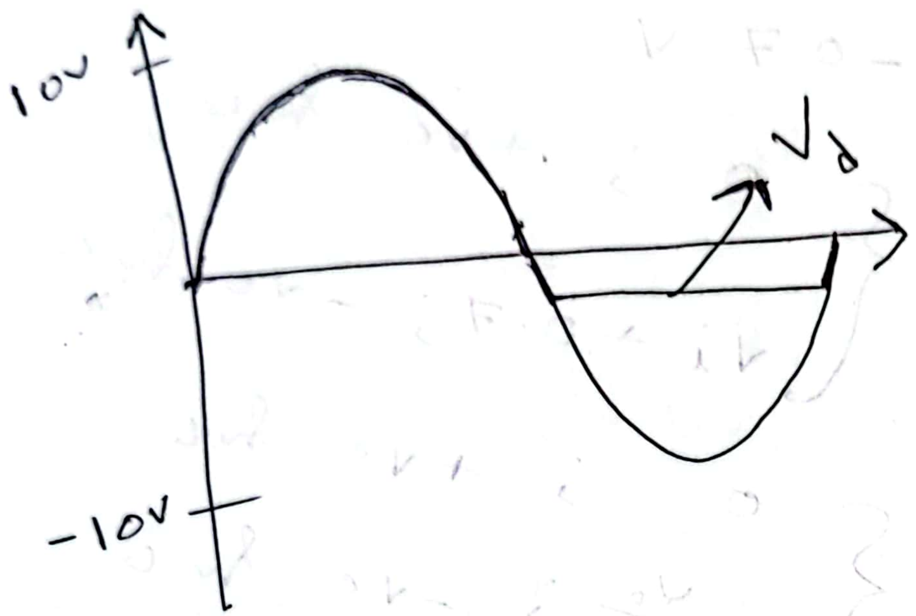
$V_d = -0.7\ V$

$$V_o = \begin{cases} 0 \ ; & +ve \text{ hc} \\ v_i + 0.7 \ ; & -ve \text{ hc} \end{cases}$$

$$i_d = \begin{cases} 0 \ ; & +ve \text{ hc} \\ \frac{v_o}{5} \ ; & -ve \text{ hc} \end{cases}$$

$$V_d = \begin{cases} v_i \ ; & +ve \text{ hc} \\ -0.7 \ , & -ve \text{ hc} \end{cases}$$





b

$V_i(avg) = 0\,V$

$V_i(rms) = \frac{10}{\sqrt{2}}\,V$

c

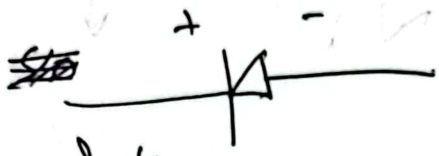
$V_{o(max)} = 9.3\,V$ [only for half wave]

$V_o(avg) = \frac{2}{\pi} \times V_o(max)$

$=$

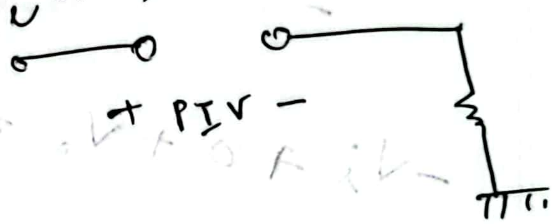
* P.I.V → Pick Inverse Voltage

→ maximum voltage that can be found accross a diode during reverse biasing,



P.I.V = 10 V

+ve the,



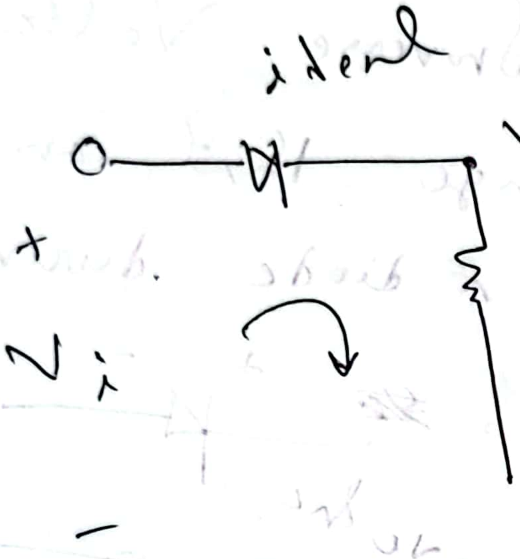
$-V_i + PIV + 5 i_d = 0$

$PIV = V_i$

$= 10\ V$

→ $V_{br} > 10\ V\ [PIV]$

*



$V_o\ dc = 2V$

$V_{o(avg)} = \frac{1}{\pi} V_{o\,max}$

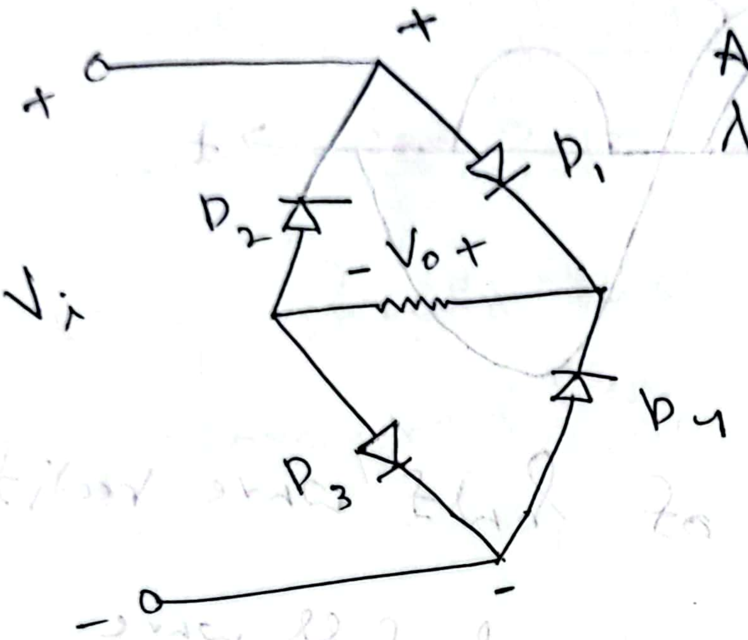
$-V_i + 0 + V_o = 0$

$\Rightarrow V_{o\,max} = V_i$

C.W
25.6.23

Elec

full wave diode bridge rectifier



All diodes should be identical

(+) hc,

$$-V_i + V_{ON} + V_o + V_{ON} = 0$$

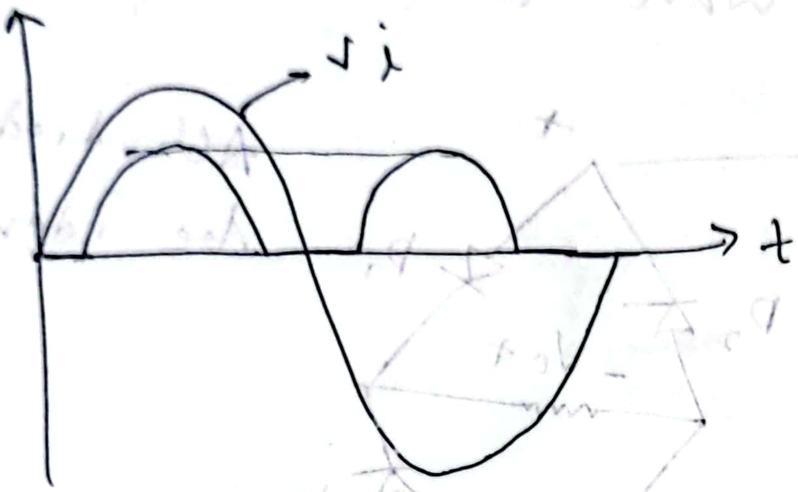
$$V_o = V_i - 2V_{ON}$$

(-) hc, D_2, D_4 are forward

$$V_o = -V_i - 2V_{ON}$$

P.T.O

$$V_o = \begin{cases} V_i - 2V_{ON}, \\ -V_i - 2V_{ON}. \end{cases}$$



* Advantages of half wave rectifier:

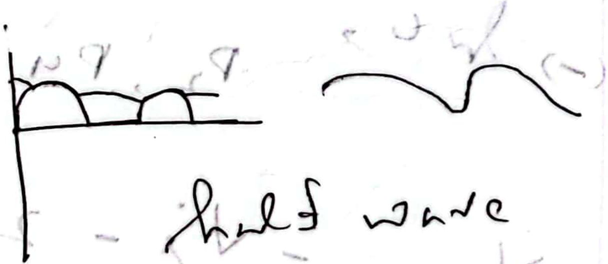
(i) $V_{o,max}$ ↑ with full wave

(ii) cost ↑

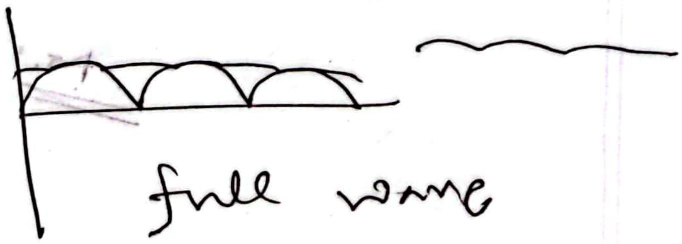
* Advantages of full wave rectifier!

(i) $V_{o,avg}$ ↑

(ii) rectification



half wave



full wave

Over all

clipping → half wave

rectification → full wave

* why should all 4 diodes in full wave rectifier be identical?

→

$V_o = V_i - 2V_{ON} \rightarrow V_o = V_i - (V_{ON_1} + V_{ON_3})$

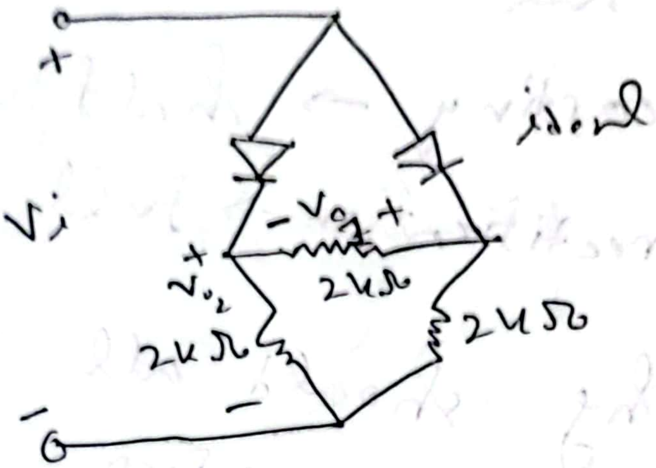
$V_o = -V_i - 2V_{ON} \rightarrow V_o = -V_i - (V_{ON_2} + V_{ON_4})$

1 = ideal, 2 = Ge, 3 = Si, 4 = Ge

$$\left.\begin{aligned} V_o &= V_i - 0.7 \\ V_o &= -V_i - 1.5 \end{aligned}\right\}$$

$V_o(p)\Big|_{(+)\text{ hc}} = V_o(p)\Big|_{(-ve)\text{ hc}}$

$\mathscr{B}$



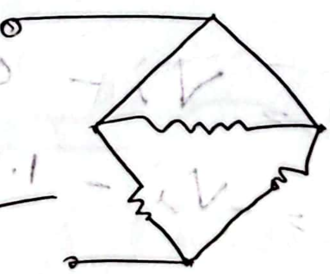
(a) Derive the expression of V_o & sketch it.

(b) Calculate $V_{o,max}$ & $V_{o,avg}$.

(c) Calculate PIV of any diode.

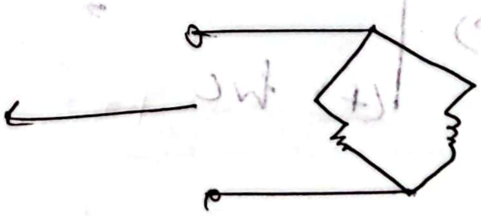
(a)

(+) hc,



$V_{o_1} = 0$

$V_{o_2} = V_i$



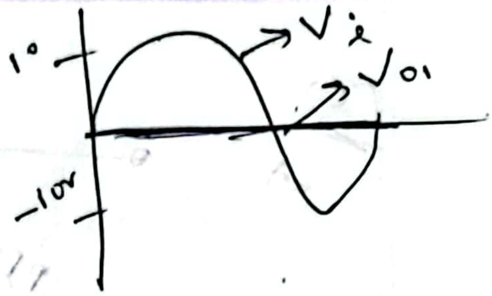
(c) here,

$i = 0$

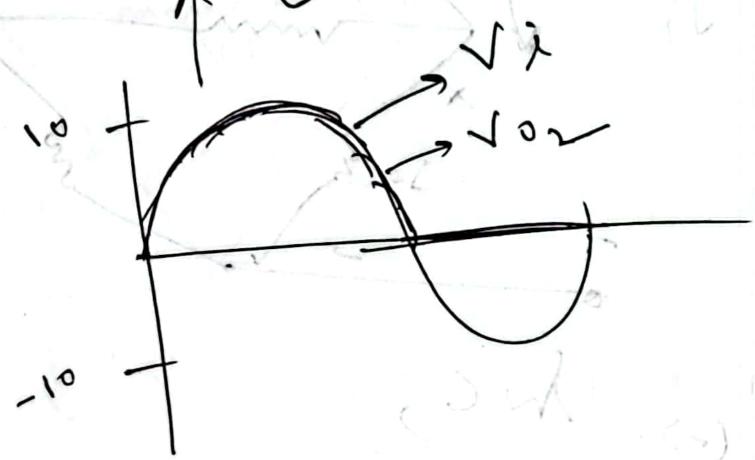
$V_{o1} = 0$

$V_{o2} = 0$

$V_{o1} = \begin{cases} 0 \\ 0 \end{cases}$



$V_{o2} = \begin{cases} V_i \\ 0 \end{cases}$



(d) V_{o1}, max = 0

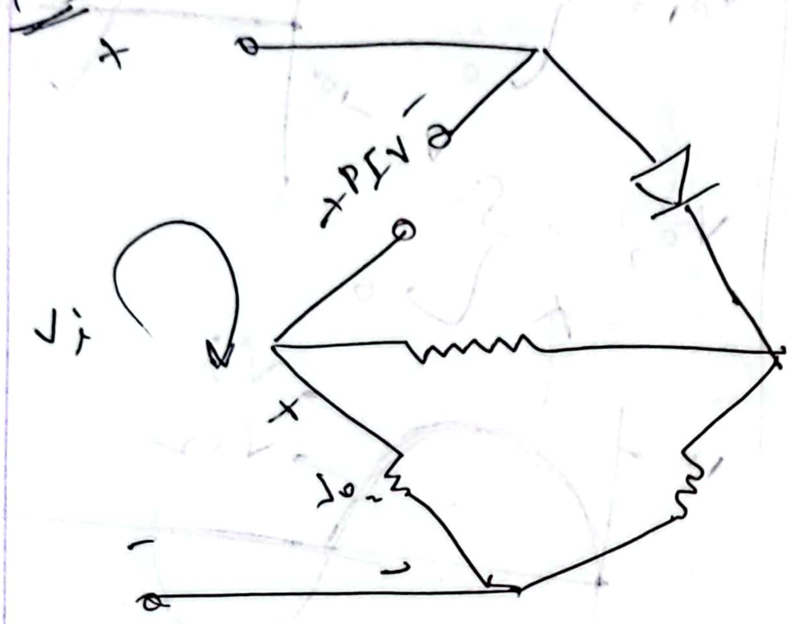
V_{o1}, avg = 0

$V_{o2} = 10\,V$

V_{o2}, avg = $\frac{10}{\pi}$ V

P.T.O.

(c)



(−) hc,

$$-V_i - PIV + V_{o_2} = 0$$

$$\Rightarrow PIV = -V_i$$

$$= -(-10)$$

$$= 10V$$

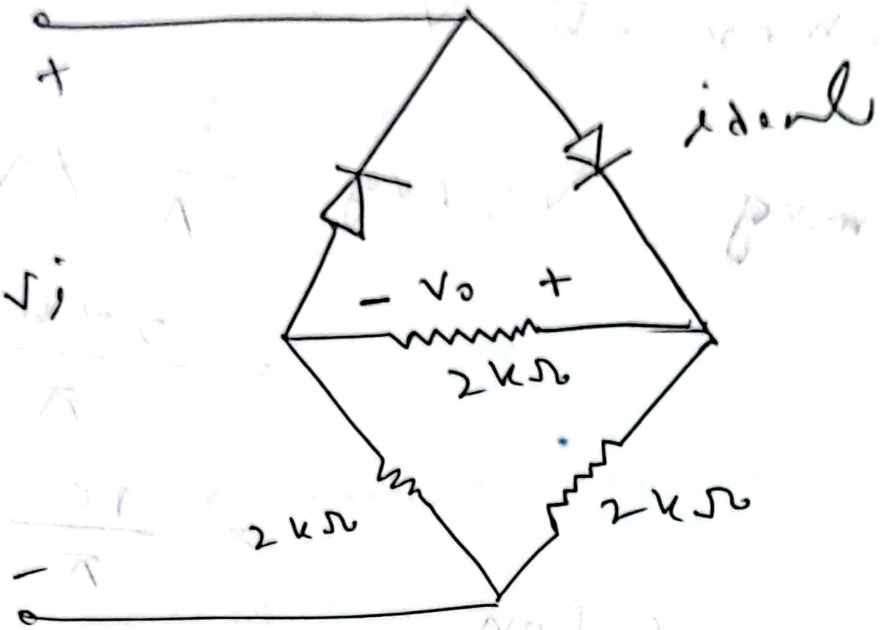
(−) hc,

$$V_{o_2} = 0V$$

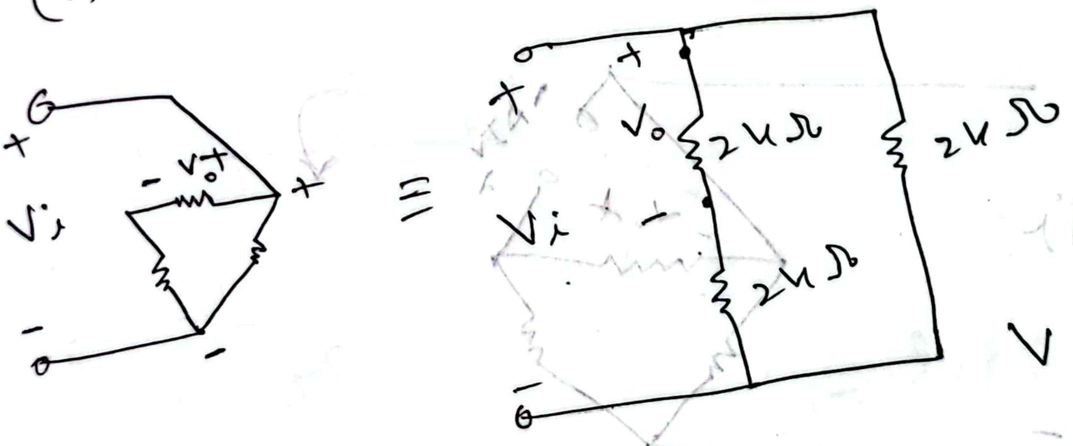
PI.V

full wave

*



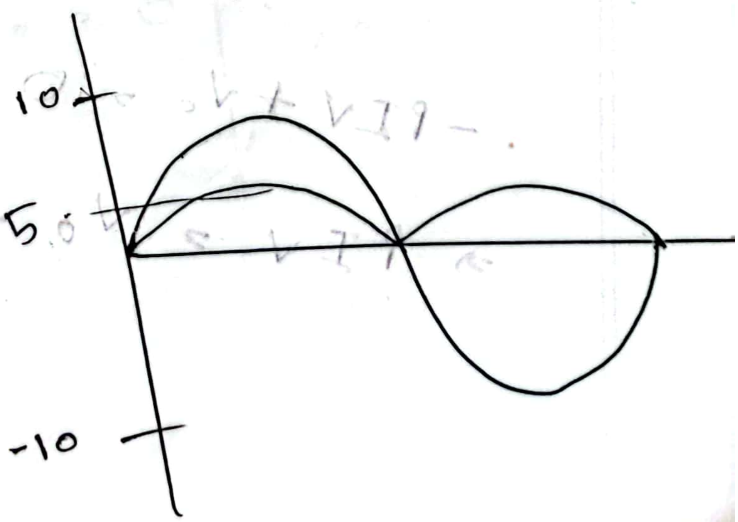
(+) h.c



$$V_o = \frac{V_i}{2}$$

(−) h.c

$$V_o = -\frac{V_i}{2}$$



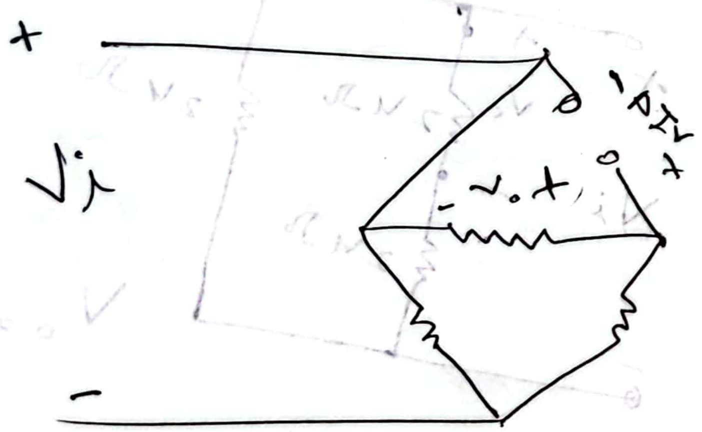
$V_{o,max} = 5 \text{ V}$

$\cancel{V_{o,avg}} = V_{o,avg} = \frac{2}{\pi} \times V_{o,max}$

$= \frac{2 \times 5}{\pi}$

$= \frac{10}{\pi} \text{ V}$

PIV calculation



$-PIV + V_o = 0$

$\Rightarrow PIV = V_o = 5V$

CT-4, July 12

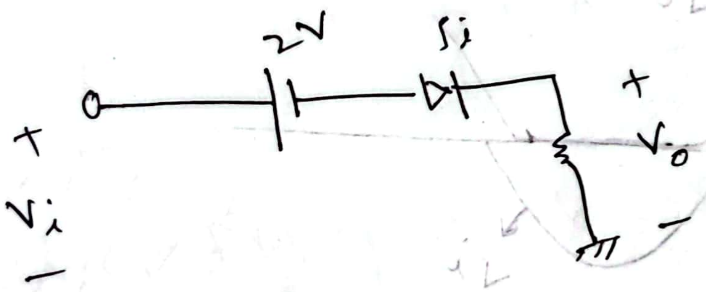
* Rectifier, half, full wave.

CW 5.7.23

Clippers

* Half wave rectifier can be considered as a clipper.

$V_i \rightarrow$ sine 10V (P)



(+) hw, FB

$-V_i + 2 + 0.7 + V_o = 0$

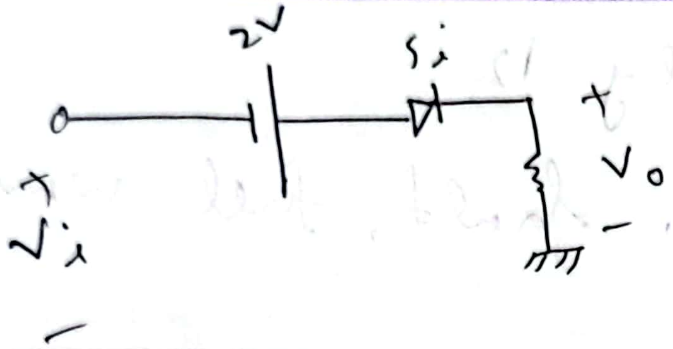
$\Rightarrow V_o = V_i - 2.7$

(−) hw, RB

$V_o = 0$

P.T.O.

*



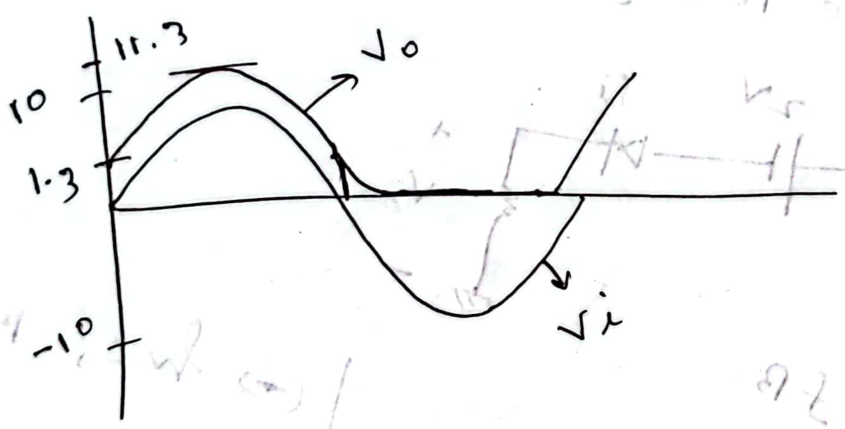
(+) hc, F.B

$-V_i - 2 + 0.7 + V_o = 0$

$\Rightarrow V_o = V_i + 1.3$

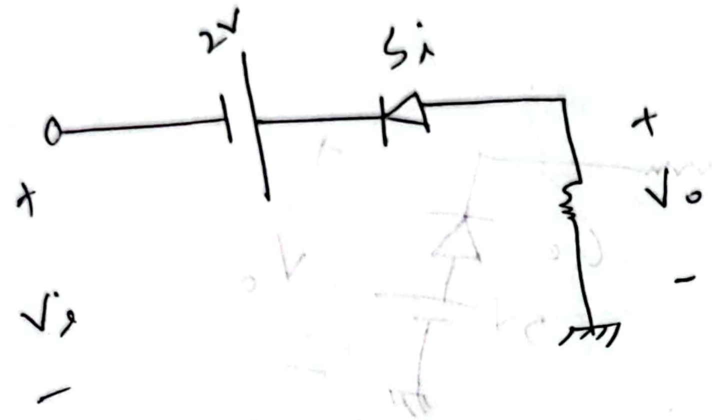
(-) hc, RB,

$V_o = 0$



P.T.O

*



(+) hc, R.B,

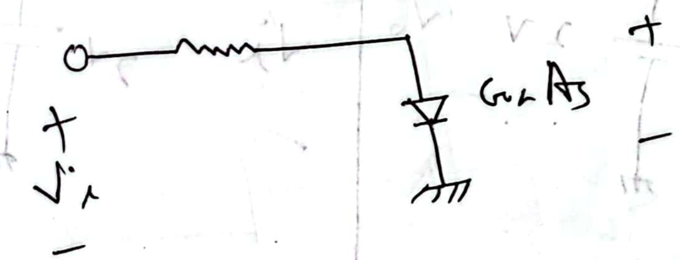
$V_o = 0$

(−) hc, f B.

$-V_i - 2 - 0.7 + V_o = 0$

$\Rightarrow V_o = V_i + 2.7$

*



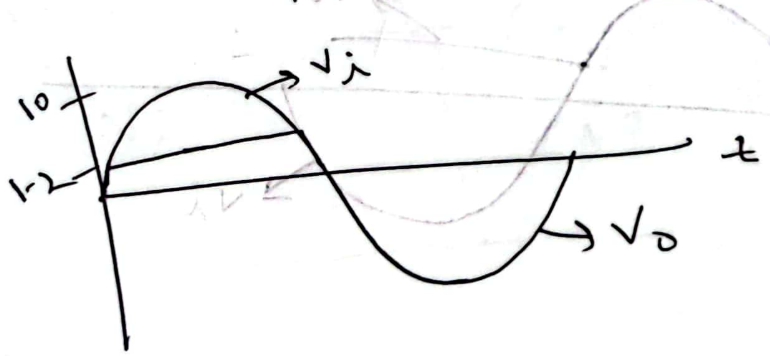
(+) hc, f B.

$V_o = 1.2$

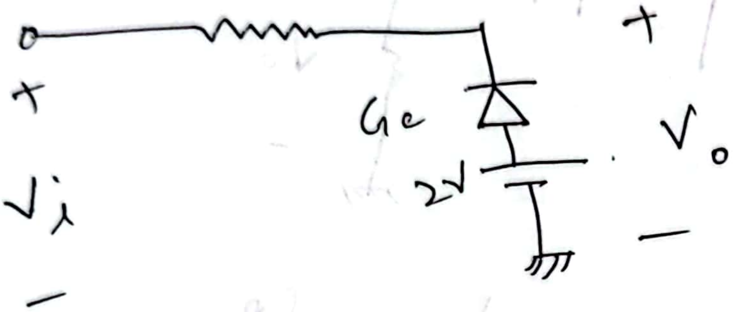
(−) hc, RB

$-V_i + \cancel{iR} + V_o = 0$

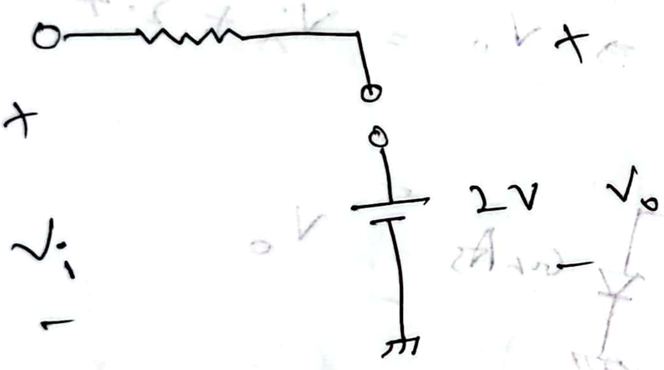
$V_o = V_i$



Q



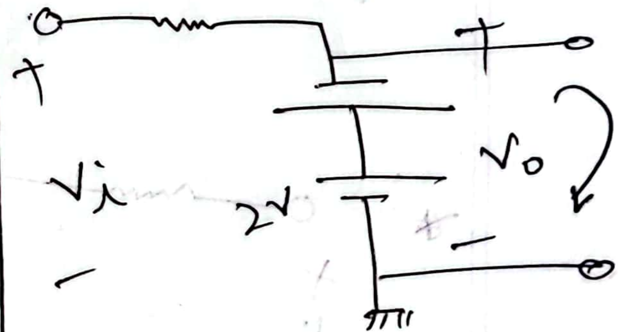
(+) hi, RB.



$\Rightarrow -V_i + \cancel{iR}^{\,0} + V_o = 0$

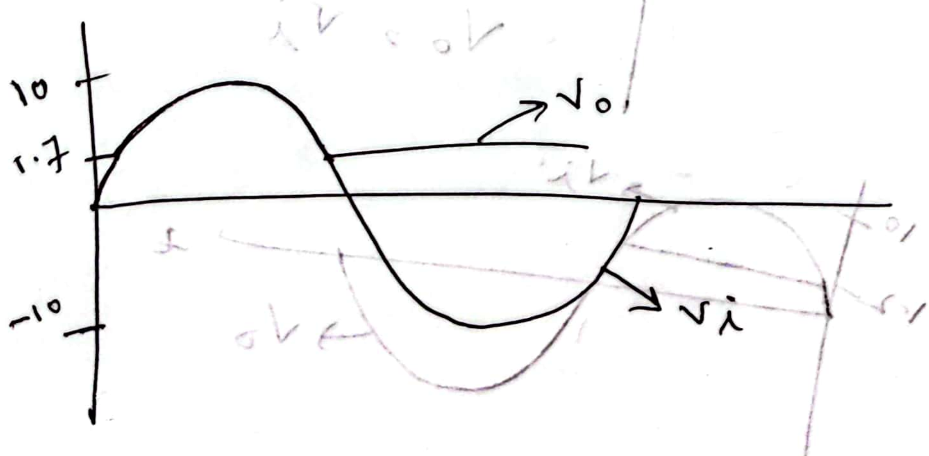
$\Rightarrow V_o = V_i$

(−) hi, fB.



$-2 + 0.3 + V_o = 0$

$\Rightarrow V_o = 1.7$



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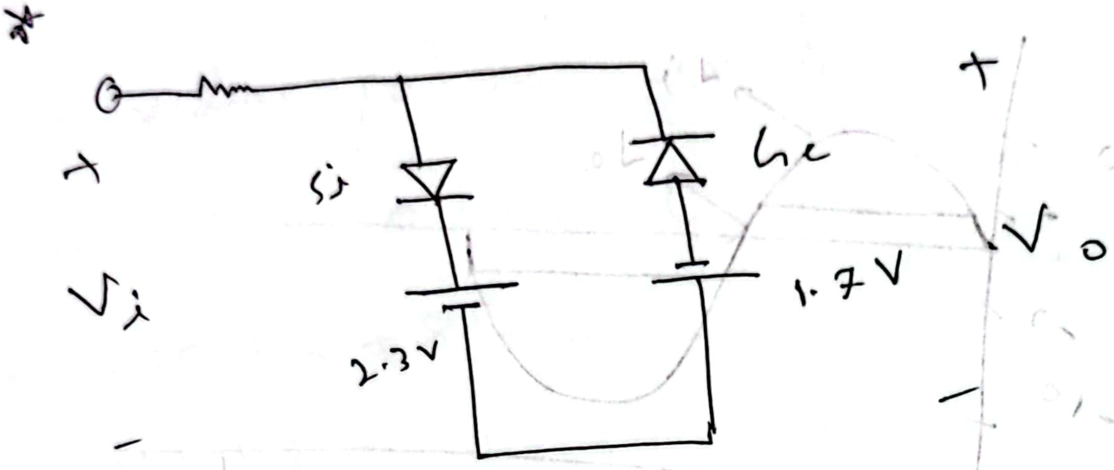
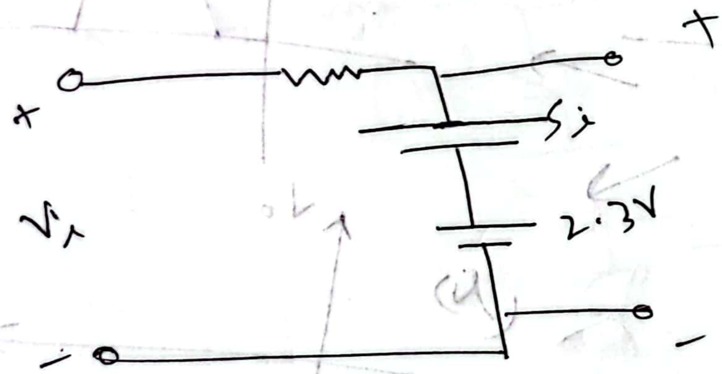


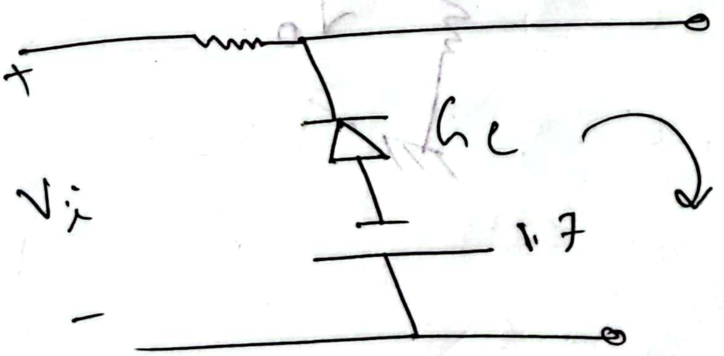
(+) hc, f B



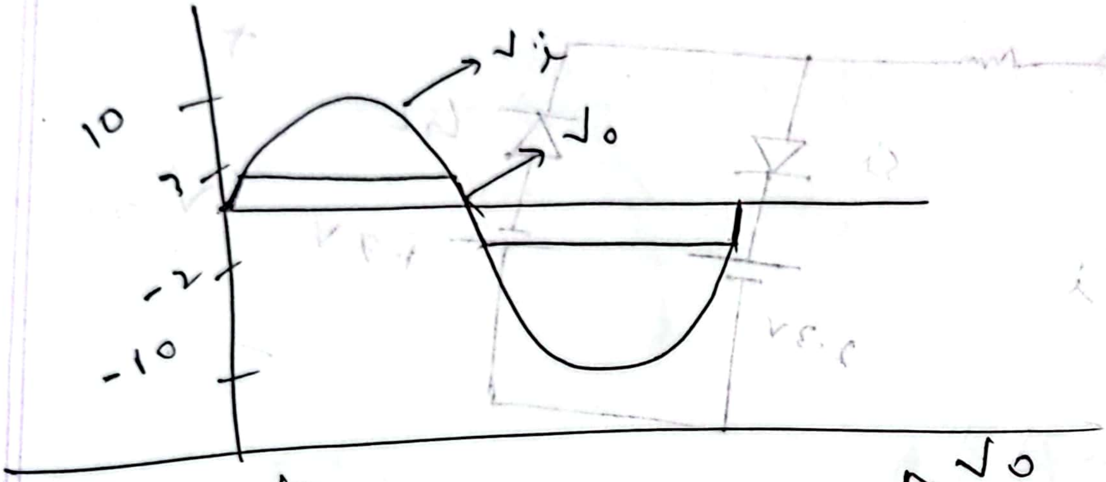
⇒ $-2.3 - 0.7 + V_0 = 0$

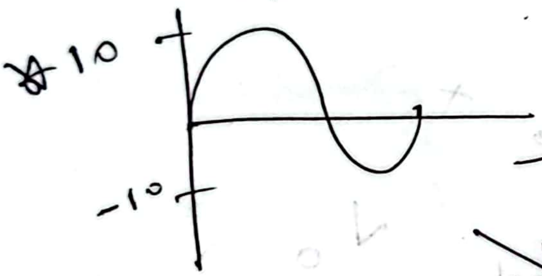
⇒ $V_0 = 3$ V

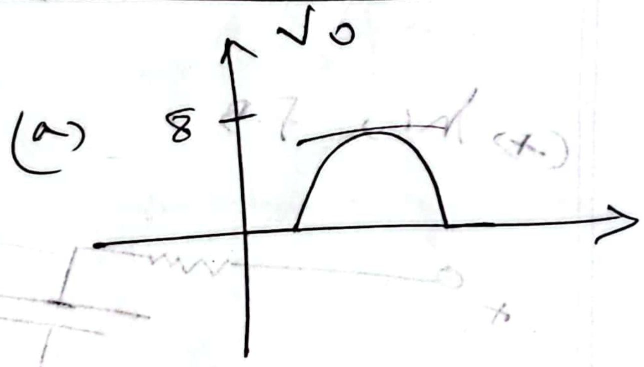
(−) hc,

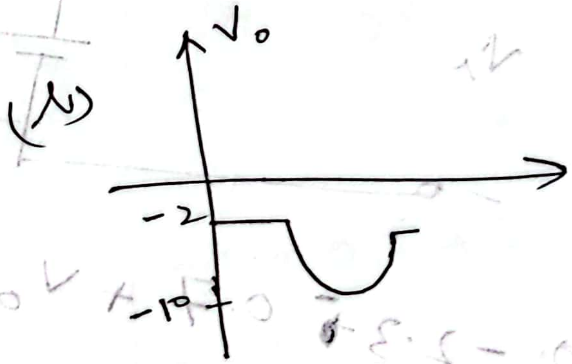


$V_0 = -2$





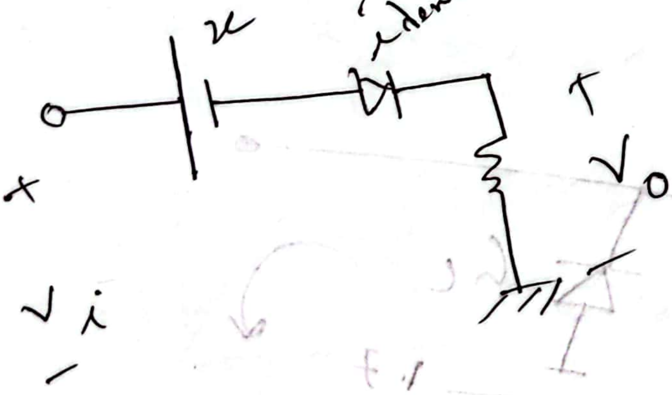




(a)

(-) hc, $V_o = 0$

ideal (R, B)



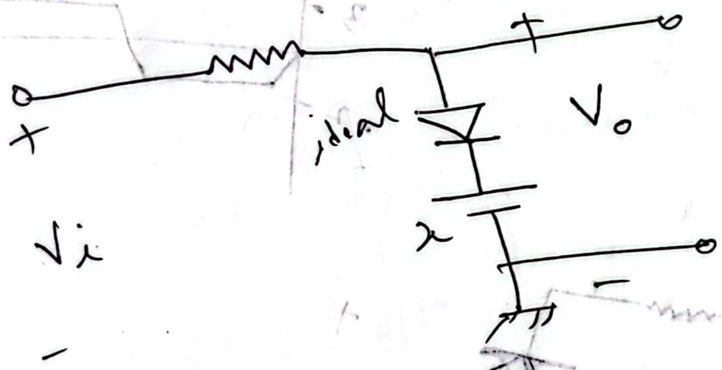
for value of x, (+) hc,

$-V_i + x + 0 + V_0 = 0$

$\Rightarrow -10 + x + 8 = 0$

$\Rightarrow x = 2V$

(ii)

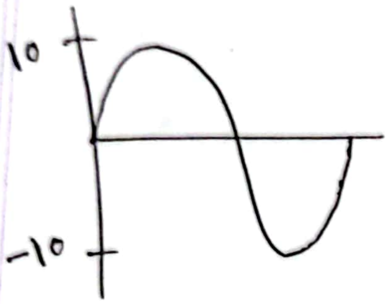


$\Rightarrow -x + 0 + 2 = 0$

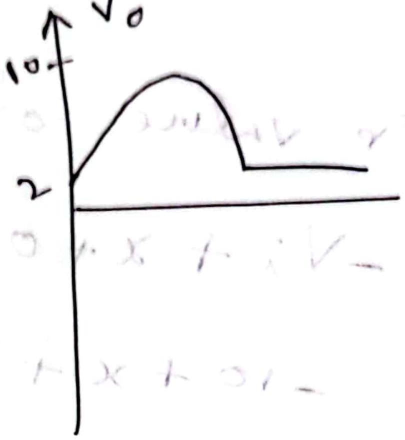
$\Rightarrow -x + 2 = 0$

$\Rightarrow x = -2$

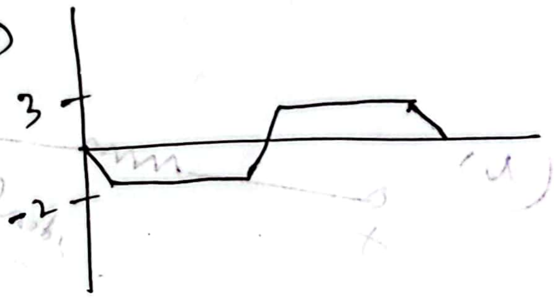
C.W
7.7.23



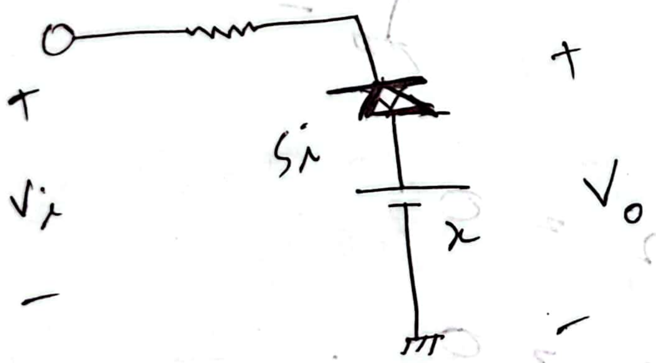
(a)



(b)



(a)



(+) hc,
$V_o = 2$

(-)hc fB

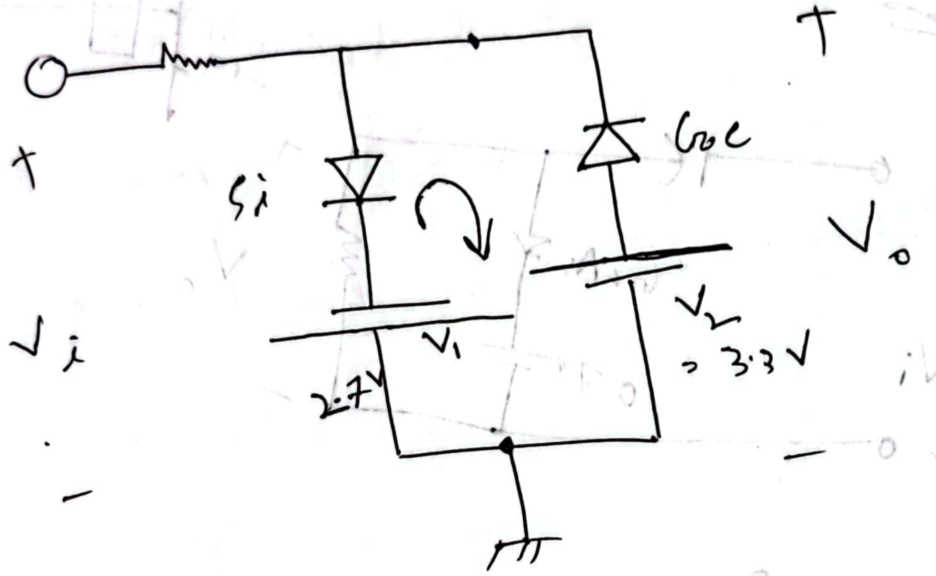
$-x + 0.7 + V_o = 0$

$\Rightarrow -x + 0.7 + 2 = 0$

$\Rightarrow x = 2.7$ V

PT.

(d)



(+) hc,

$-V_1 - 0.7 + V_o = 0$

$\Rightarrow -V_1 - 0.7 - 2 = 0$

$\Rightarrow V_1 = -2.7$

(−) hc

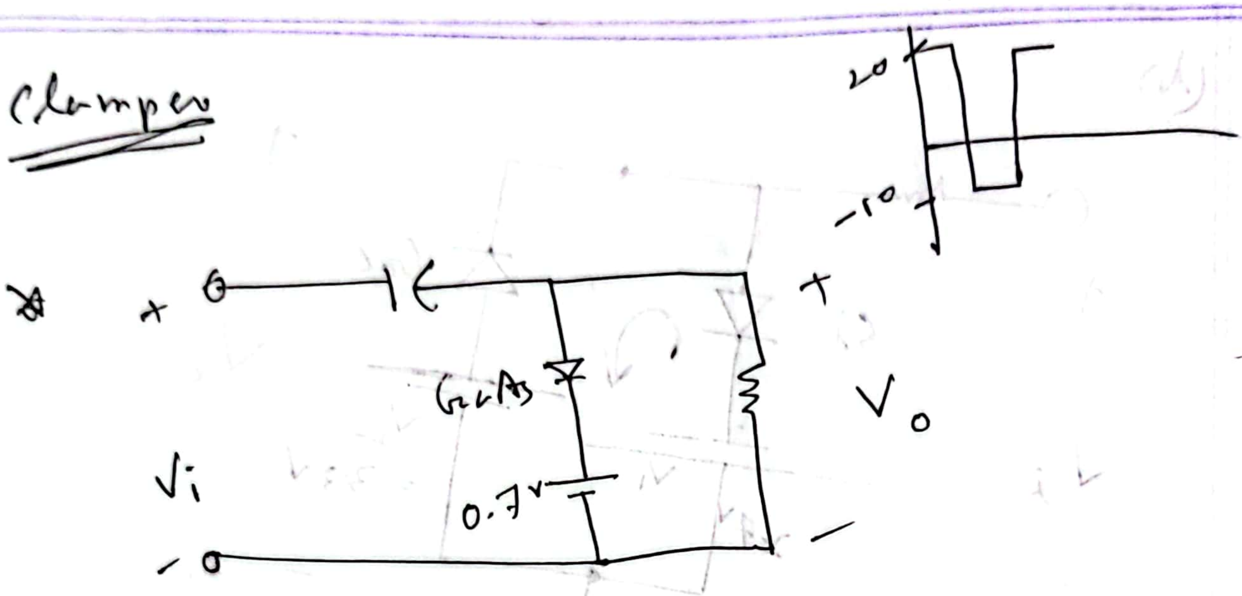
$V_2 + 0.3 + V_o = 0$

$\Rightarrow V_2 + 0.3 + 3 = 0$

$\Rightarrow V_2 = -3.3\ V$

P.T.O

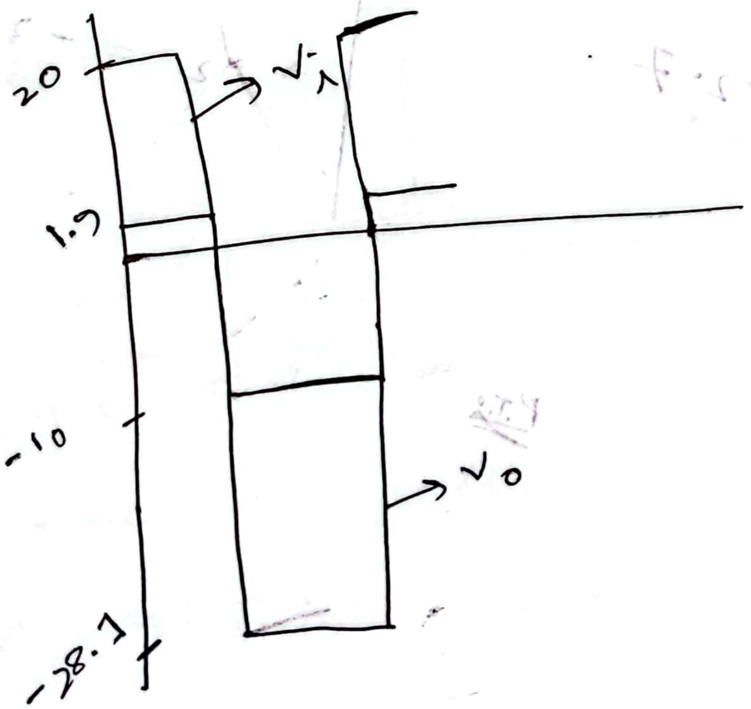
Clamper



(+) kl, fB,

$$-0.7 - 1.2 + V_o = 0$$

$$\Rightarrow V_o = 1.9\,V$$



$V_i(p\text{-}p) = V_o(p\text{-}p)$

$\Rightarrow 20-(-10) = 1.9 - x$

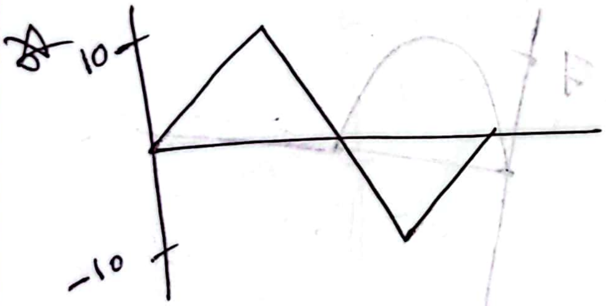
$\Rightarrow 30 = 1.9 - x$

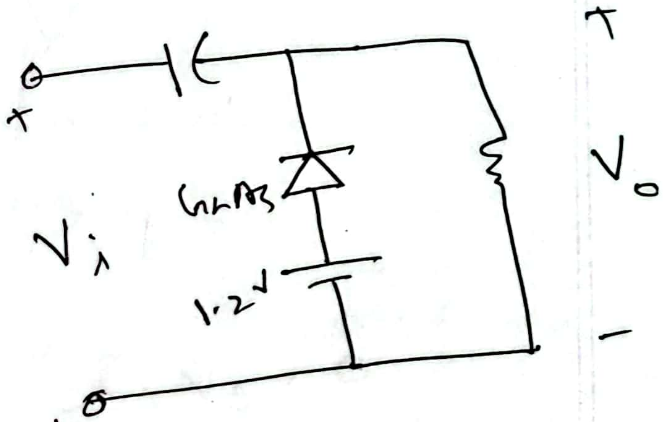
$\Rightarrow -x = 28.1$

$\Rightarrow x = -28.1$

$-5 - V_{ON} - 0$

$= 0 + 5 + V_o$

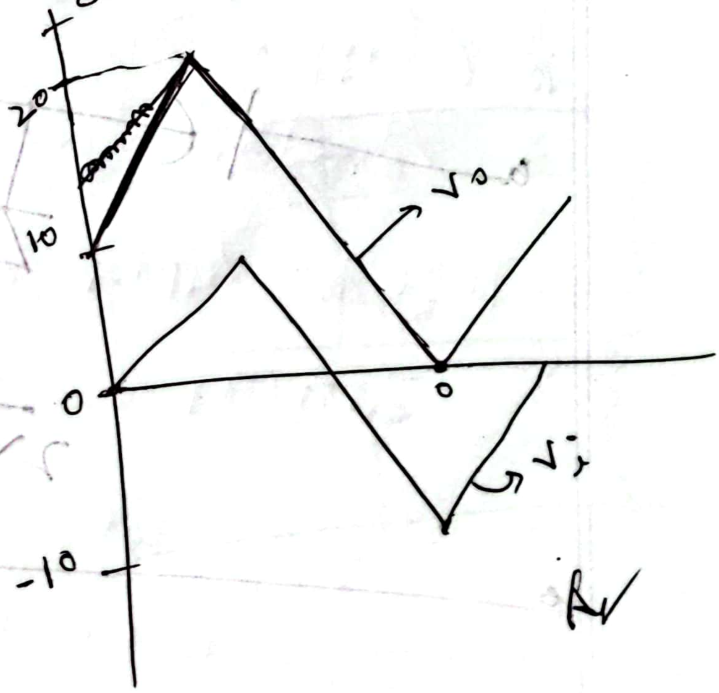


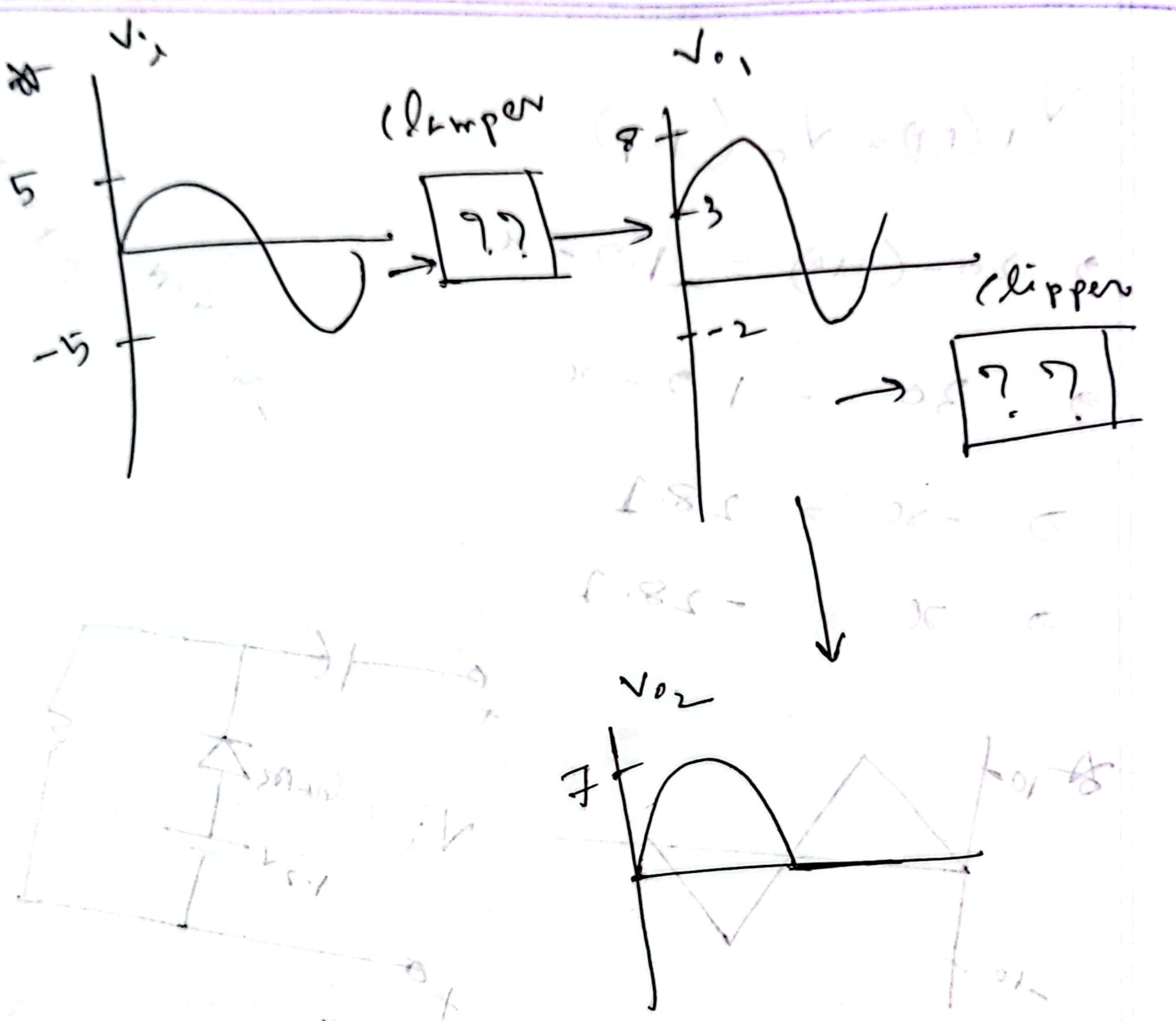


(-) hc, f-B,

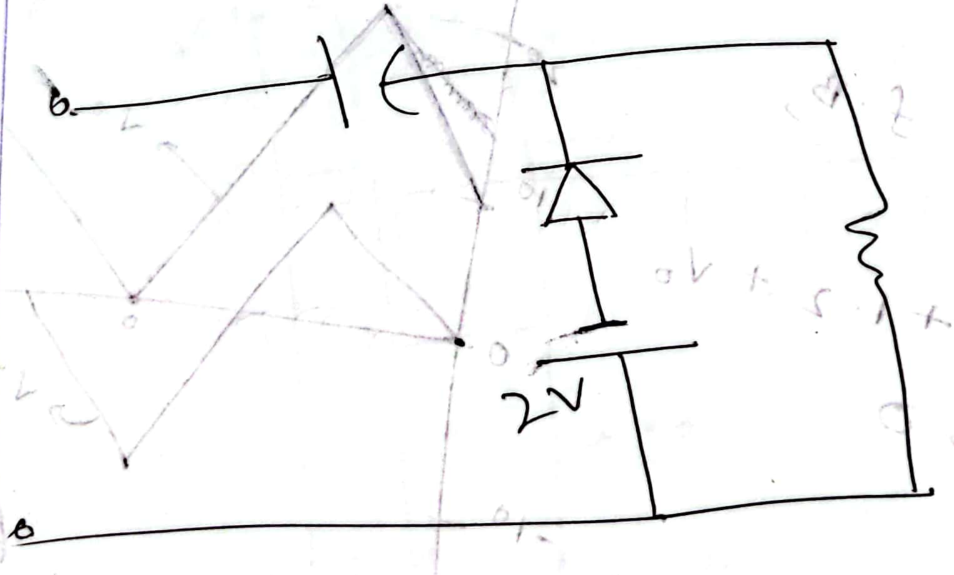
$-1.2 + 1.2 + V_o$

$\Rightarrow V_o = 0$





Vi
5
-5
Clamper
??
Vo1
8
3
-2
Clipper
??
Vo2
7



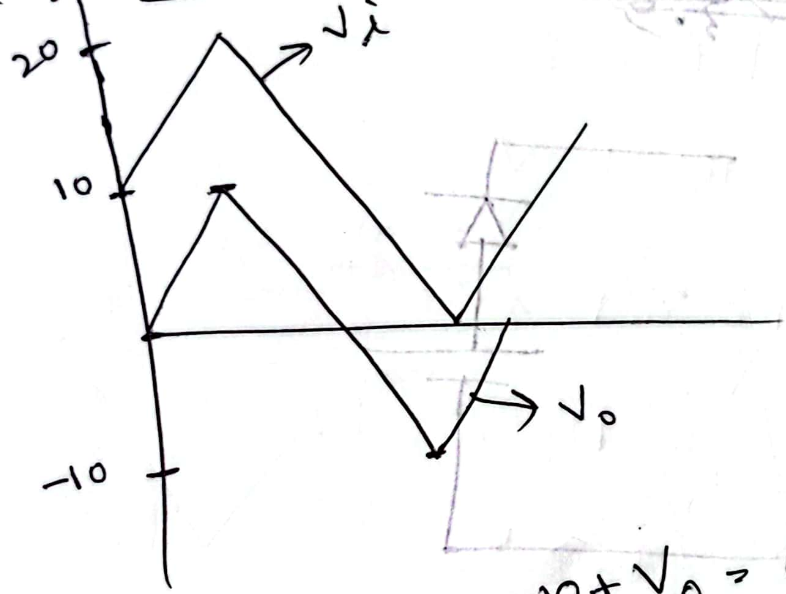
2V

(-) hc,

$- x + 0 + V_0 = 0$

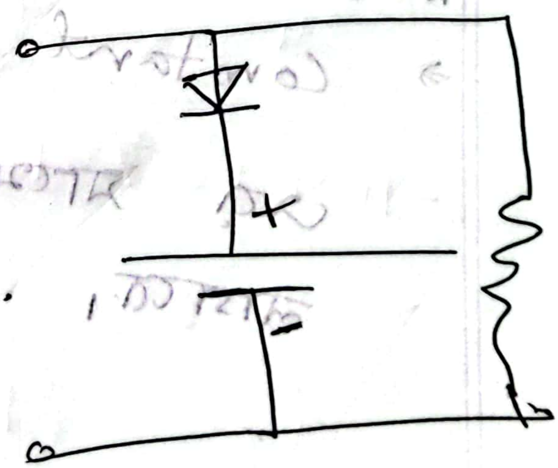
$\Rightarrow -x - 2 = 0$

$\Rightarrow x = -2$



$-10 + V_0 = 0$

$V_0 = 10$



Ans,

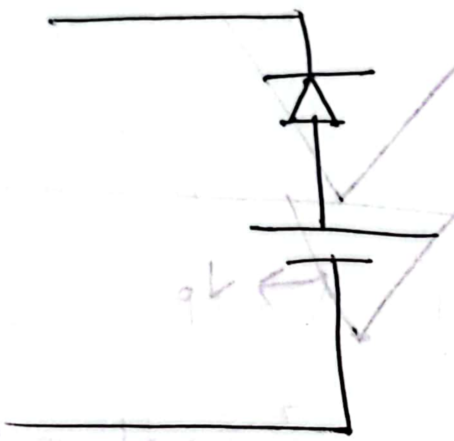
(-), $V_0 = 3.2$

(-), Ans, f.B,

$\cancel{-x + 0.7 + 3.2 = 0}$

$\cancel{\Rightarrow x = 3.9}$

(-)



* Clipper →

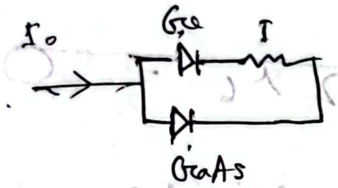
⇒ constant value ⇒ fB

এর মধ্যে KVL মিলানোর লাগবে।

* Clamper :

⇒ Positive half cycle :⇒ output

forward bias



$* \quad -12.3 + 0.3 + i_5 - 2 = 0$

$\Rightarrow \quad i_5 = 14$

$-V + 0.7 + 2.7 + 14 - 2 = 0$

$\Rightarrow \quad -V + 15.4$

$\Rightarrow \quad V = 15.4 \text{ V}$

$\cancel{-12.3 + 0.3 + 2i_6 = 0}$

$\cancel{\Rightarrow \quad 2i_6 = 12}$

$\cancel{\Rightarrow \quad i_6 = 6}$

$\cancel{\therefore \quad i_4 = i_5 + i_6 =}$

$-11.4 + 0.7 + 2.7 + 2i_6 = 0$

$\Rightarrow \quad 2i_6 = 8$

$\Rightarrow \quad i_6 = 4$

$\therefore \quad i_4 = 14 + 4 = 18$

$$-V_i + 0.7 + 200\,i = 0$$

$$\Rightarrow 200\,i = V_i - 0.7$$

$$\Rightarrow i = \frac{5-0.7}{200}$$

$$= 0.02\,\cancel{1}\,75\ A$$

$$\therefore -V_i + 0.7 + 2.15 + V_o = 0$$

$$\Rightarrow V_o = V_i - 2.85$$

CW 26.7.23

MOSFET

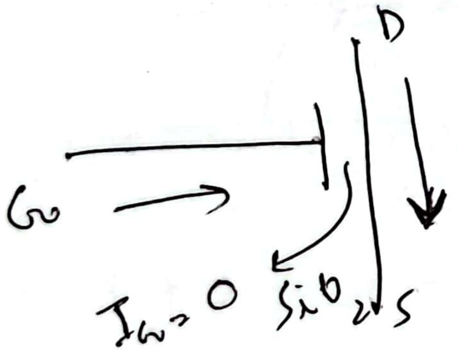
Electronics

* Metal Oxide Semiconductor Field Effect Transistor.

- → source
- → Gate
- → Drain
- → Body

n → moderately doping

n^+ excess /heavely doping



Current flow
D → S

P.T.O

Overdrive Voltage

$$V_{ov} = V_{GS} - V_t$$

* MOSFET ON কিভাবে?

Step 1: $V_{GS} \geq V_t$ ***

Step 2: MOSFET, Triode region এ or ~~saturated~~ saturation region এ ~~থাকে~~ কিভাবে?

* $V_{DS} < V_{ov} \longrightarrow$ Triode
* $V_{DS} \geq V_{ov} \longrightarrow$ Saturation

~~C.W~~ Electronics

C_{ox} : Oxide Capacitance

$$C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}}$$

$$= \frac{3.45 \times 10^{-11}}{8 \times 10^{-9}}$$

$$= 4.31 \times 10^{-3} \ F/m^2$$

$$K'_n = \mu_n C_{ox}$$

$$= 450 \times (10^{-2})^2 \times 4.31 \times 10^{-3}$$

$$= 1.94 \times 10^{-4} \ A/V^2$$

Triode

* $i_D = \mu_n C_{ox} \frac{W}{L}\left[(V_{GS} - V_t) V_{DS} - \frac{1}{2} V_{DS}^2\right]$

$= k'_n \frac{W}{L}\left[(V_{OV} \cdot V_{DS}) - \frac{1}{2} V_{DS}^2\right]$

Saturation

* $I = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_t)^2$

* $V_{DS\,min} = V_{OV}$

(b) $I = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_t)^2$

$\Rightarrow (V_{GS} - V_t)^2 = \frac{2IL}{k'_n W}$

$= \frac{2 \times 100 \times 10^{-6} \times 0.8}{1.34 \times 10^{-4} \times 8}$

$= 0.10$

$\Rightarrow V_{GS} - V_t = 0.32 \quad \therefore V_{GS} = 0.32 + 0.7$

$= 1.02\ V$

* Triode

$$I = k'_n \frac{W}{L} (V_{GS} - V_t) V_{DS}$$

$$\Rightarrow \frac{I}{V_{DS}} = k'_n \frac{W}{L} (V_{GS} - V_t)$$

$$\Rightarrow \frac{1}{R} = k'_n \frac{W}{L} (V_{GS} - V_t)$$

$$\Rightarrow V_{GS} - V_t = \frac{1 \times L}{R \times k'_n \times W}$$

$$= \frac{1 \times 0.8}{1000 \times 1.94 \times 10^{-4} \times 8}$$

$$= 0.515$$

$$\Rightarrow V_{GS} = 0.515 + 0.7$$

$$= 1.215 \text{ V}$$

*

$$V_{DS} = V_D - V_S = 0.5 - V_S$$

$$V_{OV} = V_{GS} - V_t = V_G - V_S - V_t$$

$$= 0 - V_S - V_t$$

$$= -V_S - 0.7$$

$V_{DS} > V_{OV}$
$\hookrightarrow$ saturation

$$I_D = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_t)^2$$

$$\Rightarrow I_D = \frac{1}{2} k'_n \frac{W}{L} (V_G - V_S - V_t)^2$$

$$\Rightarrow \frac{1}{2} k'_n \frac{W}{L} (-V_S - V_t)^2$$

$$\Rightarrow \cancel{0.4\times10^{-3}} = I_D = \frac{1}{2}$$

$$\Rightarrow (-V_S - V_t)^2 = \frac{I_D \times 2 \times L}{k'_n \times W} = \frac{0.4\times10^{-3} \times 2 \times 1}{100\times10^{-6} \times 32} = \frac{1}{4}$$

$$\Rightarrow -V_S - V_t = \frac{1}{2}$$

$$\Rightarrow -V_S = \frac{1}{2} + 0.7 = 1.2, \quad V_S = -1.2\ V$$

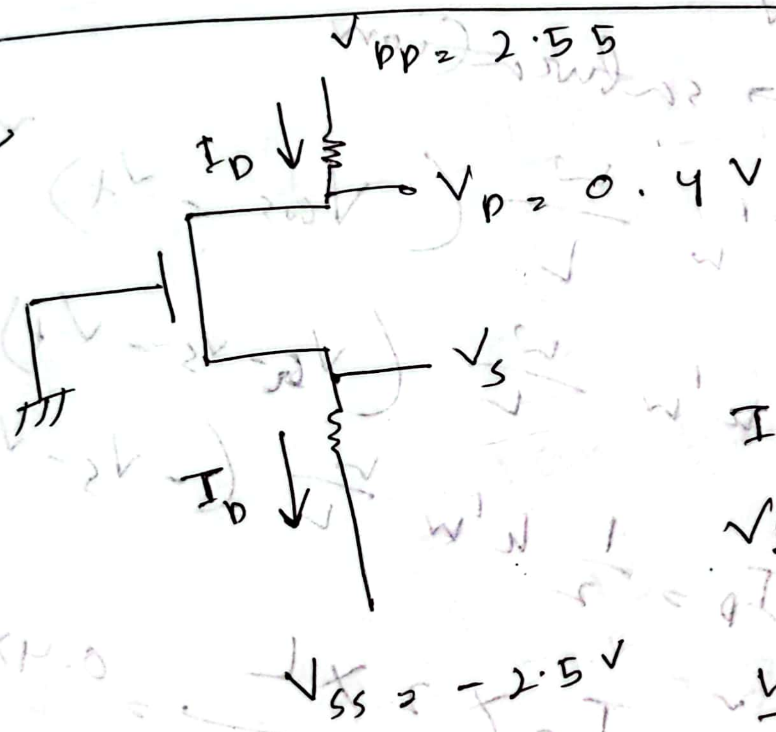
$$\therefore R_S = \frac{V_S - V_{SS}}{I_D}$$

$$= \frac{-1.2 + 2.5}{0.4 \times 10^{-3}}$$

$$= 3250\ \Omega$$

C.W
31.7.23

F



$I_D = 0.3\ mA$

$V_t = 1\ V$

$\frac{W}{L} = \frac{8}{0.8}\ \mu m$

$V_t = 2V$

$\mu_n C_{ox} = 60 \ \mu A/V^2$

$= 60 \times 10^{-6} \ A/V^2$

$V_{DS} = V_D - V_S$

$= 0.4 - V_S$

$V_{OV} = V_{GS} - V_t$

$= V_G - V_S - V_t$

$= -V_S - V_t$

$V_{DS} > V_{OV}$ [saturation]

$$I_D = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_t)^2$$

$$\Rightarrow (V_{GS} - V_t)^2 = \frac{2 I_D L}{k'_n \times W}$$

$$= \frac{2 \times 0.3 \times 10^{-3} \times 3 \times 10^{-6}}{60 \times 10^{-6} \times 120 \times 10^{-6}}$$

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

$$\Rightarrow V_{GS} - V_t = \frac{1}{2}$$

$$\Rightarrow V_{GS} = 1 + \frac{1}{2} = 1.5$$

$$\Rightarrow -V_S = 1.5$$

$$\Rightarrow V_S = -1.5$$

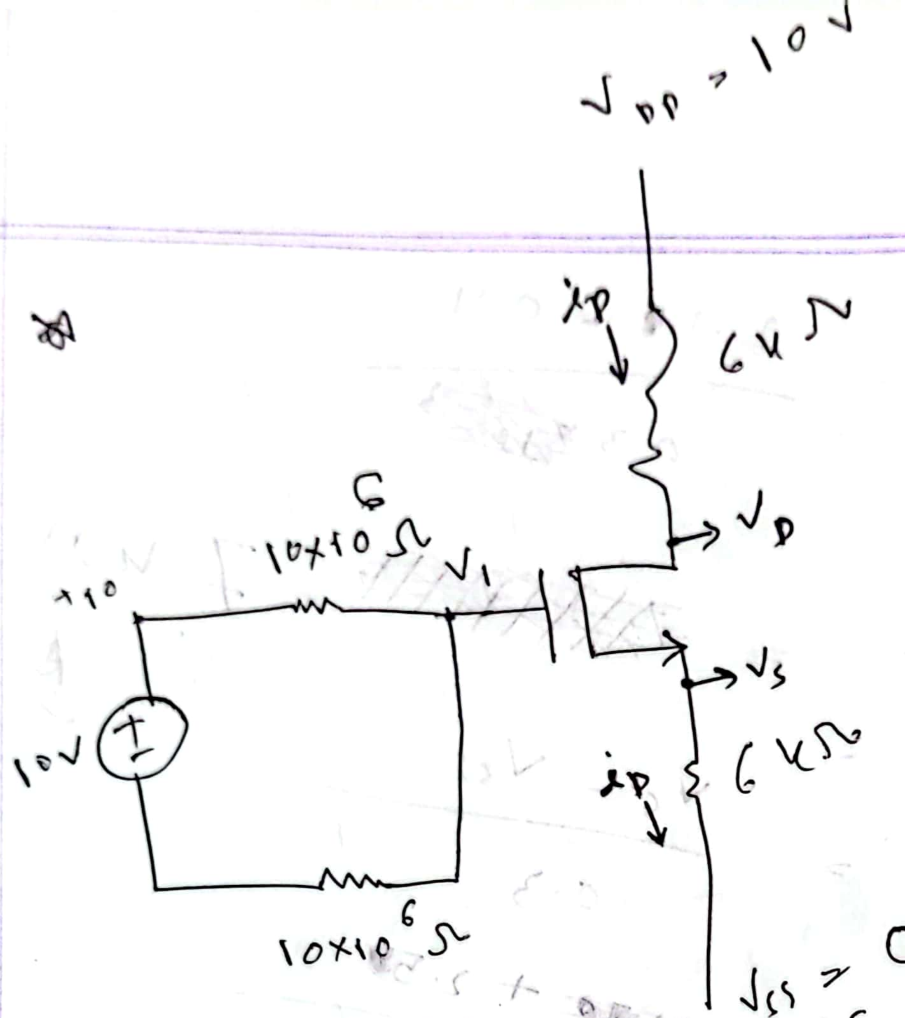
$$\therefore R_D = \frac{2.5 - 0.4}{0.3}$$

$$= 7\ k\Omega$$

$$R_S = \frac{V_S - V_{SS}}{0.3}$$

$$= \frac{-2.5 + 2.5}{0.3}$$

$$= 3.33\ k\Omega$$



$V_t = 1V$

$k'_n\left(\frac{W}{L}\right) = 1\,mA/V^2$

$$-10 + 10\times10^{6}\,i + 10\times10^{6}\,i = 0$$

$$\Rightarrow 2\times10^{7}\,i = 10$$

$$\Rightarrow i = \frac{10}{2\times10^{7}} = 5\times10^{-7}\ A$$

$$V_{10} = 10 - V_1$$

$$\Rightarrow 5 = 10 - V_1$$

$$\Rightarrow 5 - 10 = -V_1 \qquad \therefore V_G = 5V$$

$$\Rightarrow V_1 = 5V$$

$$10 - V_D = 6 i_D$$

$$\Rightarrow V_D = 10 - 6 i_D$$

$$V_S - 0 = 6 i_D$$

$$V_S = 6 i_D$$

$$V_{DS} = 10 - 6 i_D - 6 i_D$$

$$= \underbrace{10 - 12 i_D}_{\to\, x}$$

$$V_{OV} = V_G - V_S - V_t$$

$$= \underbrace{5 - 6 i_D}_{\to\, \frac{1}{2} x} - 1$$

$$= \cancel{4 - 6 i_D}$$

$$= \frac{1}{2} x - 1$$

$$V_{DS} > V_{OV}$$

So it is in saturation mode.

$$i_D = \frac{1}{2} k'_n \frac{W}{L} (V_{GS} - V_t)^2$$

$$= \frac{1 \times \cancel{\ }}{2} (5 - 6 i_D - 1)^2$$

$$\Rightarrow 2 i_D = (4 - 6 i_D)^2$$

$$\Rightarrow 2 i_D = 16 - 48 i_D + 36 i_D^2$$

$$\Rightarrow 2 i_D - 36 i_D^2 + 48 i_D - 16 = 0$$

$$\Rightarrow 50 i_D - 36 i_D^2 - 16 = 0$$

$$\Rightarrow 36 i_D^2 - 50 i_D + 16 = 0$$

$$\Rightarrow i_D = \frac{8}{9}, \frac{1}{2} \text{ mA}$$

$$\cancel{= \frac{8}{9}, 0.5 \; (A)}$$

$$\cancel{V_S = 6 \times \frac{8}{9} = 5.33 > V_G}$$

$$\cancel{V_S = 6 \times 0.5 = 3 < V_G}$$

in saturation

$V_{GS} > V_t$ $\quad$ ~~$V_t = 1V$~~ $\quad$ $V_t = 1V$

$V_{GS} = V_G - V_S$

$= 5 - 6 I_D$ $\quad$ $[I_D = \frac{8}{9}]$

$= -0.33 < V_t$ [not possible]

$V_{GS} = 5 - 6 I_D$ $\quad$ $[I_D = 0.5]$

$= 2 > V_t$

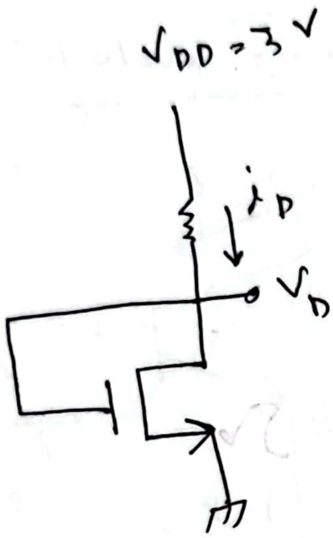
so, $i_D = 0.5$ mA

$V_D = 10 - 6 i_D$

$= 7V$

$V_S = 3V$

8



$I_D = 80 \times 10^{-6}$ A

$V_t = 0.6V$

$k'_n = 200 \times 10^{-6}$ A/V^2

$\frac{W}{L} = \frac{4}{0.8}$

$V_S = 0V$

$V_G = V_D$

$V_{DS} = V_D - V_S$

$= V_D$

$V_{OV} = V_{GS} - V_t$

$V_{OV} = V_G - V_S - V_t$

$= V_D - V_t$

$V_{DS} > V_{OV}$

$I_D = \frac{1}{2} k'_n \frac{W}{L} (V_G - V_S - V_t)^2$

$\Rightarrow 80 \times 10^{-6} = \frac{1}{2} \times 200 \times 10^{-6} \times \frac{4}{0.8} (V_D - 0.6)^2$

$\Rightarrow (V_D - 0.6)^2 = \frac{4}{25}$ $\Rightarrow V_D - 0.6 = \frac{2}{5}$

$\Rightarrow V_D = 1 V$

$$V_{DD} - V_D = R_D I_D$$

$$\Rightarrow R_D = \frac{V_{DD} - V_D}{I_D}$$

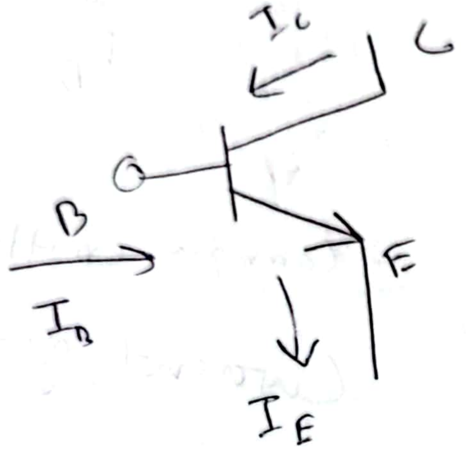
$$= \frac{3-1}{80\times10^{-6}}\ \Omega$$

$$= 25000\ \Omega$$

C.W
6.8.23

Electronics

Bipolar Junction Transistor

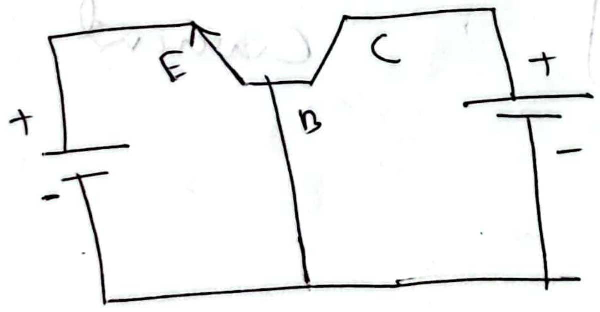


E = Emitter

B = Base

C = Collector

$$I_E = I_B + I_C$$



Cut-off

A

P (connected) ⟶ (-)

N (") ⟶ (+)

NBJT

$$i_C = i_S\, e^{\frac{V_{BE}}{V_T}}$$

$$i_B = \frac{i_C}{\beta}$$

$$i_E = \frac{i_C}{\alpha}$$

$$\boxed{\beta = \frac{\alpha}{1-\alpha} \qquad \alpha = \frac{\beta}{1+\beta}}$$

$$\beta = \frac{I_C}{I_B}$$

↓

Common emitter Current gain

$$\alpha = \frac{I_C}{I_E} < 1$$

↓

Common base Current gain

$$V_T = \frac{kT}{q} =$$

P.T.O

$V_{BE} = 0.7\,V$, $I_C = 1\,mA$

$$I_C = I_S\, e^{\frac{V_{BE}}{V_T}}$$

$V_T = 0.024\,V$

$$\Rightarrow I_S = \frac{I_C}{e^{\frac{V_{BE}}{V_T}}}$$

$$= \frac{1}{e^{\frac{0.7}{0.024}}}$$

$$= 2.153 \times 10^{-13}\ mA$$

$$\therefore I_C = I_S\, e^{\frac{V_{BE}}{V_T}}$$

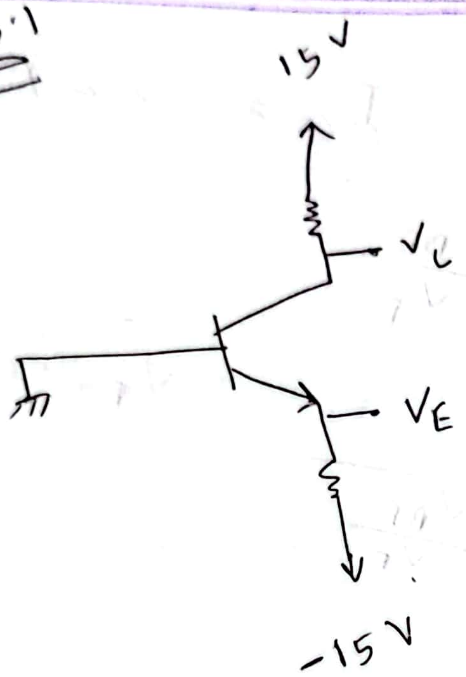
$I_C = 0.1\,m$

$$\Rightarrow \ln\left(\frac{I_C}{I_S}\right) = \frac{V_{BE}}{V_T}$$

$$\Rightarrow V_{BE} = \ln\left(\frac{I_C}{I_S}\right) \cdot V_T$$

$$= 0.64\ V$$

Exm: 5.1



$i_C = 2mA$

$V_C = 5V$

$R_C = \frac{15-5}{2}$

$= 5\,k\Omega$

$V_{BE} = V_B - V_E$

$\Rightarrow 0.7 = 0 - V_E$

$\Rightarrow V_E = -0.7\ V$

$\cancel{I_E = I_B + I_C = 2mA}$

$\therefore \cancel{R_E = \frac{-0.7+15}{2}}$

$\cancel{= 7.15 k\Omega}$

$\beta = 100$

$i_B = \frac{i_C}{\beta} = 0.02 \ mA$

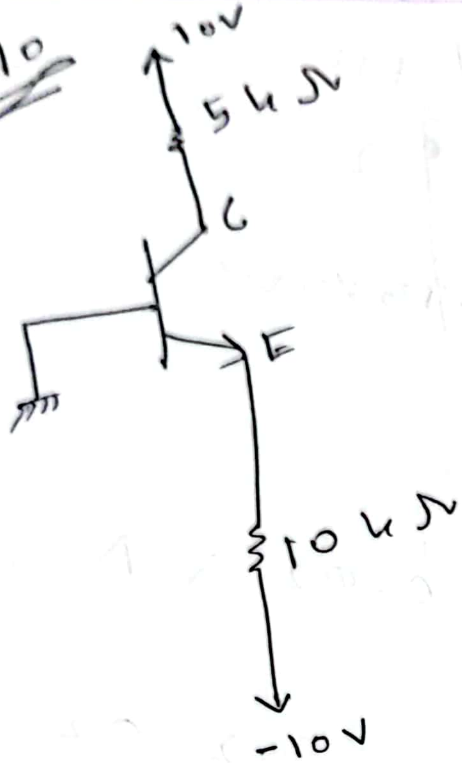
$\therefore I_E = 0.02 + 2 = 2.02$

$\therefore R_E = \frac{-0.7+15}{2.02}$

$= 7.079 \ k\Omega$

C.W
7.8

5.10



$\beta = 50$

$V_E = -0.7$

$V_B = 0$

$\therefore \frac{-0.7+10}{10} = I_E$

$\Rightarrow I_E = 0.93 \text{ mA}$

$\alpha = \frac{\beta}{1+\beta} = \frac{50}{51} = 0.98$

$\therefore \alpha = \frac{I_C}{I_E}$ $\therefore I_C = 0.9114 \text{ mA}$

$I_E = I_C + I_B$

$\Rightarrow I_B = 0.069\ mA$ ~~A~~

Active

(i) EBJ [F.B] $\quad V_{CB} > -0.4$

$V_{BE} = 0.7$

$V_{BE} > V_{BE\,on} \quad [V_{BE\,on} = 0.5]$

(ii) CBJ [R.B]

$V_{CE} \geq 0.3\ V$

Saturation

(i) EBJ [F.B]

$V_{BE} = 0.7\ V$

(ii) CBJ [F.B]

$V_{CE} = 0.2\ V$, [At the edge of sat, $V_{CE} = 0.3\ V$]
(sat)

↓
(Active)

$$\beta_{forced} = \frac{I_C\ (sat)}{I_B}$$

$$\text{Overdrive factor} = \frac{\beta_f}{\beta_{forced}}$$

CS CamScanner

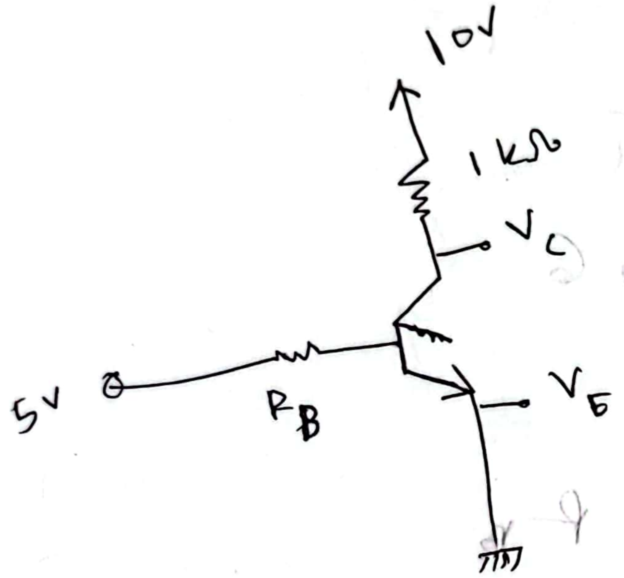
*

$\beta = 50$ to 150

$$\frac{\beta_f}{\beta_{force}} = 10$$

at least 10

minimum β_f



$V_{BE} = 0.7$, $V_{CE} = 0.2$

$$\therefore \frac{10 - 0.2}{1} = i_C = 9.8 \text{ mA}$$

$$\Rightarrow 10 = \frac{50}{\beta_{forced}} = 5$$

$\Rightarrow \beta_{forced} = 5$

$$\beta = \frac{i_c}{i_B}$$

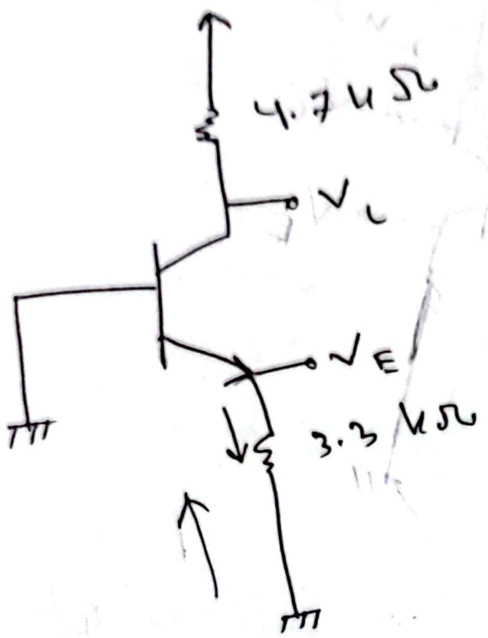
$$\Rightarrow i_B = \frac{9.8}{5}$$

$$= 1.96$$

$$\therefore \frac{5 - 0.7}{1.96} = R_B$$

$$= 2.2 \ k\Omega$$

10V



$V_B = 0$

$V_{CB} = V_C - V_B$

$= V_C$

$V_{BE} = V_B - V_E$

$\Rightarrow 0.7$

$\Rightarrow V_E = -0.7$

I_E have to be forward

$I_E = \frac{-0.7}{3.3}$

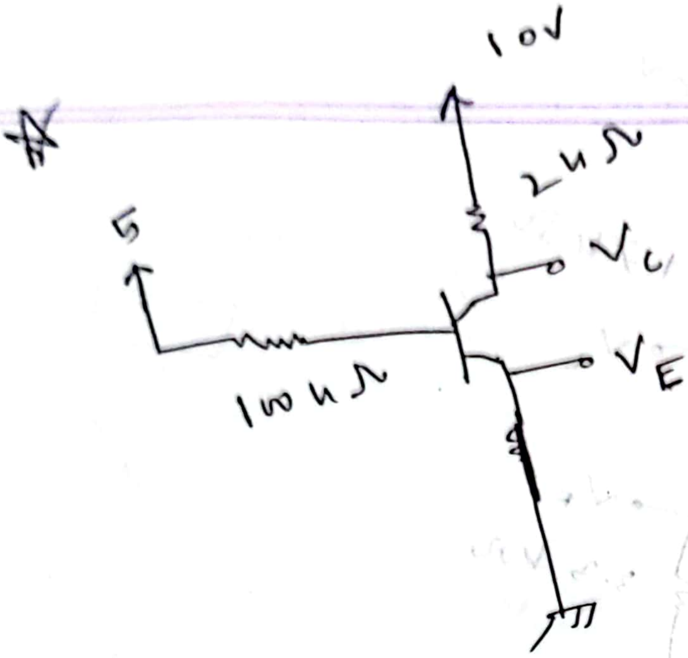
$= -0.21 \text{ mA}$

I_E [Reverse Bias]

$I_E = 0 \text{ mA}$

$I_B = 0 \text{ mA}$

$I_C = 0 \text{ mA}$



$V_E = 0$

$V_{BE} = V_B - V_E$

$\Rightarrow V_B = 0.7$

$\frac{5 - 0.7}{100} = I_B$

$\Rightarrow I_B = 0.043 \text{ mA}$

$I_C = \beta I_B$

$= 100 \times 0.043$

$= 4.3 \text{ mA}$

$\therefore I_E = 4.343 \text{ mA}$

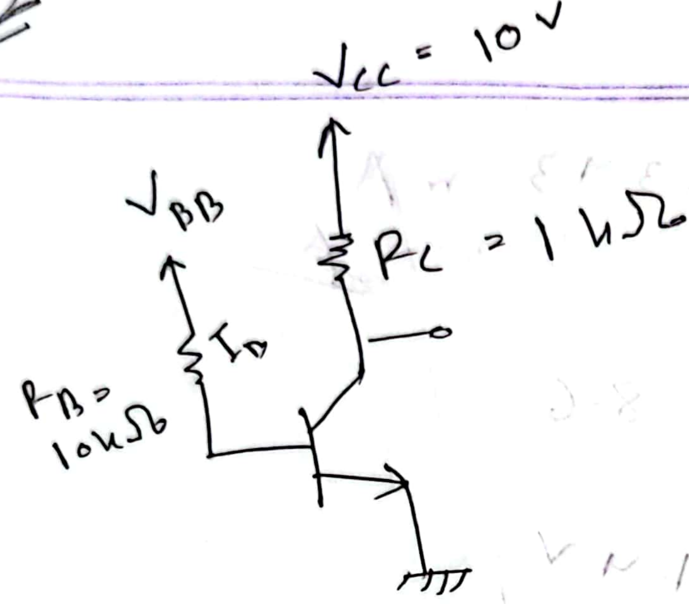
$10 - V_C = 8.6$

$\Rightarrow V_C = 1.4 \text{ V}$

বিষয়: $\rightarrow$ MOSFET

13.8.23

Electronics



$V_E = 0V$

$V_{CE} = 5V$ $\qquad V_{CE} \neq 0.3V$

$V_{BE} = 0.7$ $\qquad V_{CE} = 5V$

$V_B = 0.7$

$\beta = 50$ $\qquad \beta = \frac{I_C}{I_B}$

$I_C = \frac{V_{CC} - 5}{1}$ $\qquad \Rightarrow I_B = \frac{I_C}{\beta}$

$= \frac{10-5}{1}$ $\qquad = \frac{5}{50}$

$= 5 mA$ $\qquad = 0.1 mA$

$\therefore \cancel{V_{BB} = 5 = 1}$

$\Rightarrow V_{BB} = 6\,V$

$V_{BB} - 0.7 = 1$

$\Rightarrow V_{BB} = 1.7\,V$

$V_{CE} = 0.3$

$V_C = 0.3\,V$

$$\therefore I_C = \frac{V_{CC} - 0.3}{1}$$

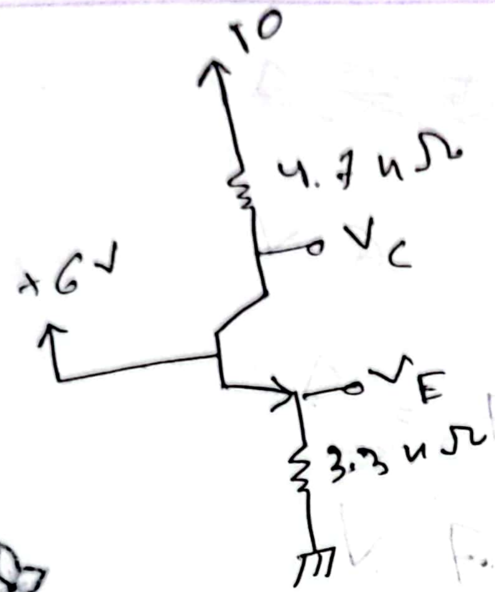
$$= \frac{10 - 0.3}{1} = 9.7$$

$$\therefore I_B = \frac{9.7}{50} = 0.194$$

$$\therefore V_{BB} = 0.7 + (10 \times 0.194)$$

$$= 2.64\,V$$

*



$V_B = 6$

$\therefore V_{BE} = 0.7$

$\Rightarrow 6 - V_E = 0.7$

$\Rightarrow V_E = 5.3V$

$I_E = \dfrac{5.3}{3.3} = 1.61 \ mA$

$\beta = 50$ (not lent)

$$\alpha = \frac{\beta}{1+\beta} = 0.98$$

$$\therefore \alpha = \frac{I_C}{I_E}$$

$$\Rightarrow I_E = \alpha I_E$$

$$= 0.98 \times 1.61$$

$$= 1.5778 \text{ mA}$$

$$\therefore I_B = I_E - I_C$$

$$= 0.032$$

$$\therefore 10 - V_C = (4.7 \times 1.5778)$$

$$\Rightarrow V_C = 10 - 7.42$$

$$= 2.58$$

$$V_{CB} = 2.58 - 6 = -3.42\text{V} < -0.4$$

(Saturation

$$V_{CE} = 0.2$$

$$\Rightarrow V_C - V_E = 0.2$$

$$\Rightarrow V_C = 0.2 + 5.3$$

$$= 5.5$$

$$I_C = \frac{10 - 5.5}{4.7}$$

$$= 0.96 \text{ mA}$$

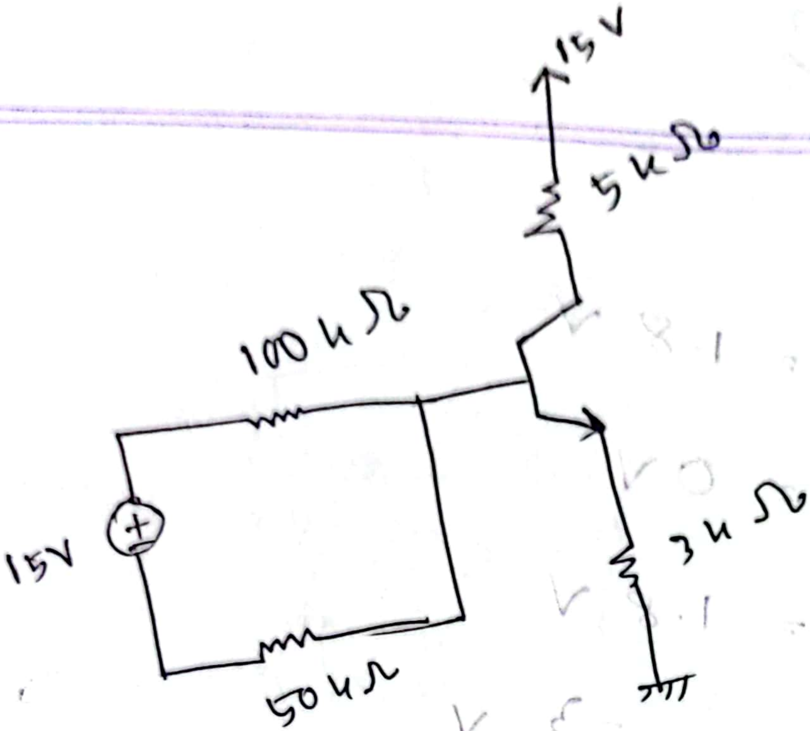
$$\therefore I_B = 0.65 \text{ mA}$$

$$\cancel{\therefore V_{BB} - V_C = 3.055}$$

$$\cancel{\Rightarrow V_C = 10 - 3.055}$$

$$\cancel{= 6.945 \text{ V}}$$

$$\beta_{force} = \frac{I_C}{I_B} = 1.5$$



$-15 + 100i + 50i = 0$

$\Rightarrow i = \frac{15}{150} = 0.1 \text{ mA}$

$15 - V_B = 10$

$\Rightarrow V_B = 5 \text{ V}$

Sum. 22

2

1(a)

$V_G = 1.8\ V$

$V_S = 0\ V$

$V_{GS} = 1.8\ V$

$V_D = 50\times10^{-3}\ V$

$= 0.05\ V$

$V_{DS} = 0.05\ V$

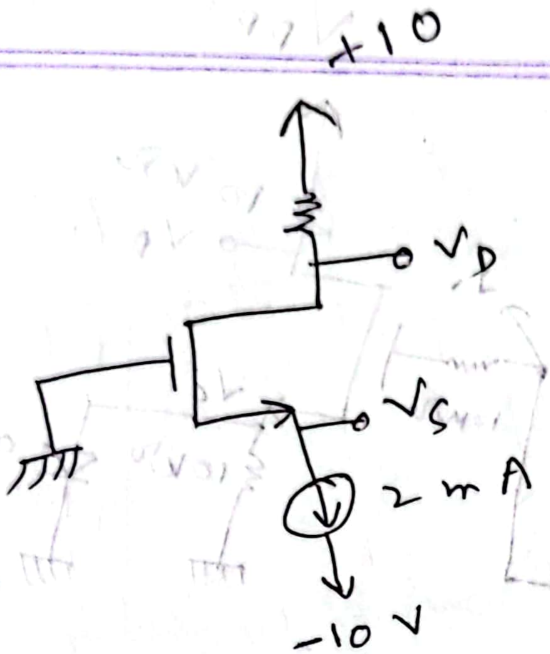
$V_{OV} = V_{GS} - V_t$

$= \cancel{0.05}\ 1.8 - 0.5$

$= 1.3\ V$

$V_{DS} < V_{OV}$

b



$$V_D = 10 - 4I_D$$
$$V_S = -10 + 2$$

$V_G = 0V$

$10 - V_D = 4 \times 2$

$V_t = 0.7$

$\Rightarrow 10 - V_D = 8$

$\Rightarrow V_D = 2 V$

$V_{OV} = 0 - V_S - 0.7$

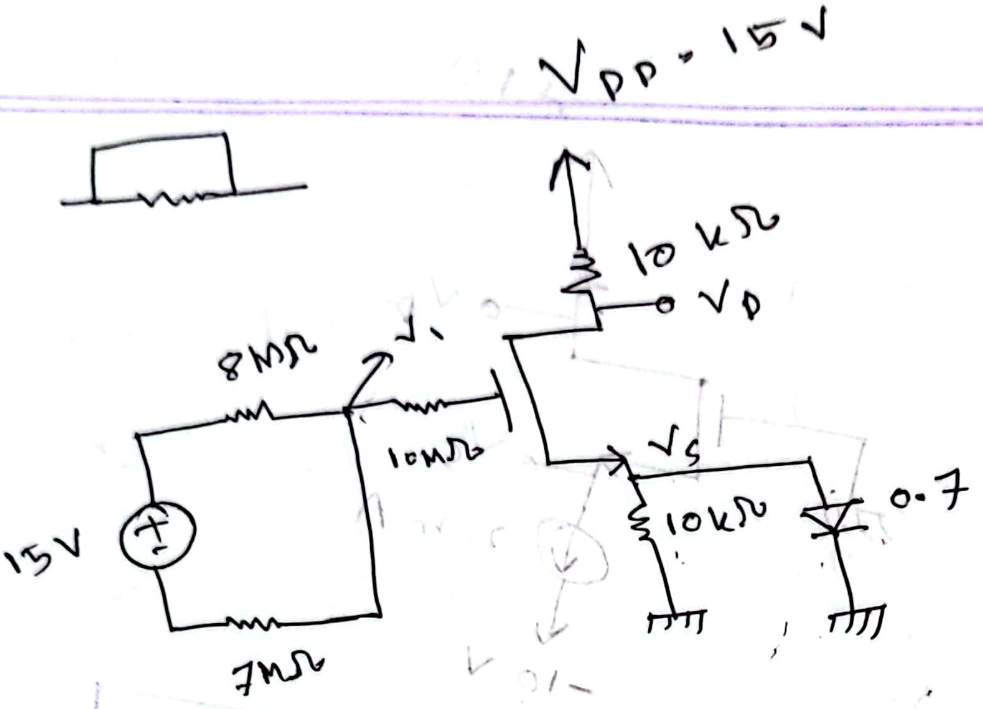
$= -V_S - 0.7$

$V_{DS} = 2 - V_S$

$= -V_S + 2$

$V_{DS} > V_{OV}$ (saturation)

(b).



$-15 + 8i + 7i = 0$

$15 - V_1 = 8$

$\Rightarrow V = 7$ V

$\Rightarrow 15i = 15$

$\Rightarrow i = 1\ \mu A$

$= 1 \times 10^{-3}$ mA

~~$i_D = \frac{0.7}{10} = 0.07$ mA~~

$V_G = 7V$

$15 - V_D = 10\, i_D$

$\Rightarrow V_D = 15 - 10\, i_D$

$V_S = 0.7$

Assume ~~triode~~ saturation,

$\cancel{i_D = k'_n \frac{W}{L}\left(V_{GS} - V_t\right)V_{DS} - \frac{1}{2}V_{DS}^2}$

$i_D = \frac{1}{2} k'_n \frac{W}{L}\left(V_{GS} - V_t\right)^2$

$i_D = \frac{1}{2} \times 2.5 \; (7 - 0.7 - 0.75)^2$

$= 38.5 \; mA$

$V_{DS} = 15 - (38.5 \times 10) - V_S$

$= -370.7 \; V$

$V_{ov} = V_{GS} - V_t$

$= 7 - 0.7 - 0.75$

$= 5.55$

CW 20.8.23

Not gate

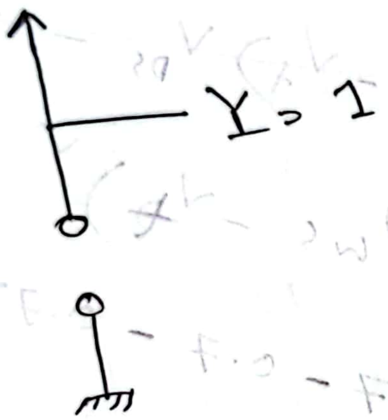
Cmos
↳ Complementary

Active :

A = 0 : (low voltage)

NMos : off

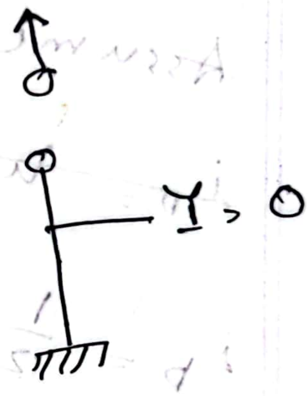
PMos : ON

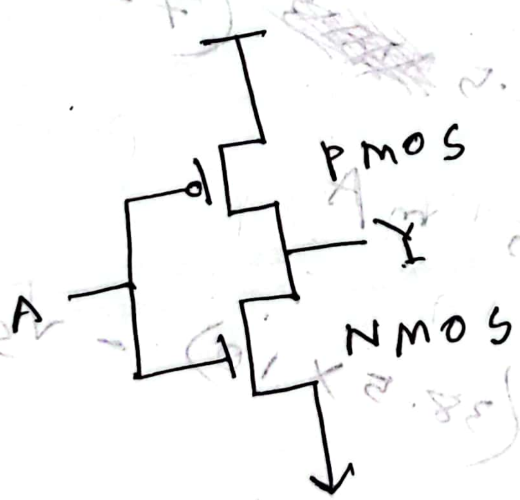


A = 1 (High voltage)

NMos : ON

PMos : OFF





যতগুলো input থাকবে ততগুলো NMOS থাকবে।

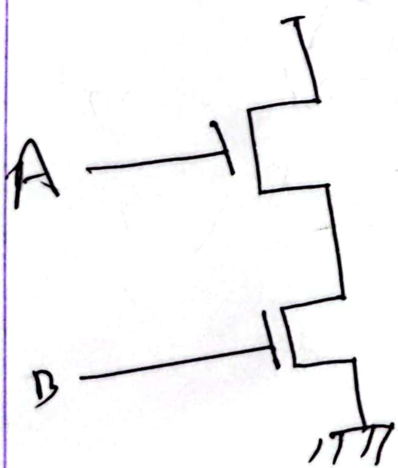
NAND Gate (NMOS)

* Input যদি গুণ আকারে থাকে তাহলে NAND gate NMOS series এ থাকবে।

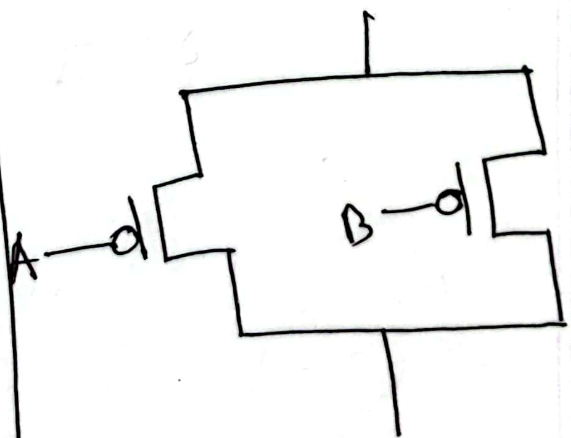
* " " যোগ " " "
NAND gate NMOS parallel এ থাকবে।

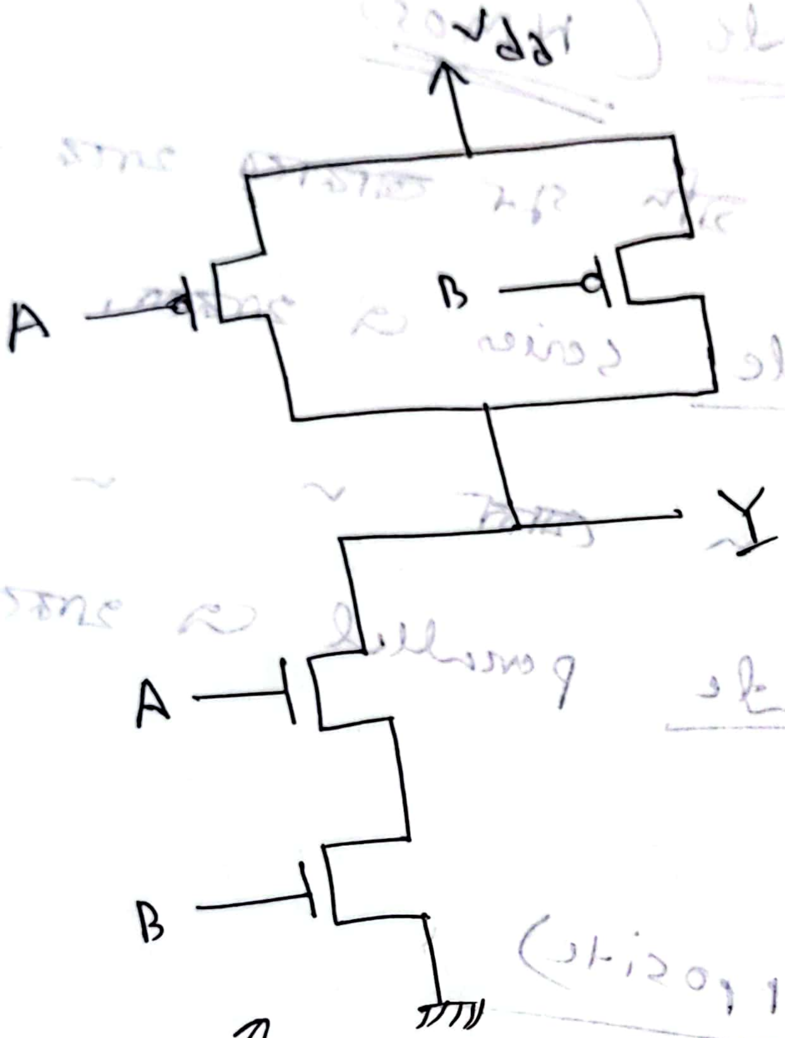
(PMOS opposite)

$Y = \overline{AB}$ (NMOS)



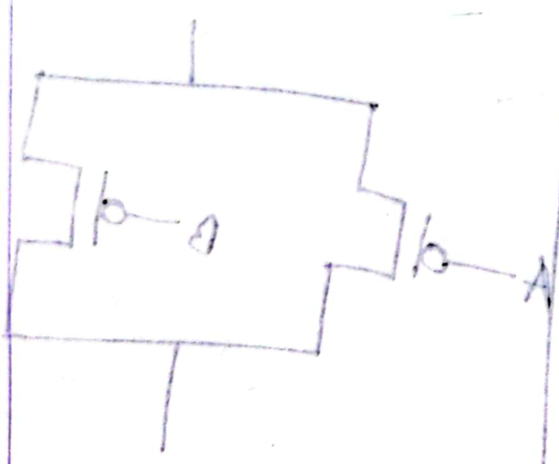
(PMOS)

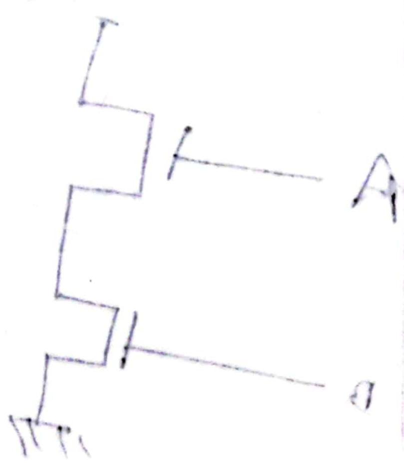




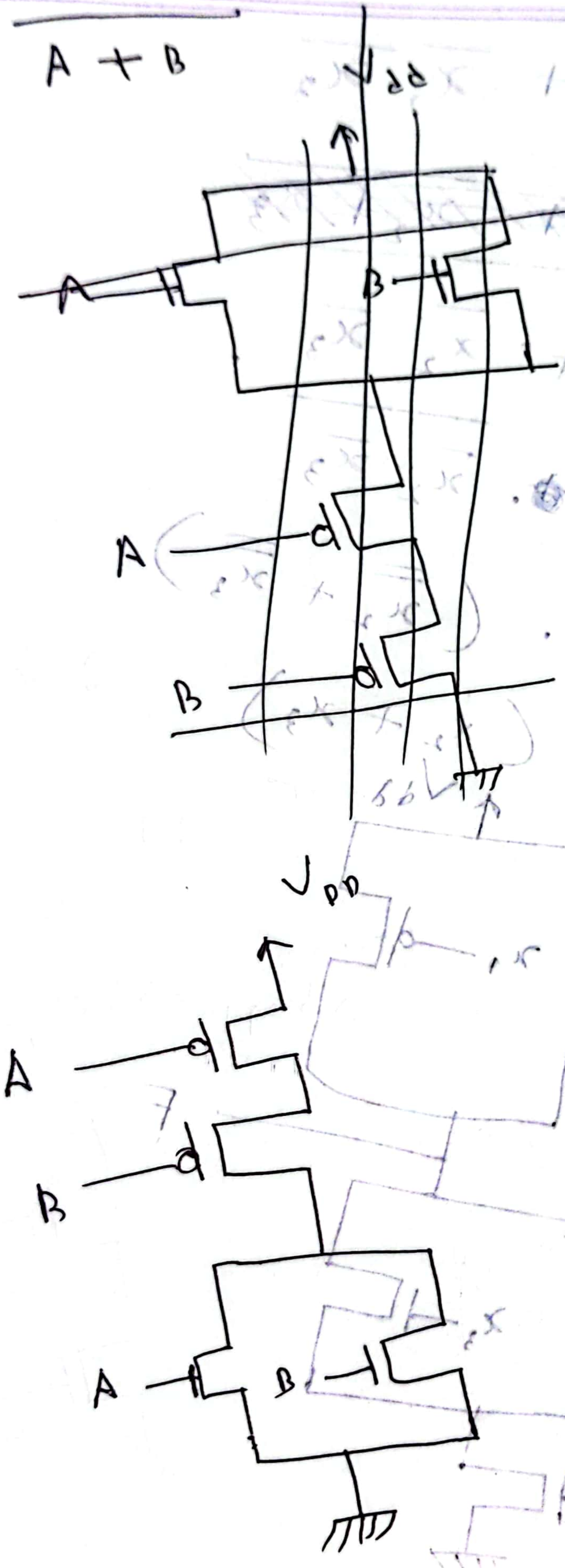
$Y = \overline{AB}$

$Y = AB$ (NAND এর সাথে NOT)





$Y = \overline{A + B}$



$$F = \bar{x}_1 + \bar{x}_2 \bar{x}_3$$

$$= \cancel{\overline{x_1 + x_2 x_3}}$$

$$\overline{F} = \overline{\bar{x}_1 + \bar{x}_2 \bar{x}_3}$$

$$= \bar{\bar{x}}_1 \cdot \overline{\bar{x}_2 \bar{x}_3}$$

$$= x_1 \cdot (\bar{\bar{x}}_2 + \bar{\bar{x}}_3)$$

$$= x_1 \cdot (x_2 + x_3)$$