Unit – 01

Semiconductor Diode & its applications.

⇒ Semiconductors are materials which have electrical conductivity b/w the conductors and insulators. Semiconductors are classified as.

- Intrinsic Semiconductor.
- Extrinsic Semiconductor.

Semiconductors
- Semi Intrinsic Conductor (Pure form of Ge, Si) ($n_h = n_e$)
- Extrinsic Semiconductor (Intrinsic Semiconductor + Doping = Extrinsic Semiconductor)
  - P-type (Trivalent impurities
  - n-type (Pentavalent impurites) ($n_e > n_h$)

Intrinsic Semiconductor	Extrinsic Semiconductor
① Pure Form	Impure Form
② Number of holes and number of electrons are equal	② Number of holes and number of electrons are not equal
③ Low conductivity	③ High conductivity.

Page ______

Date ______

Que → What do you mean by doping and why it is required ?

Ans → Doping is the process of adding impurities to the intrinsic Semiconductor to charge their properties. Doping is required to control conductivity.

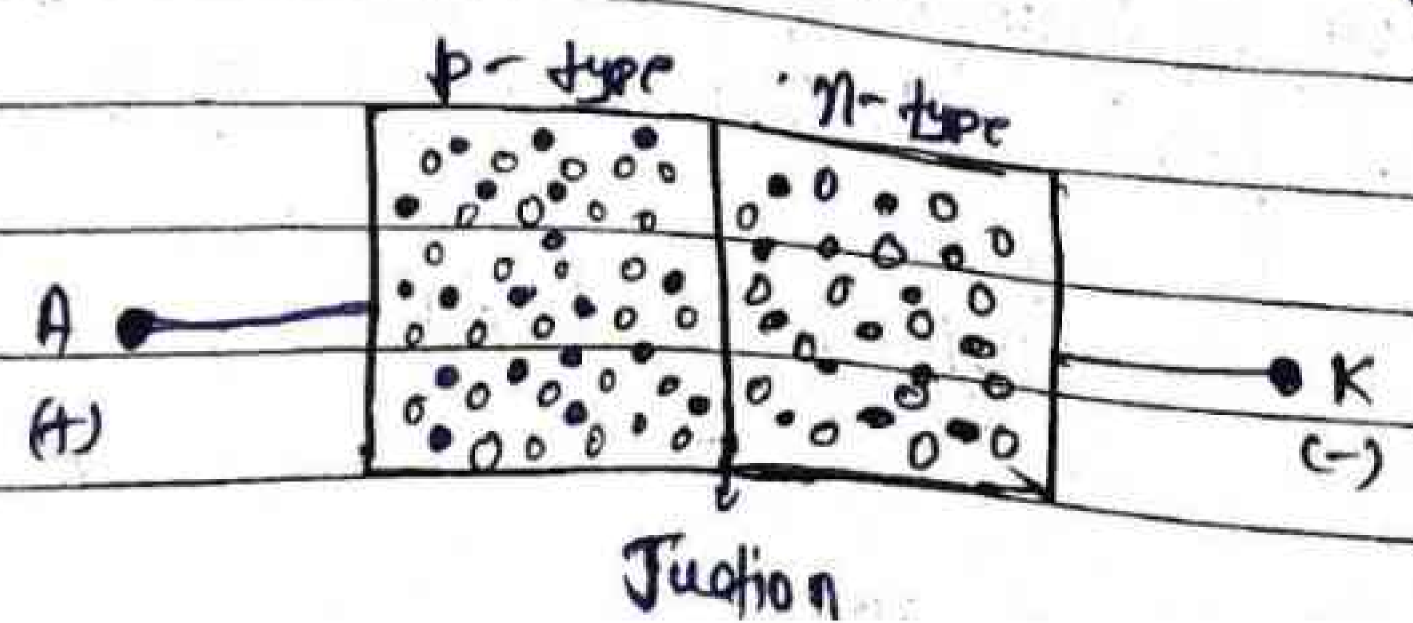
* Effect of temprature on conductors. Semiconductor and insulator :-

① With an increases in temprature the resistivity of conductors increases. there fore the conductivity of condutors decreases.

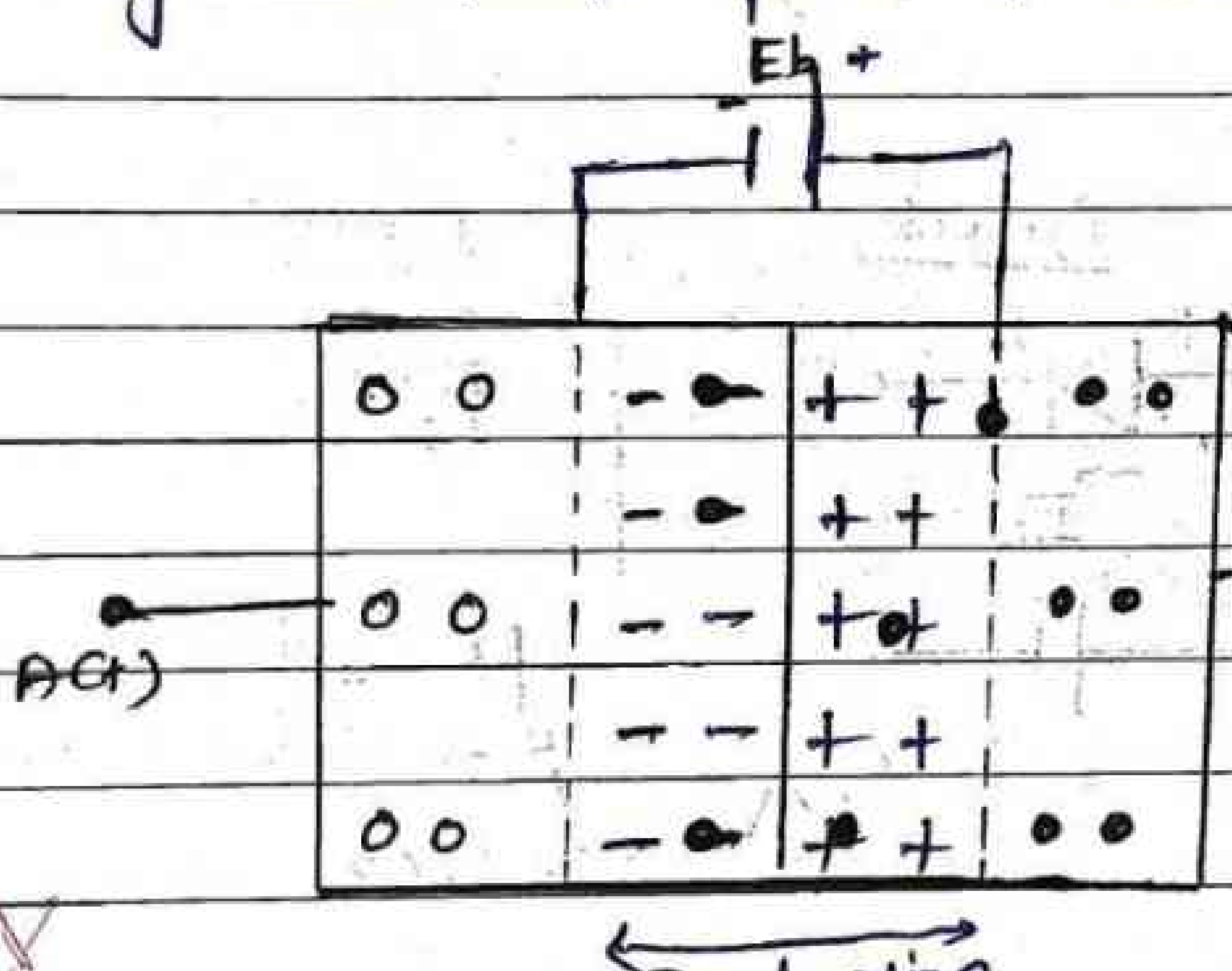
② With an increases in temprature the resistivity of semi-conductors and insulators decreases. therefore the conductivity of semiconductor and insulators increases.

Que → Explain the Construction and working of P.N. Juction Diode. Also draw its V.I. charateristics.

Ans → Construction → When a piece of p-type Semiconductor is joined with a piece of n-type Semiconductor such that the crystal structure remains continious at the boundary. then a junction is formed and the device so formed is know as p-n juction diode-



By the Diffusion Process (i.e. the charge will move from thier higher density towards their lower density) a region becomes created where no mobile charge ions are present is knaw as Depletion region or Depletion layer and its acts as Depletion barrier which apposes the flow of holes from P-side to n-side and the flow of electrons from n-side to p-side.



Depleation region

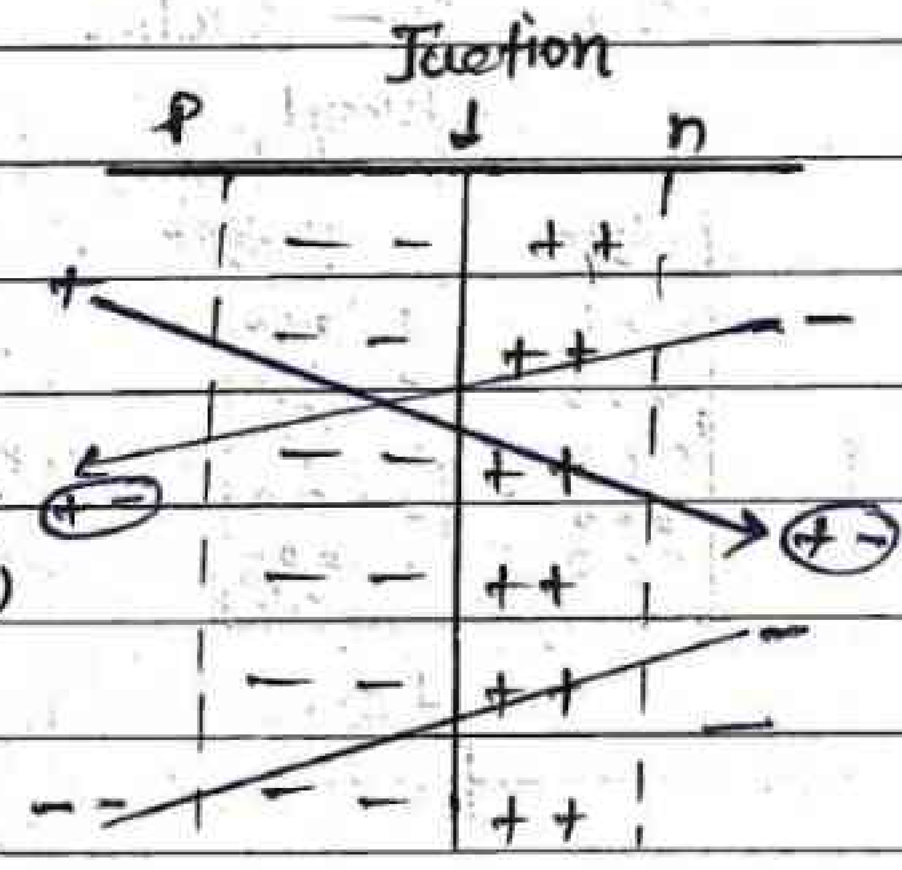
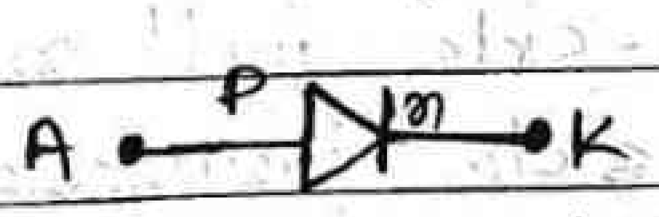


Fig.→ Diffusion Process.

⇓



Symbol

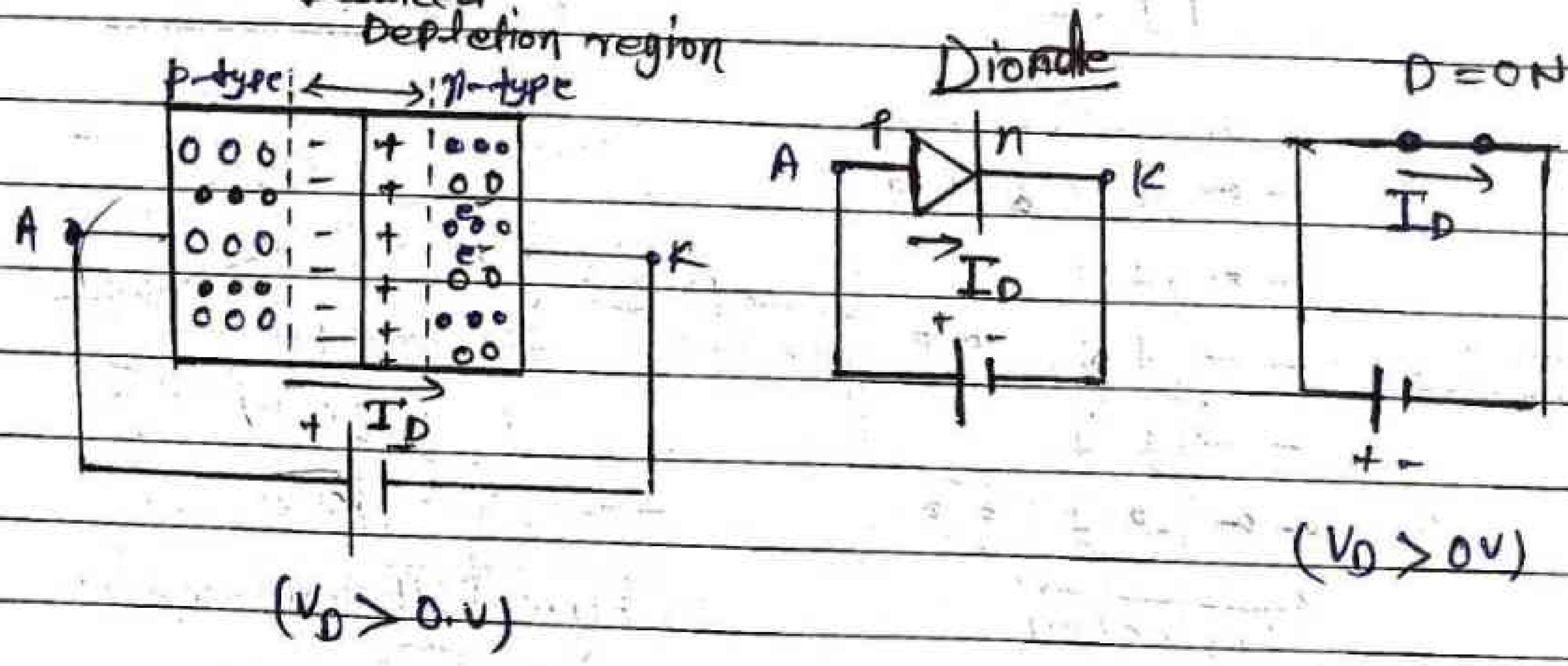
* Working :-

Case - I :- No Bios Condition (i.e. $V_D = 0\,V$) :-

Under no bios condition, no external voltage is applied b/w the anode and cathode terminals.

Case-II → <u>Forward bias condition (ie. $V_D > 0V$.)</u>

⇒ Under forward bois condition, some positive volts is applied b/w the anode and the cathode terminals. Such that the positive terminal of the battery is connected with the p-side and the negative terminal of the battery is connected with the n-side.



In this condition the electrons which are the majority charge carriers of the n-side will move from the n-side towards the p-side therefore, A conventional current will flow from the Anode terminal towards the cathode terminal. This current is know as forward current of a diode and is given by the eqn which is known as <u>diode current eqn</u>

Where- I_D = Diode current or forward current
I_0 = Reverse saturation current

Diode current eq^n :-

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

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

Wher,

I_D = Diode current or forward current
I_0 = Reverse saturation Current
V_D = Applied Voltage across a diode
η = Constant
1 (Ge)
2 (Si)

V_T = Voltage equivalent of temprature

$$V_T = \frac{KT}{q} = \frac{T}{11600}$$

K = Boltzmann's Constant = 1.38×10^{-23} J/K
q = Electric charge 1.6×10^{-19} C
T = Diode juction temp (°K)

V_T = 26mV (at room temp.)

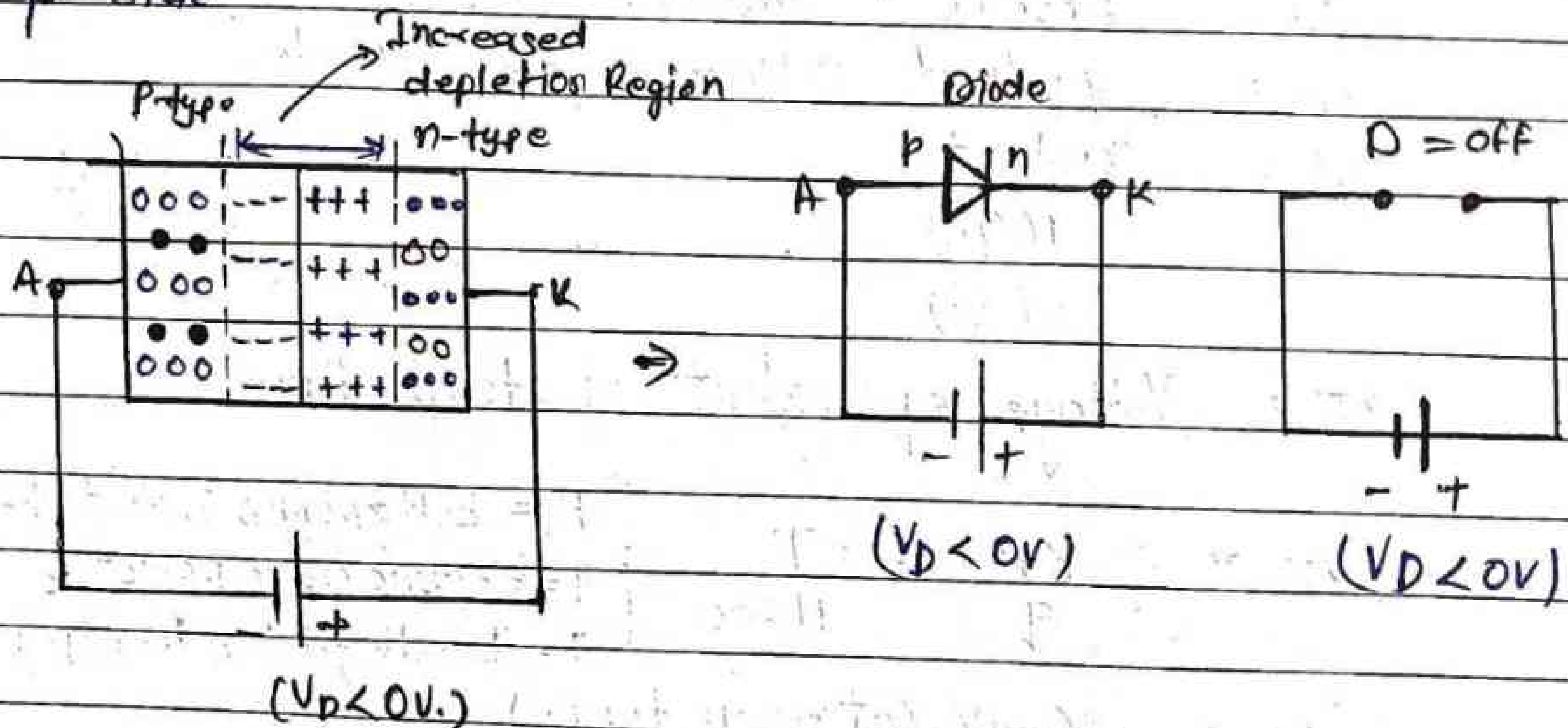
* Note :- Under forward bias condition the width of Depletion region decreases.

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

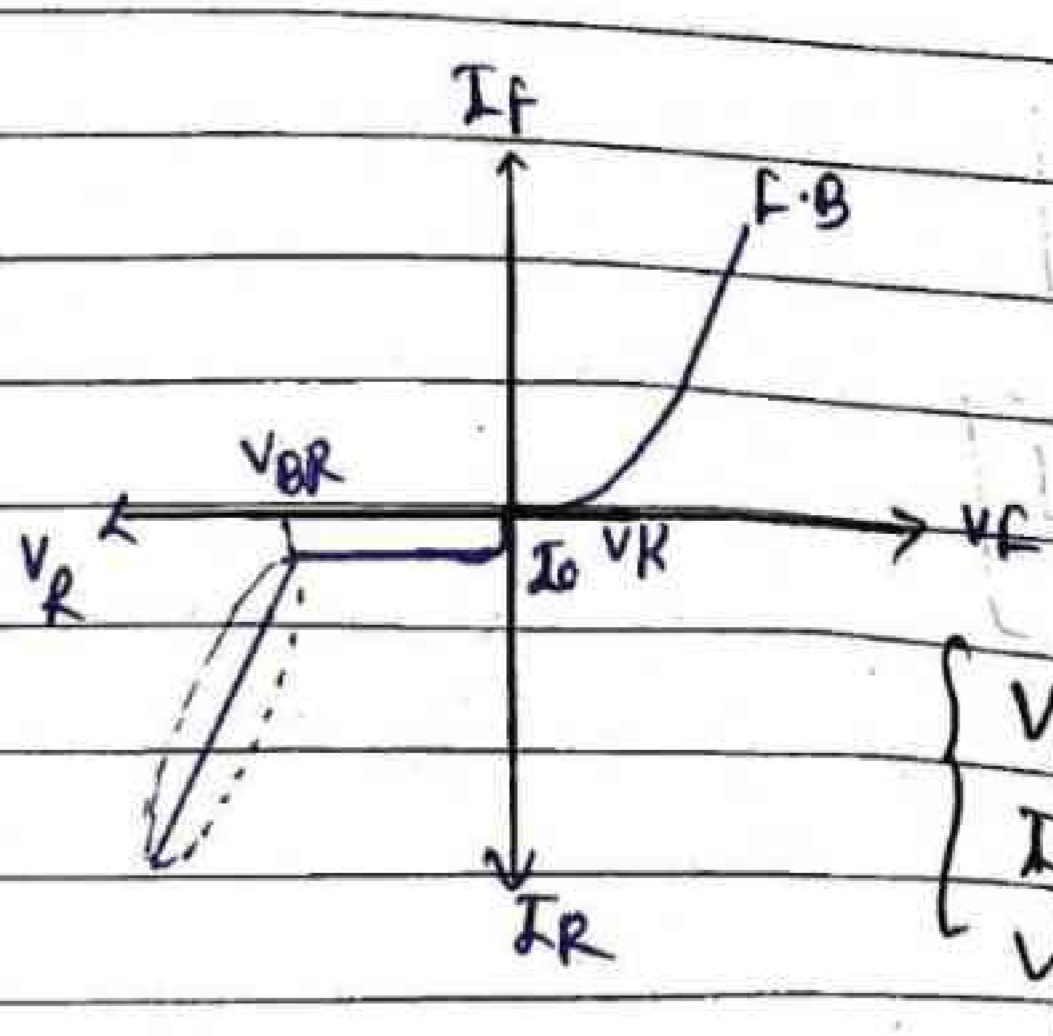
$$= I_0 \left[e^{\frac{qV_D}{\eta KT}} - 1 \right]$$

Case-III → Reverse Bias Condition. (ie. $V_D < 0V$)

Under reverse bias condition, some (-)ve voltage is applied ~~within~~ b/w the anode terminals and the kathode terminals. Such that, the (+)ve terminal of the battery is connected to ~~f~~ with n-side and the (-)ve terminal of the battery is connected with the p-side



*** Note :-** Under reverse bias Condition, the width of depletion region increases.

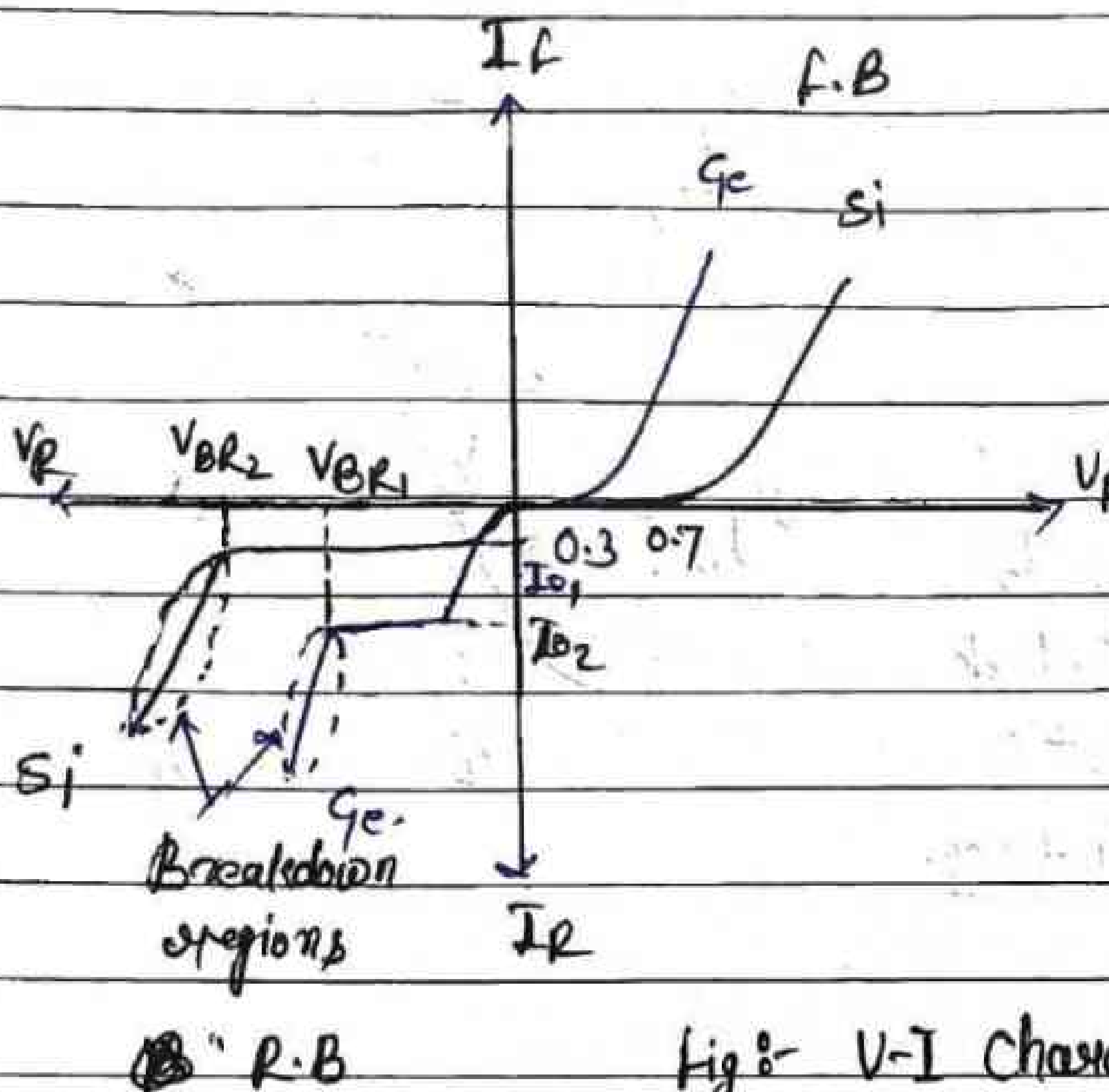


Knee voltage / ~~Barrier Potential~~ / Cut in Voltage

Ge Diode =	0.3V
Si Diode =	0.7V

V_K = Knee voltage
I_o = Reverse saturation current
V_{BR} = Reverse breakdown Voltage

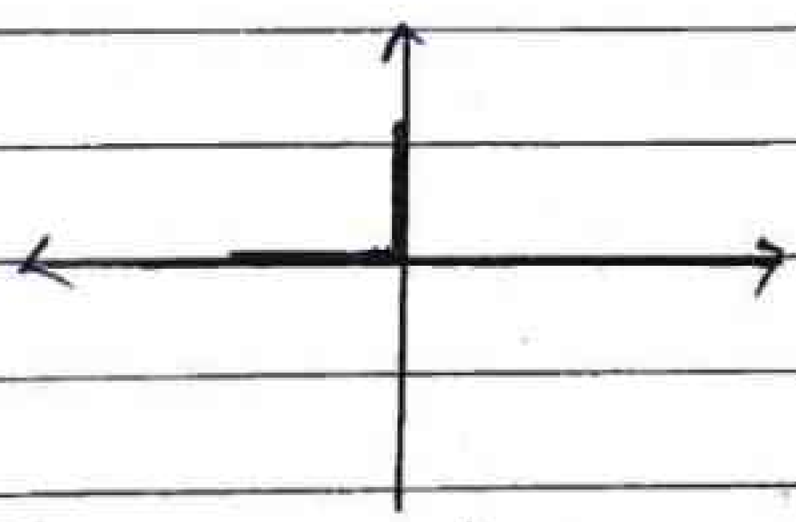
Fig → V-I charateristic of P-n Jemction Diode



Ge Diode → 0.3V, I_{O_2}, V_{BR_1}

Si Diode → 0.7V, I_{O_1}, V_{BR_2}

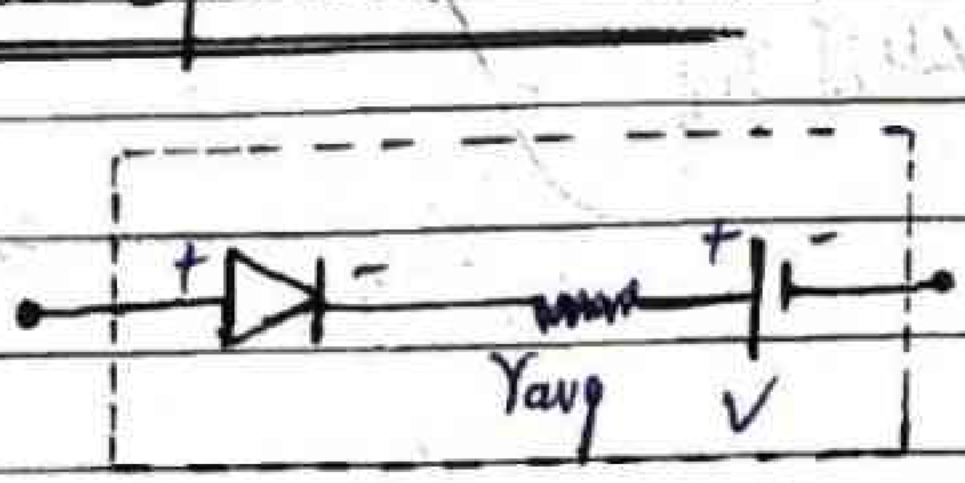
Fig :- V-I Charactarstic of Semiconductor Diode (Ge & Si)



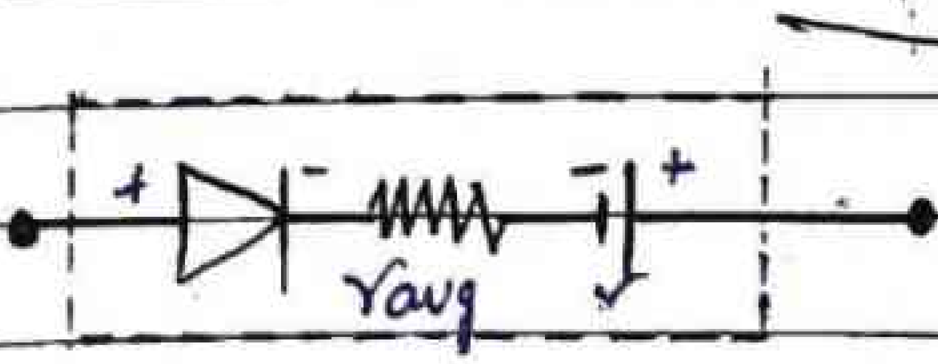
* Infinite amount of current
* Zero knee voltage
* Zero voltage saturation current

Fig :- Characteristic of an Ideal Diode.

Diode equivalent Circuit :-



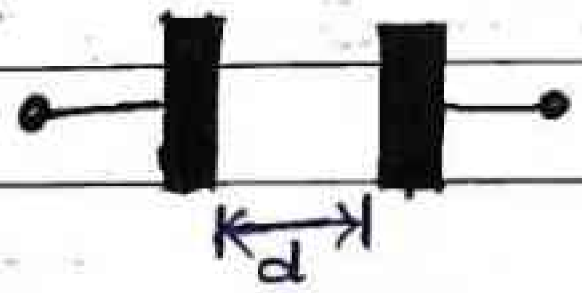
Reverse



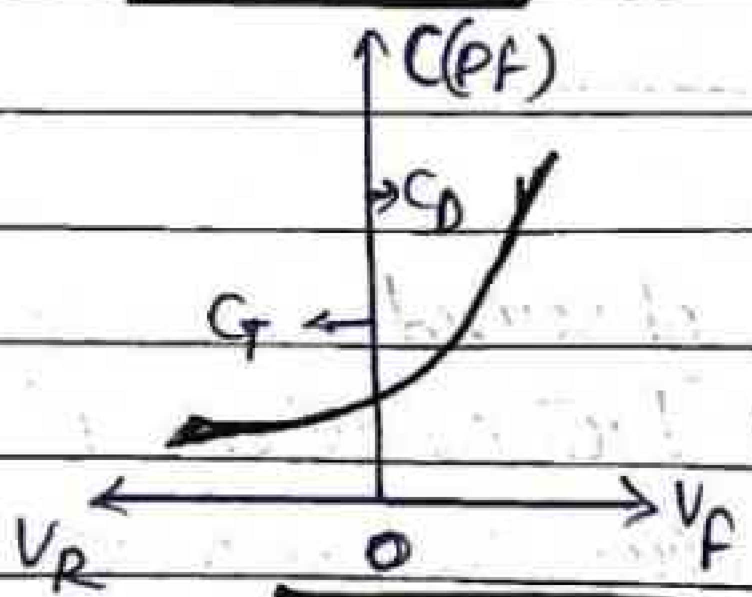
Forward

② **Trancition Capacitance :-** It is observed across a diode under reverse bias condition.
It is denoted by C_T and is also known as **Depletion Capacitance** of a diode.

$$C_T = \frac{K}{\sqrt{V}}$$



$$C = \frac{\epsilon A}{d}$$



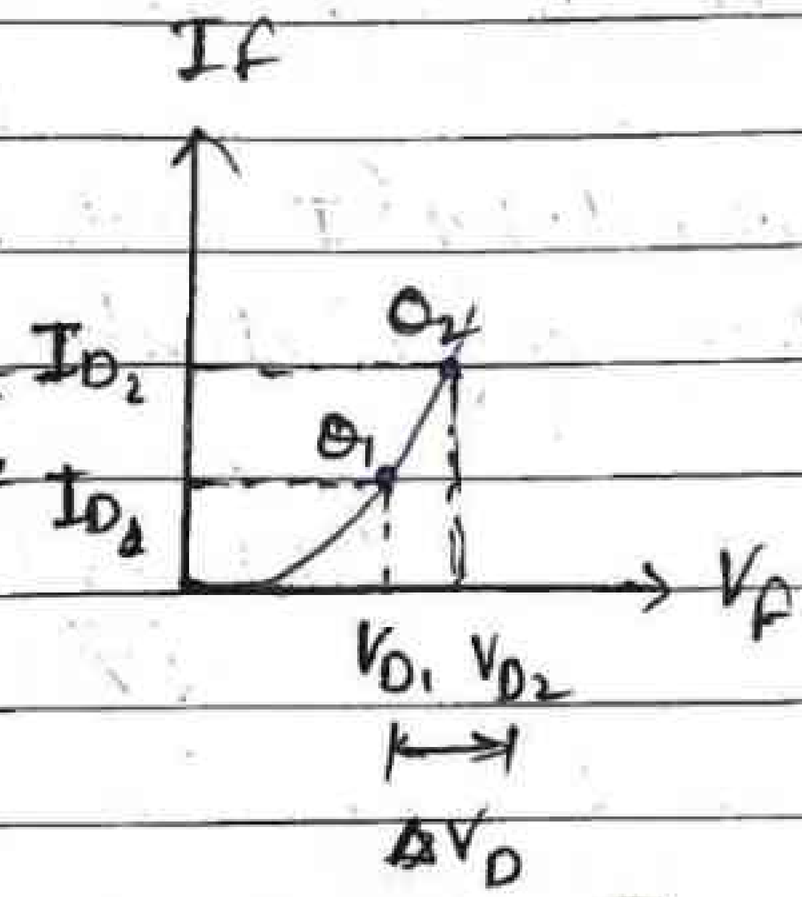
$$C_D >> C_T$$

Fig. Capacitance Vs Applied Voltage across a diode.

Page ______
Date ______

Average a.c. resistance :-

It is defined as the ratio of change in voltage a diode (ΔV_D) to the change in ΔI_D Current across a diode (ΔI_D) b/c of two operating Points Q_1 and Q_2



$$\gamma_{avg} = \frac{\Delta V_D}{\Delta I_D}$$ b/c of Q_1 and Q_2

Diode Capacitances :-

① Diffusion Capacitance :- It is ~~obsere~~ observed across a diode under forward bias condition. It is denoted by C_D and it is also known as Storage capacitances of a diode.

$$C_D = \frac{\tau I_D}{\eta V_T}$$

Where

τ = mean life time period of carriers

I_D = forward Current or Diode Current

η = Constant
= 1 (Ge)
= 2 (Si)

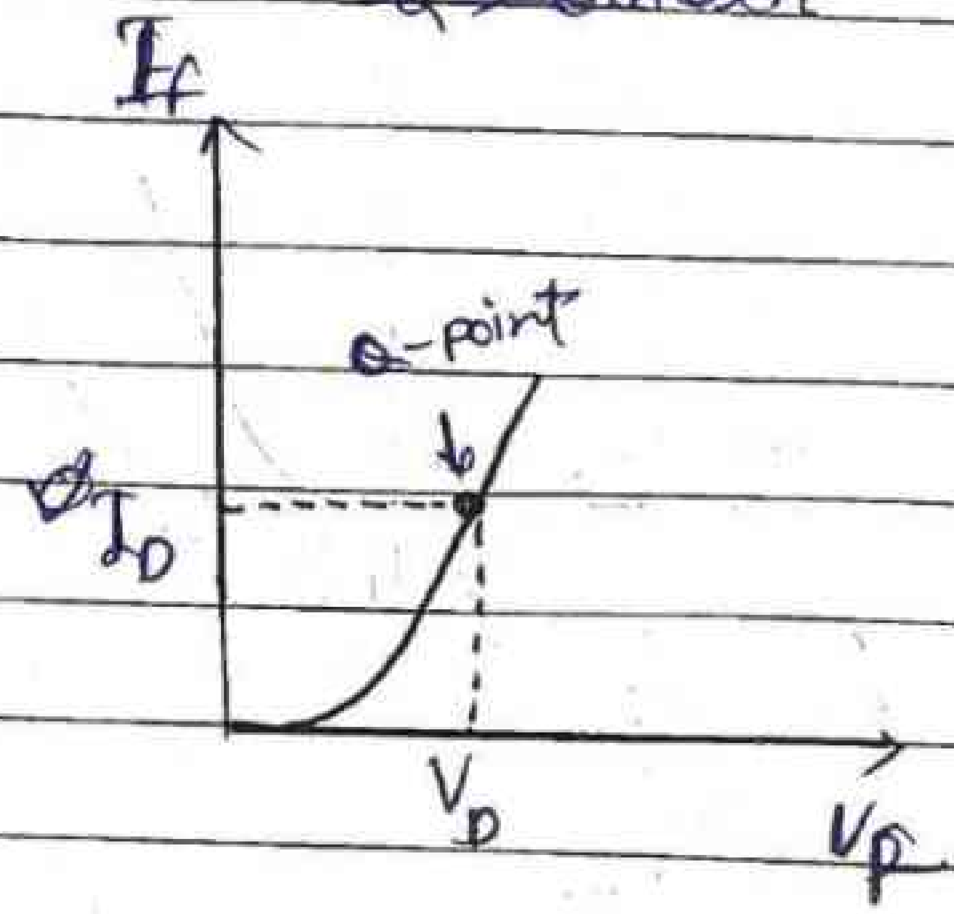
V_T = voltage equivalent of Temp^r

Page
Date

Q → Quiescent / oprating

~~Q → Quiescen~~

* Diode Resistances :-



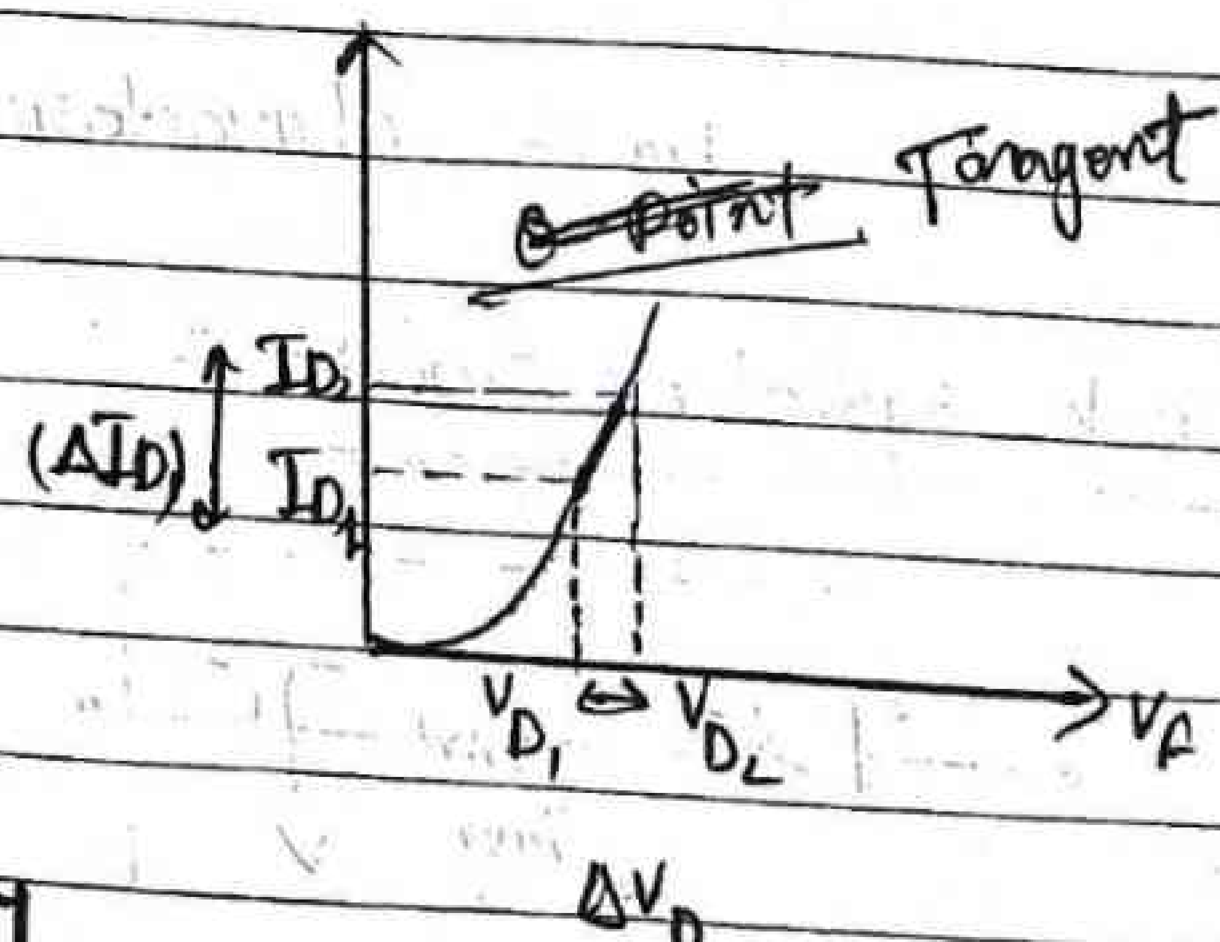
① Static Resistance :-

It is defined as the ratio of voltage across a diode (V_D) to the current across a ~~current~~ diode (I_D) at a single oprating point Q. It is also know as D.C. resistance of a diode.

$$R_D = \frac{V_D}{I_D} \Big|_{\text{at Q. Point}}$$

② Dyanamic Resistance :-

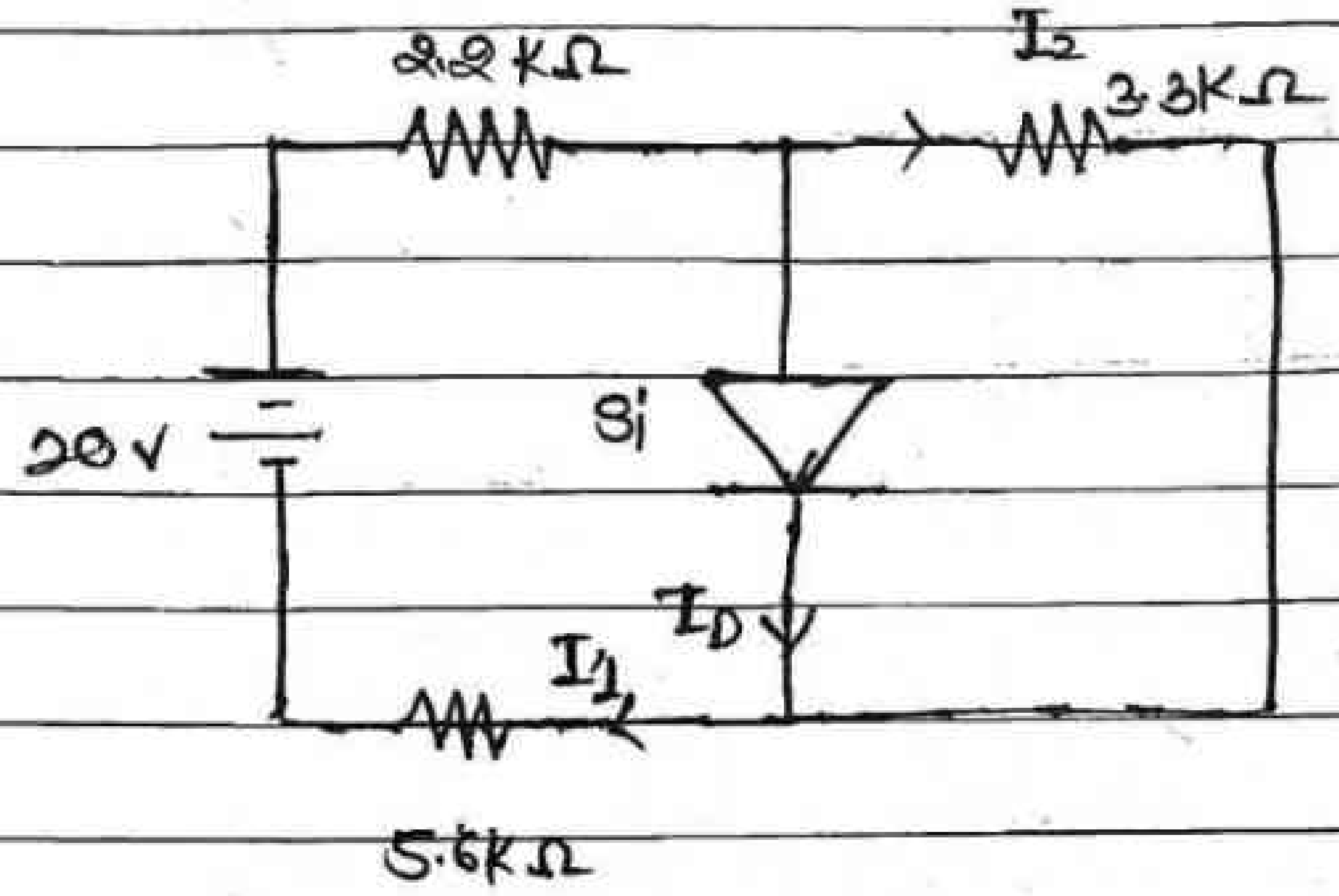
It is defined as the ratio of change in voltage across a diode (ΔV_D) to the change in current across a diode (ΔI_D) because of tangent drawn at Q-Point. It is also known as a.c. resistance of a diode.

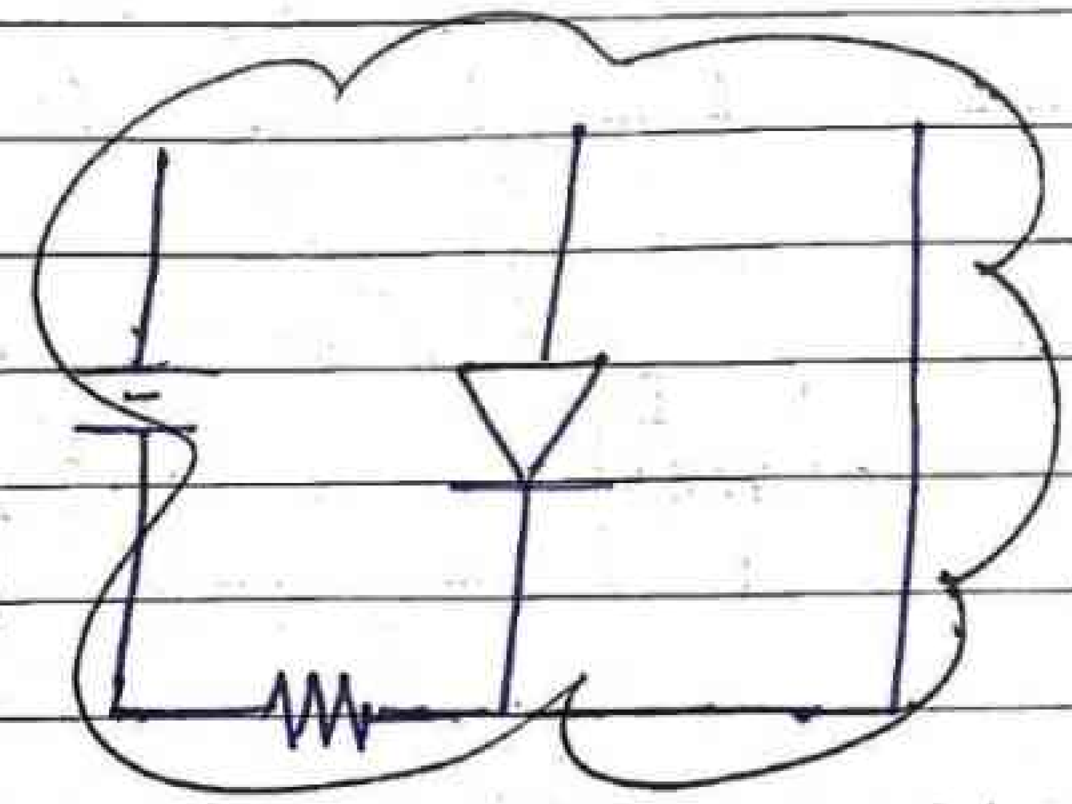


$$r_D = \frac{\Delta V_D}{\Delta I_D} \Big| \text{ b/c of tangent drawn at a point}$$

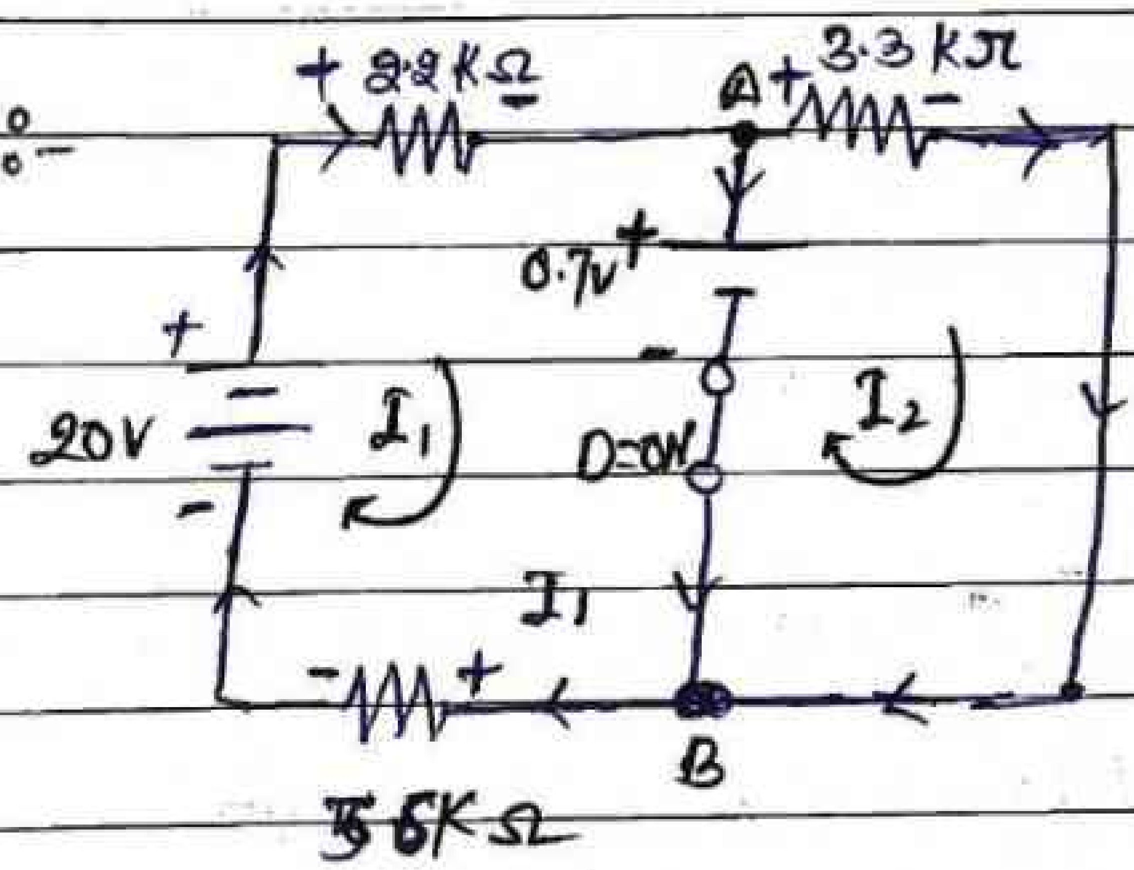
$$r_D = \frac{\eta V_T}{I_D + I_0}$$

Que : Determine I_1, I_2 and I_D for the given circuit.





Sol^n :-



Using KVL.

$$20 - 2.2I_1 - 0.7 - 5.6I_1 = 0$$

$$19.3 - 7.8I_1 = 0$$

$$I_1 = \frac{19.3}{7} = 2.47\,mA$$

and

$$-3.3I_2 + 0.7 = 0$$

$$I_2 = \frac{0.7}{3.3} = 0.21\,mA$$

Now, by using KCl at point A

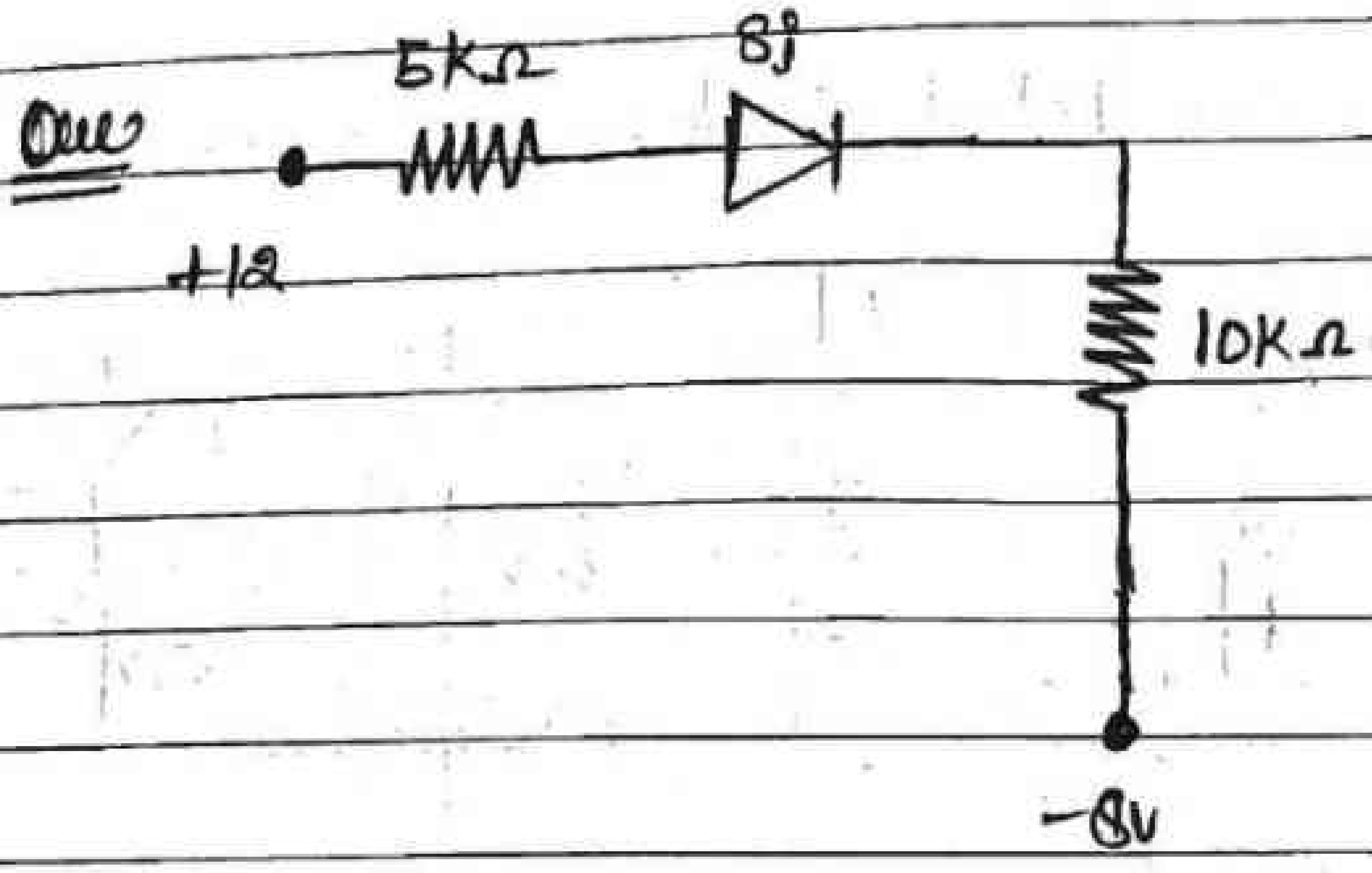
$$I_1 = I_2 + I_D$$

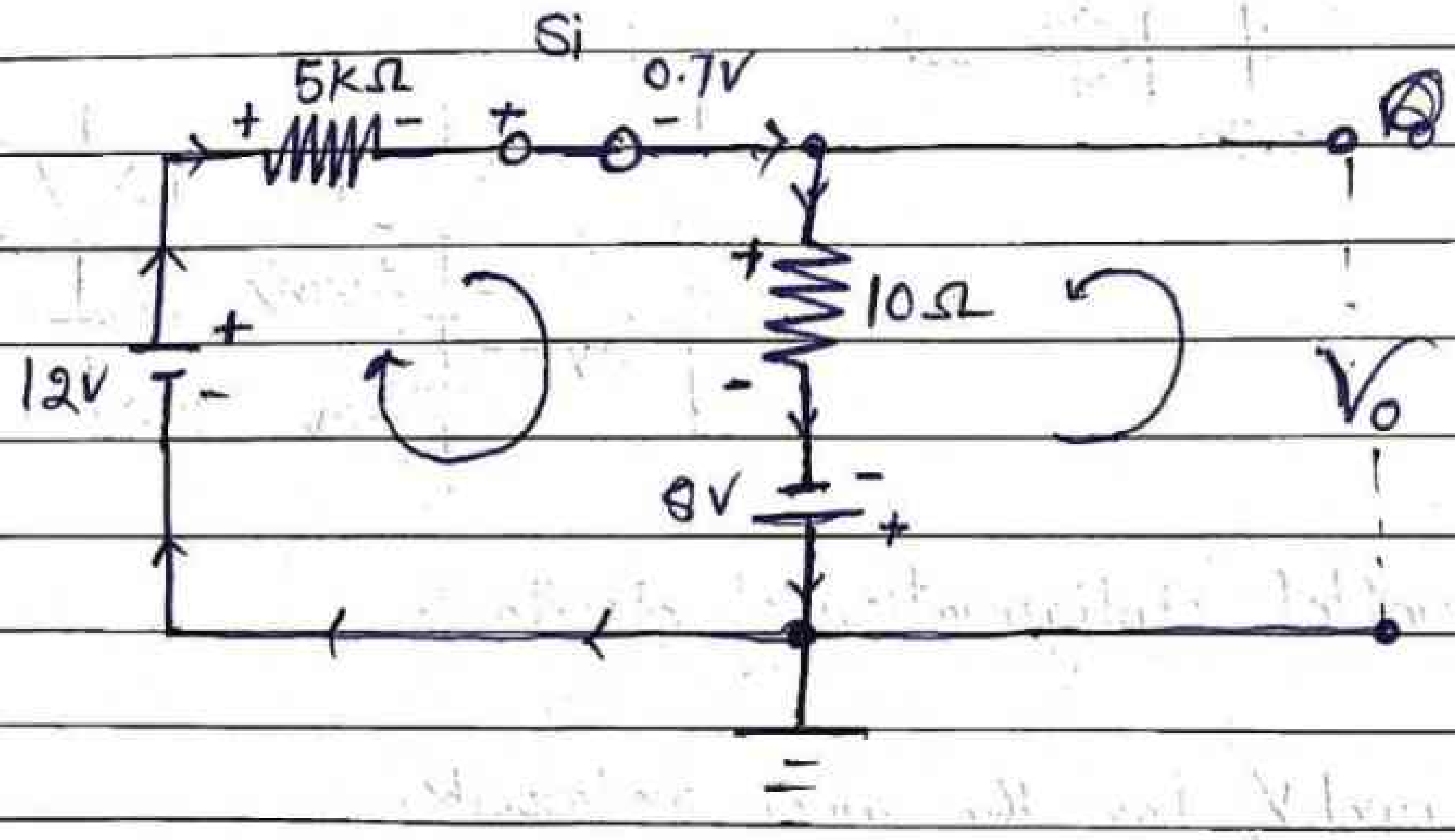
$$2.47 = 0.21 + I_D$$

$$2.26 = I_D$$

$$\boxed{I_D = 2.26\,mA}$$ Ans

Que





$12 - 5I_D - 0.7V - 10I_D + 8 = 0$

$20 - 15I_D - 0.7 = 0$

$+15I_D = +19.3$

$I_D = \frac{19.3}{15} = 1.28$

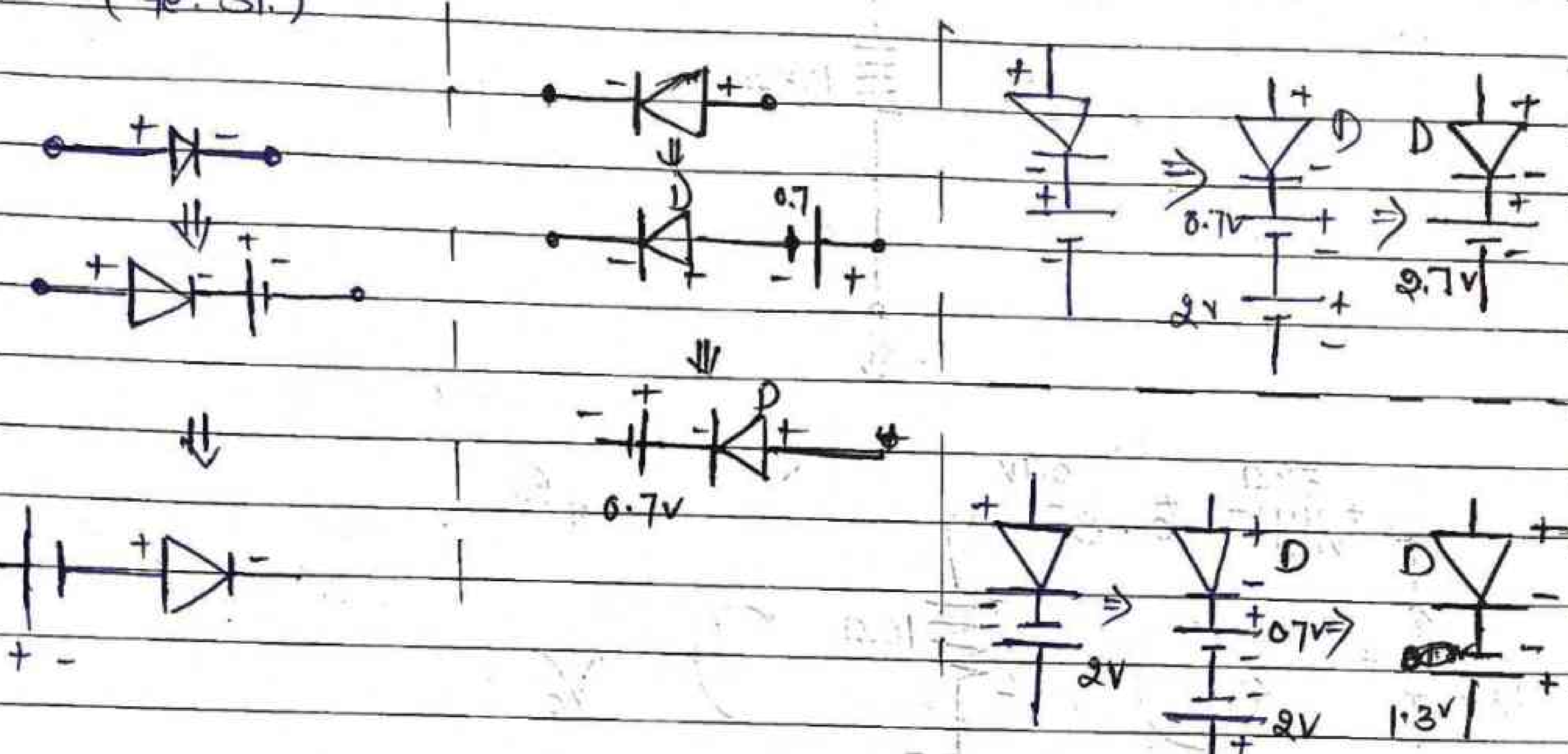
$-10I_D + 8 + V_D = 0$

$-10 \times 1.28 + 8 + V_D = 0$

$-12.8 + 8 + V_0 = 0$

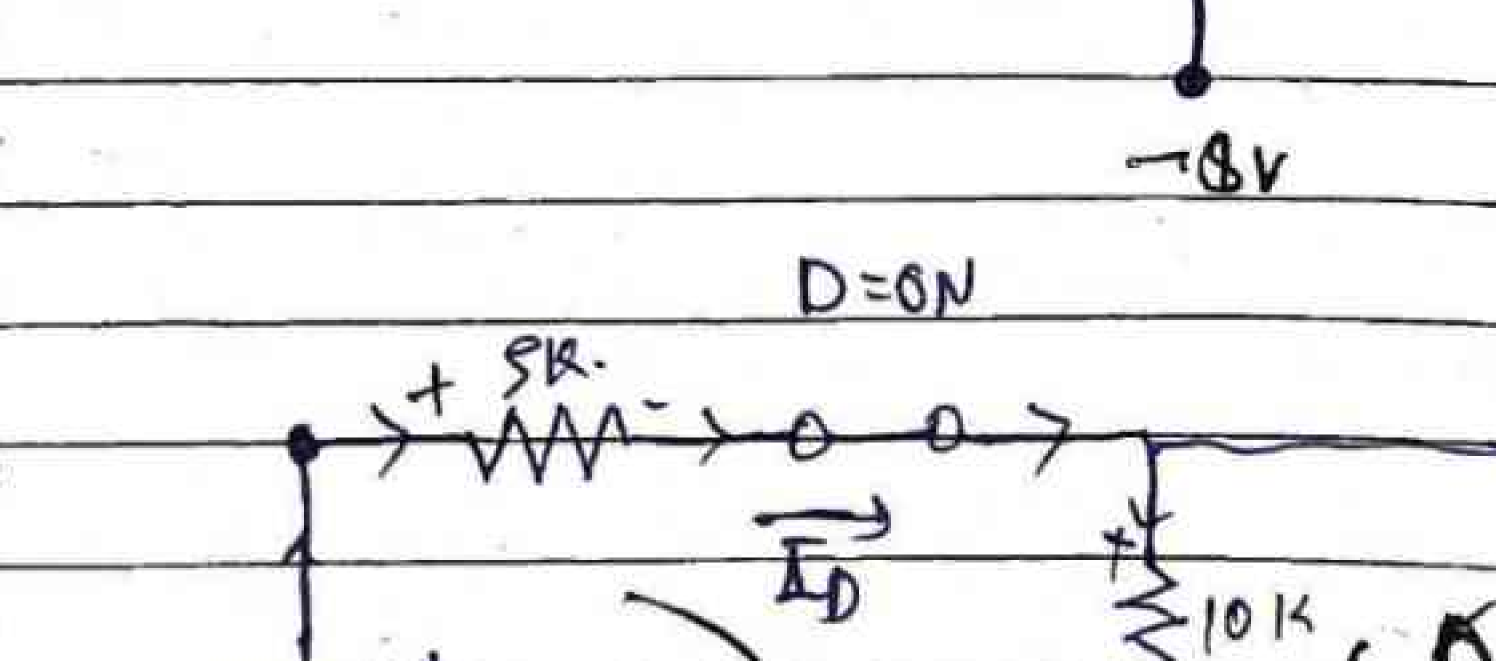
$V_0 = +4.8$ Ans

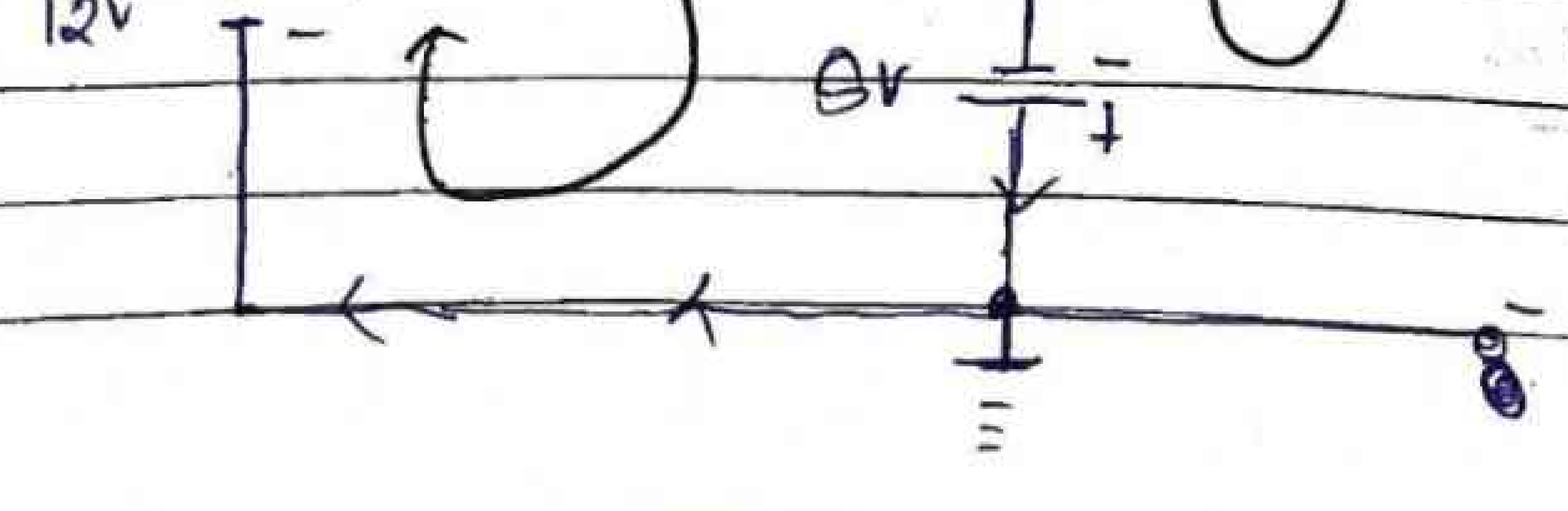
* Practicle Diode :- (Change) → Ideal diode
(Ge. Si.)



Series and parellel Configuration of diode :-

Que :- Determine I_D and V_o for the given network.





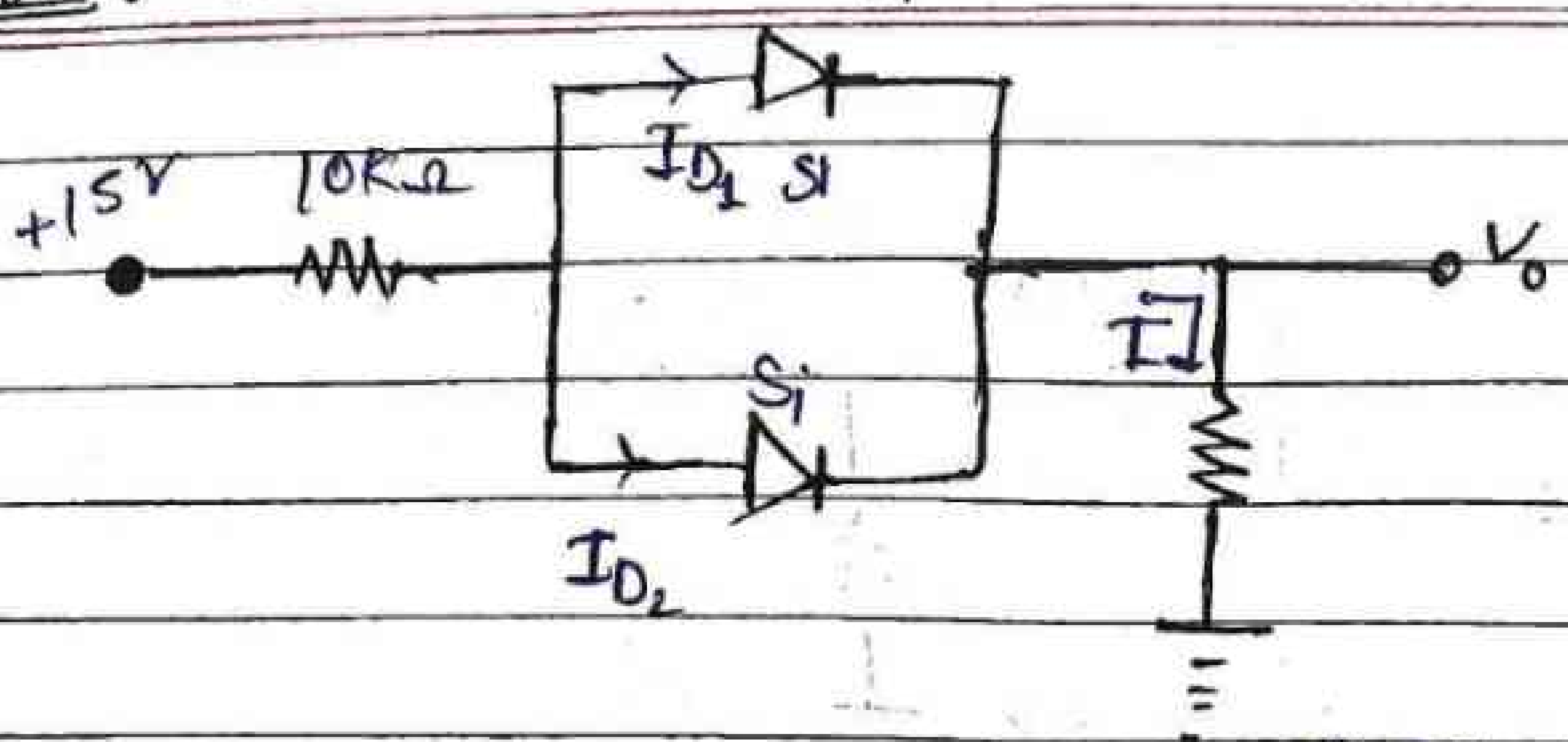
Using KVL

$$12 - 5I_D - 10I_D + 8 = 0$$
$$20 - 15I_D = 0$$
$$-15I_D = -20$$
$$I_D = \frac{20}{15} = 1.3\,mA$$

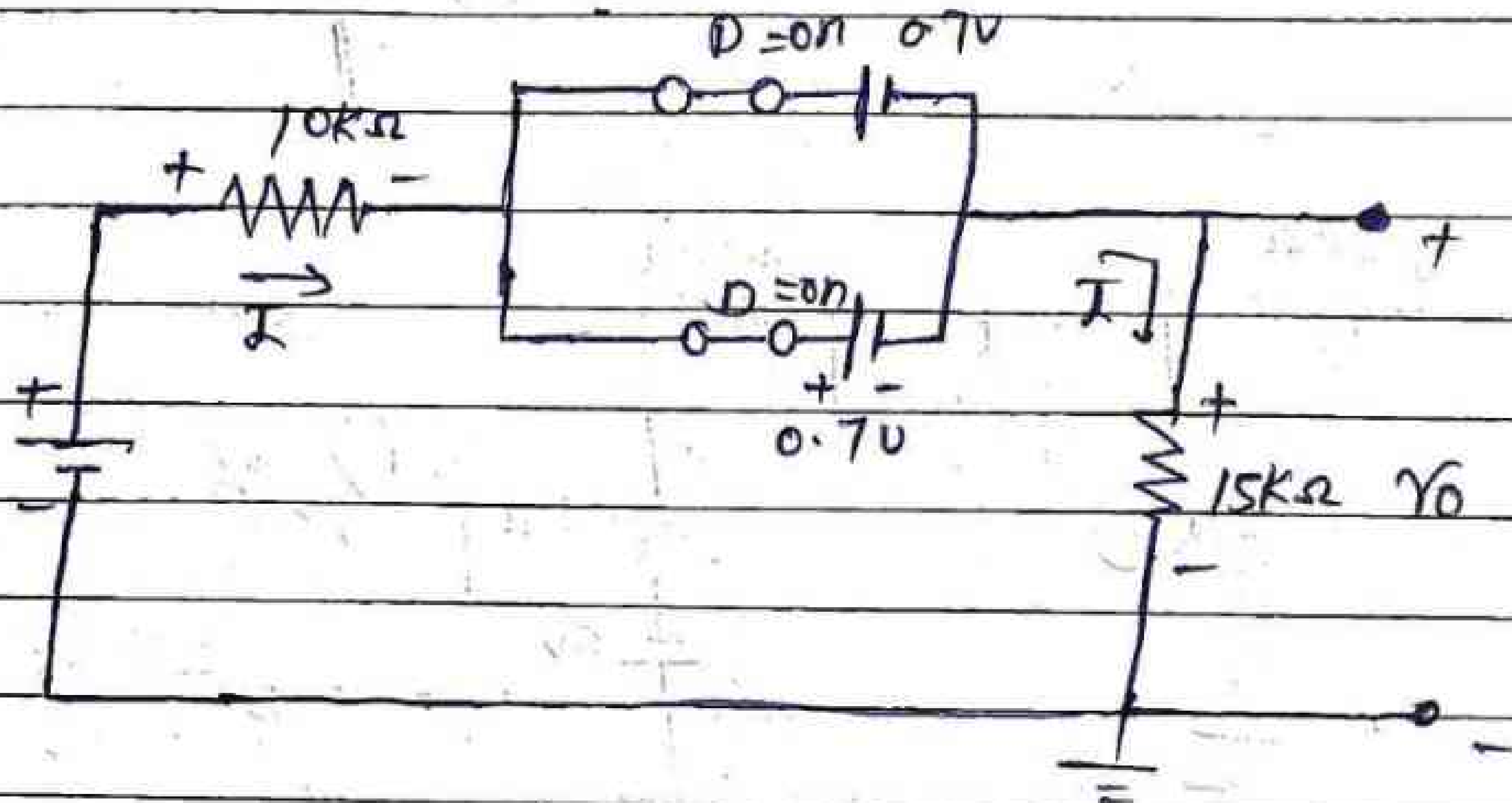
and

$$-10I_D + 8 + V_o = 0$$
$$V_o = 10I_D - 8$$
$$= (10 \times 1.33) - 8$$
$$= 13.3 - 8$$
$$V_o = 5.3\,V$$

Que :- Determine the I_{D_1}, I_{D_2} and V_o for the given network



Soln :-



Using KVL

$$15 - 10I - 0.7 - 15I = 0$$

$$25I = 14.3$$

$$I = 0.572$$

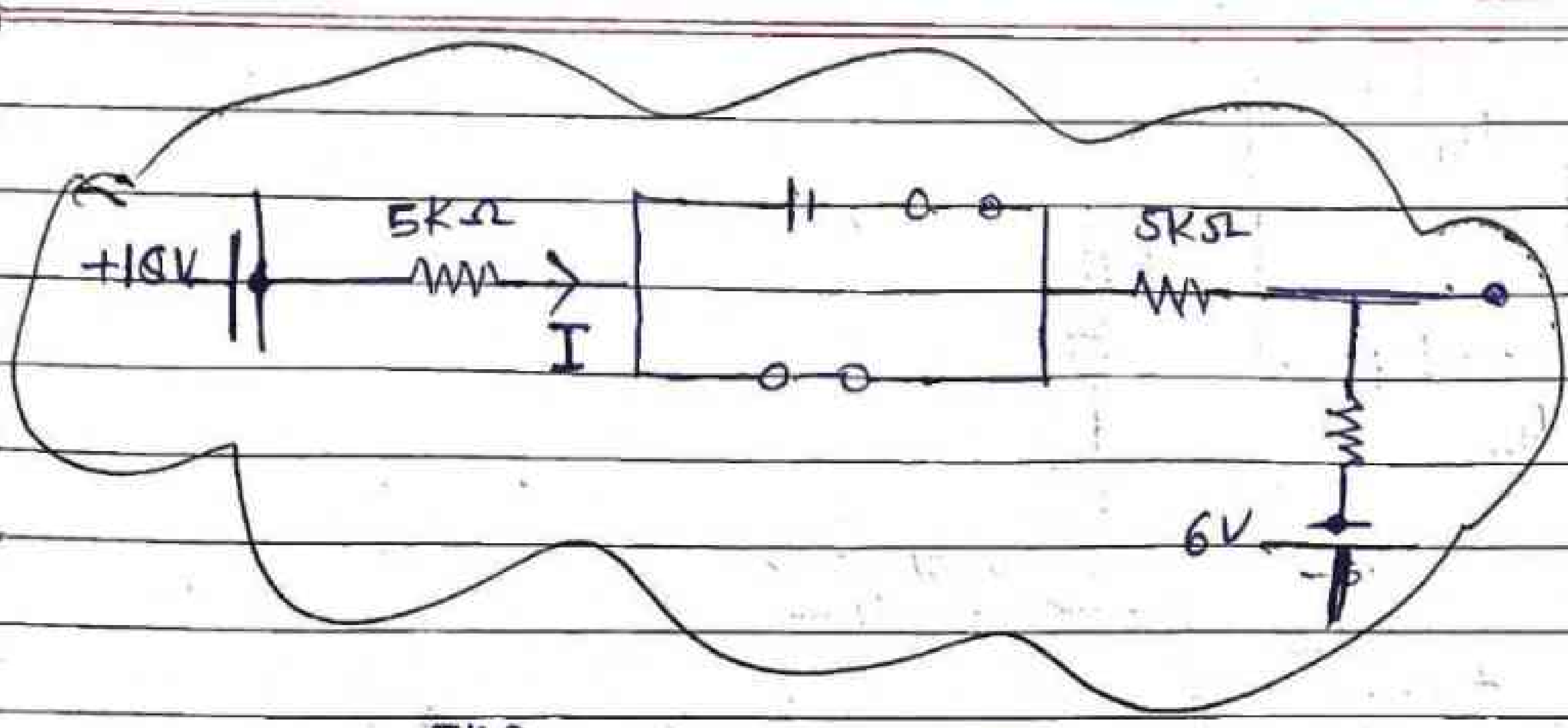
$$I_{D_1} = I_{D_2} = \frac{I}{2} = \frac{0.572}{2} = \boxed{0.286 \text{ mA Ans}}$$

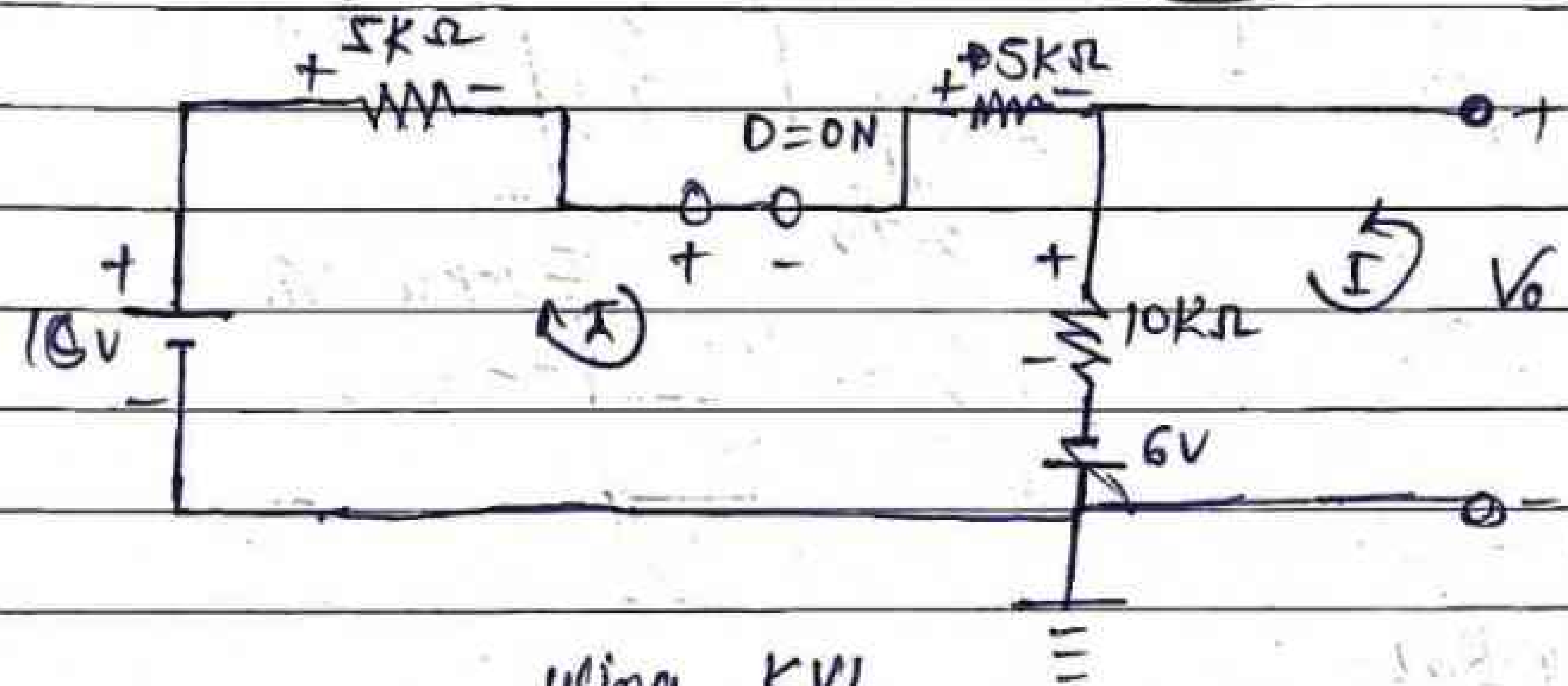
$$-15I + V_o = 0$$

$$-15 \times 0.572 = -V_o$$

$$\boxed{V_o = 8.58\,V}$$

Page
Date





using KVL

$10 - 5I - 5I - 10I + 6 = 0$

$I = \frac{24}{20} = 1.2mA$

and $-10I + 6 + V_0 = 0$

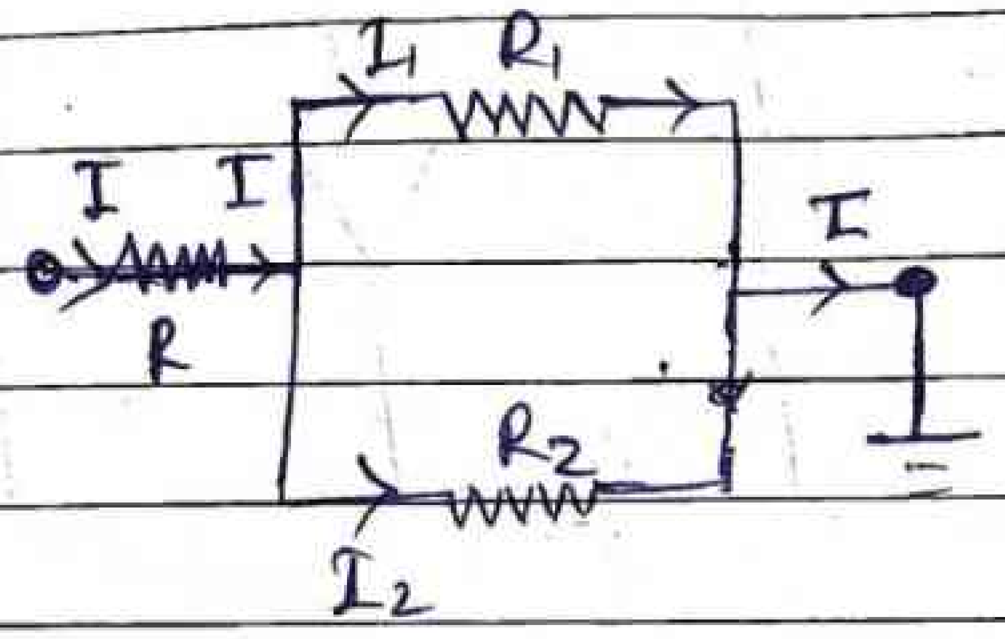
$V_0 = 10I - 6$

$= (10 \times 1.2) - 6 = 12 - 6$

$V_0 = 6$

Careel

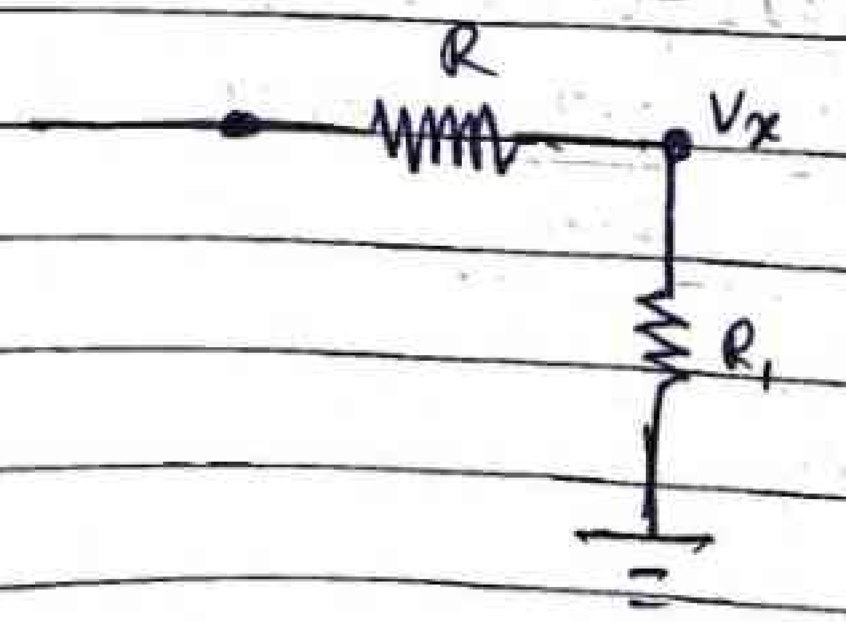
* Current divider rule (CDR)



$$I_1 = I \times \frac{R_2}{R_1 + R_2}$$

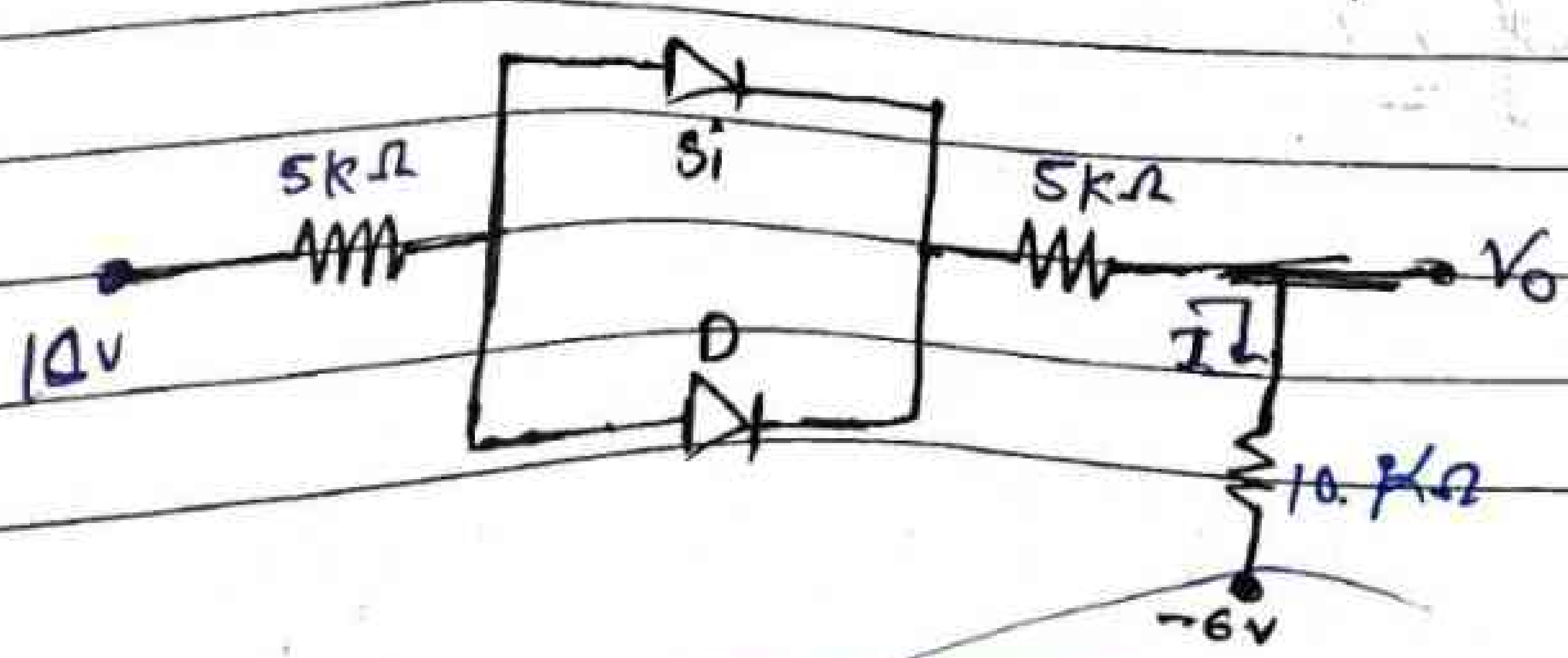
$$I_2 = I \times \frac{R_1}{R_1 + R_2}$$

* Voltage divider rule (UDR).



$$V_x = \frac{R_1}{R + R_1} \times V$$

Ques :- Determine I and V_o for the given circuit

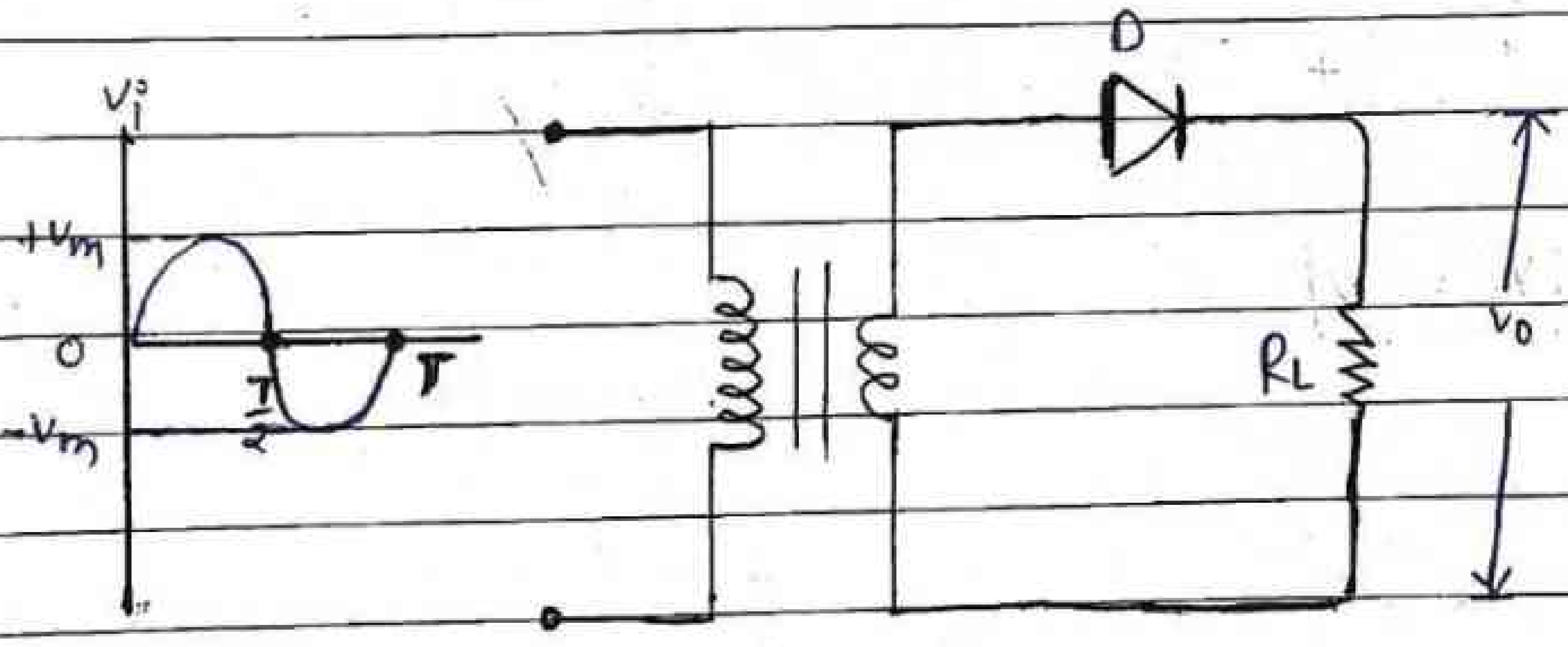


Page ____
Date ____

Rectifier

- Half wave Rectifier (HWR) — usage 1 diode
- Full wave Rectifier (FWR)
  - Center-Trapped (FWR) (CT-FWR) — uses 2 diode
  - Bridge-Type FWR (BT-FWR) — uses 4 diode

* Half Wave Rectifier

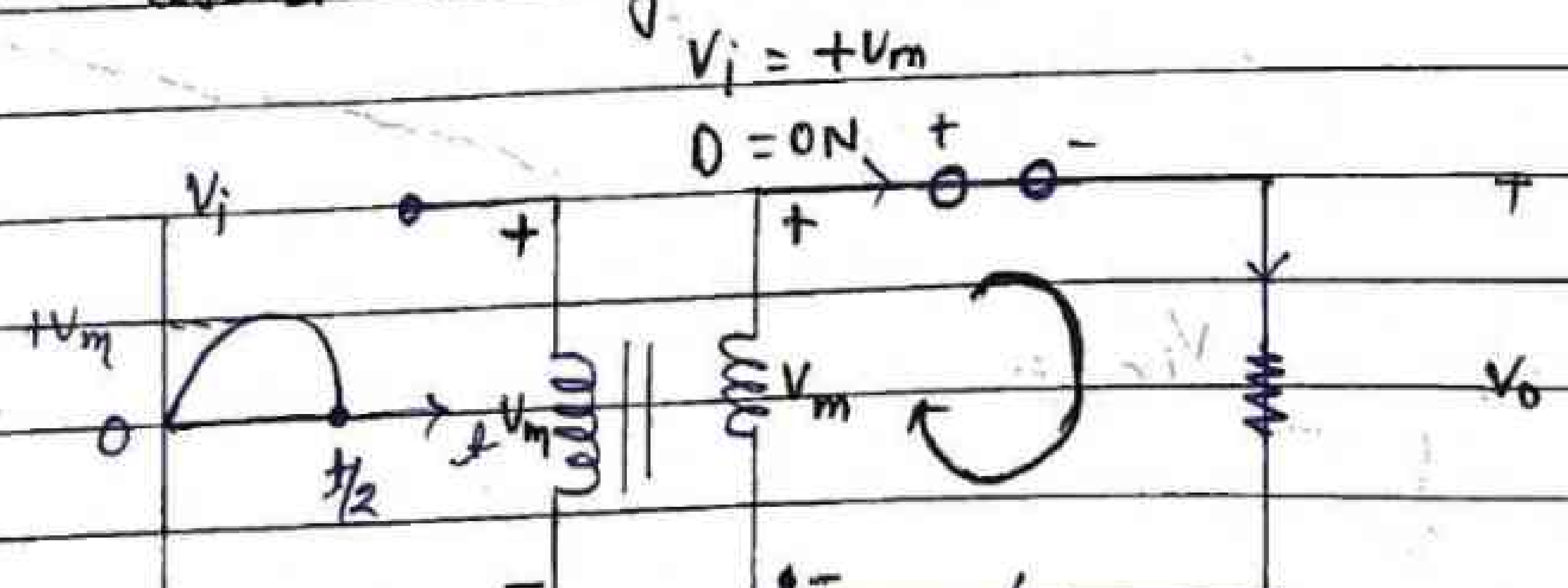


* Working

* Case I: During +ve half wave cycle:-

$V_i = +V_m$

D = ON



using KVL

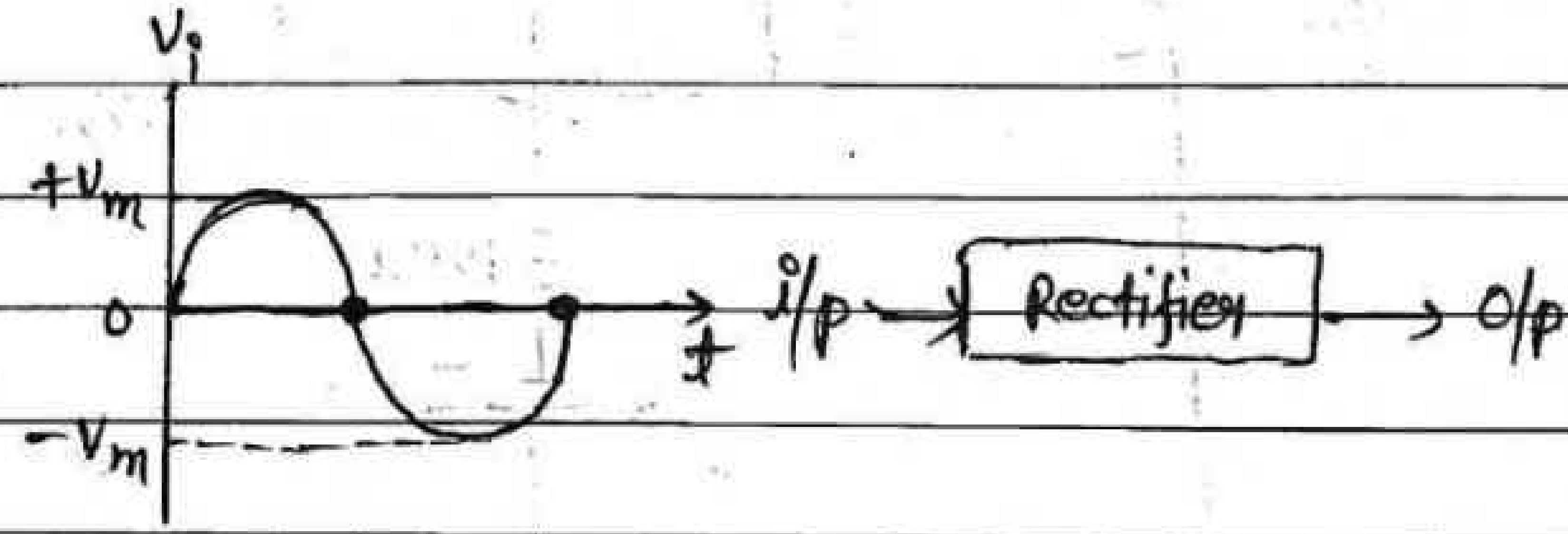
$V_m - V_0 = 0$

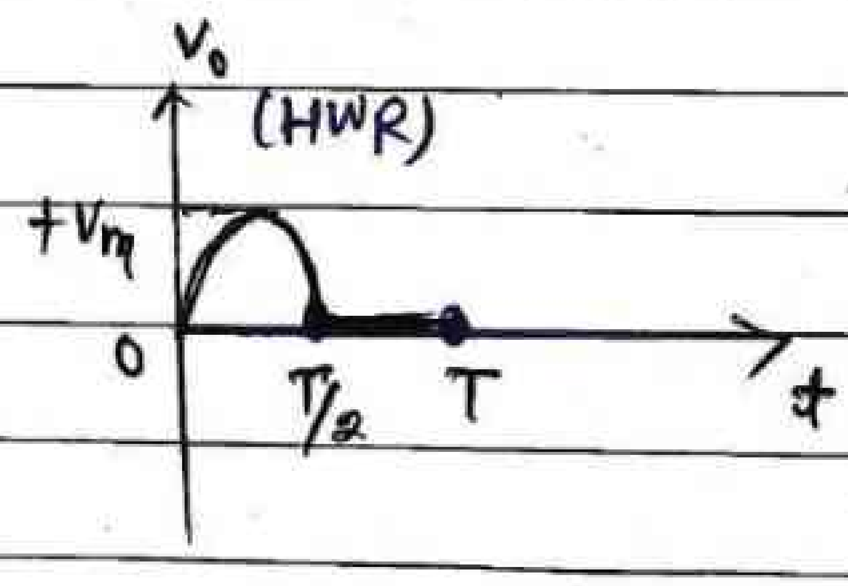
$+V_0 = +V_m$

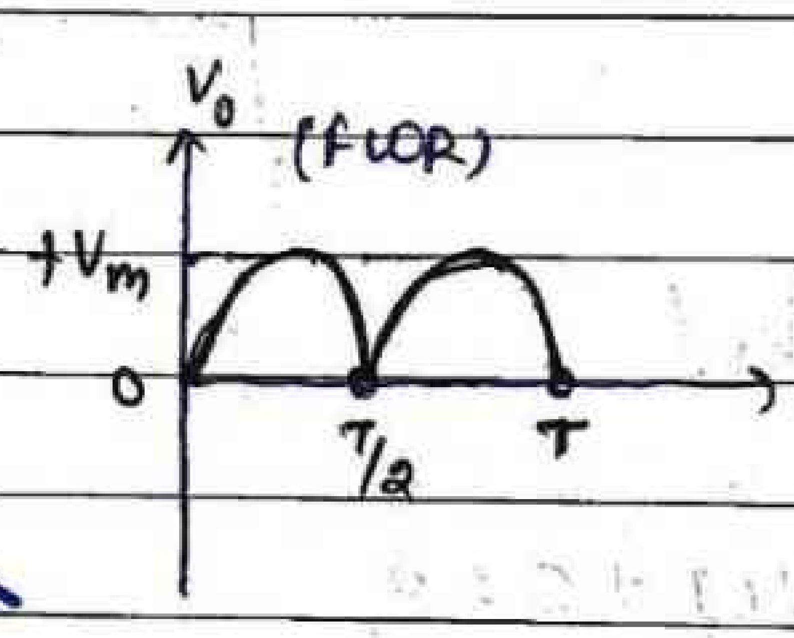
$\boxed{V_0 = V_m}$

* Rectifier:

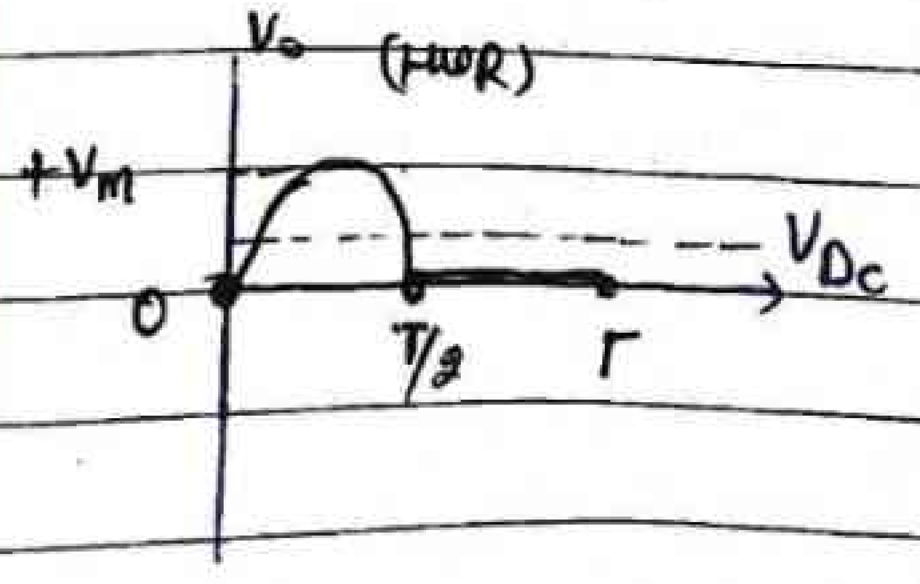
 # Rectifier :- Rectifier is a circuit which is used to convert a.c. signal into Pulsating D.C. signal.

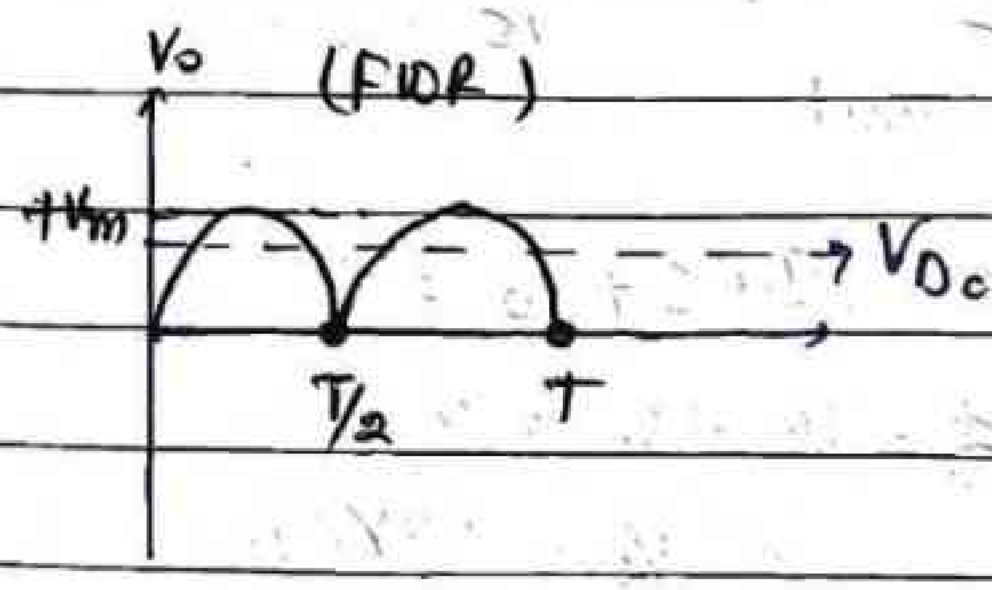






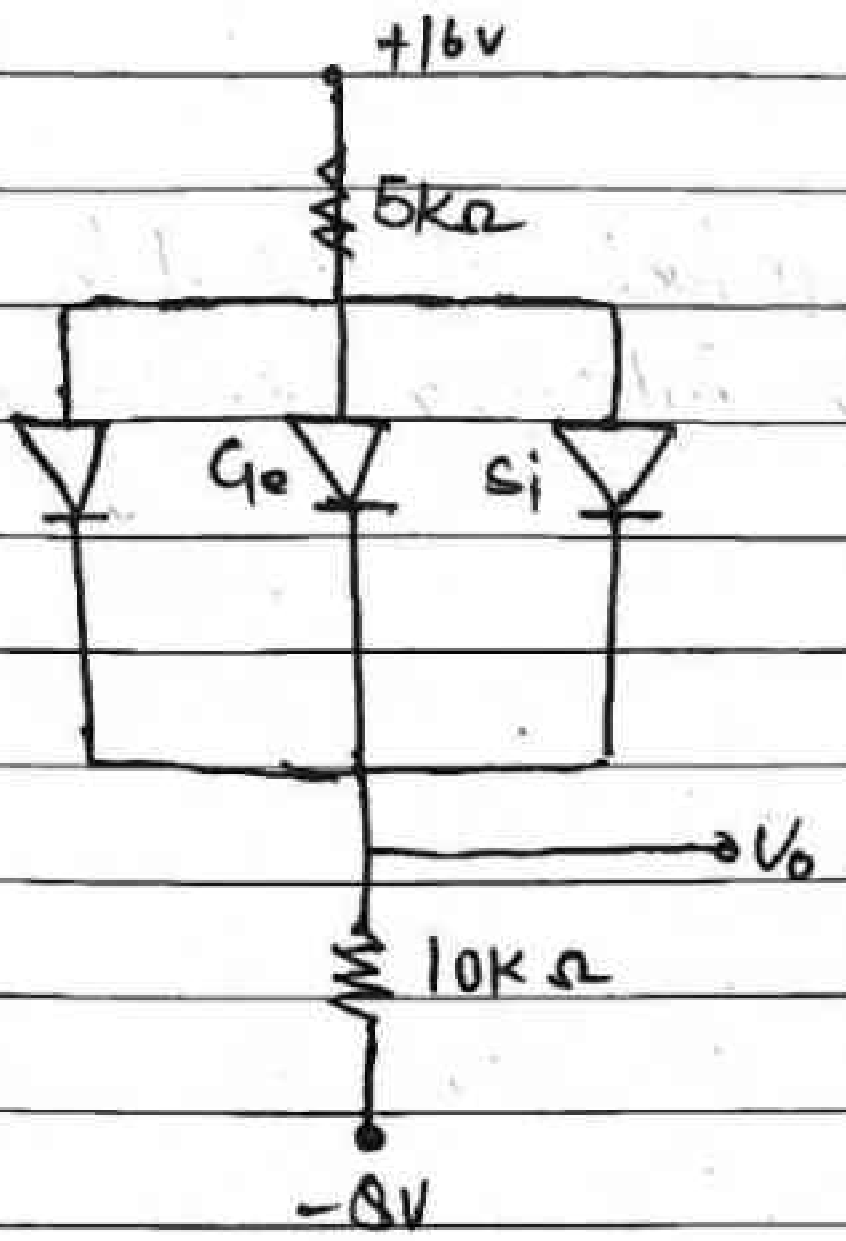
Classification of Rectifier.

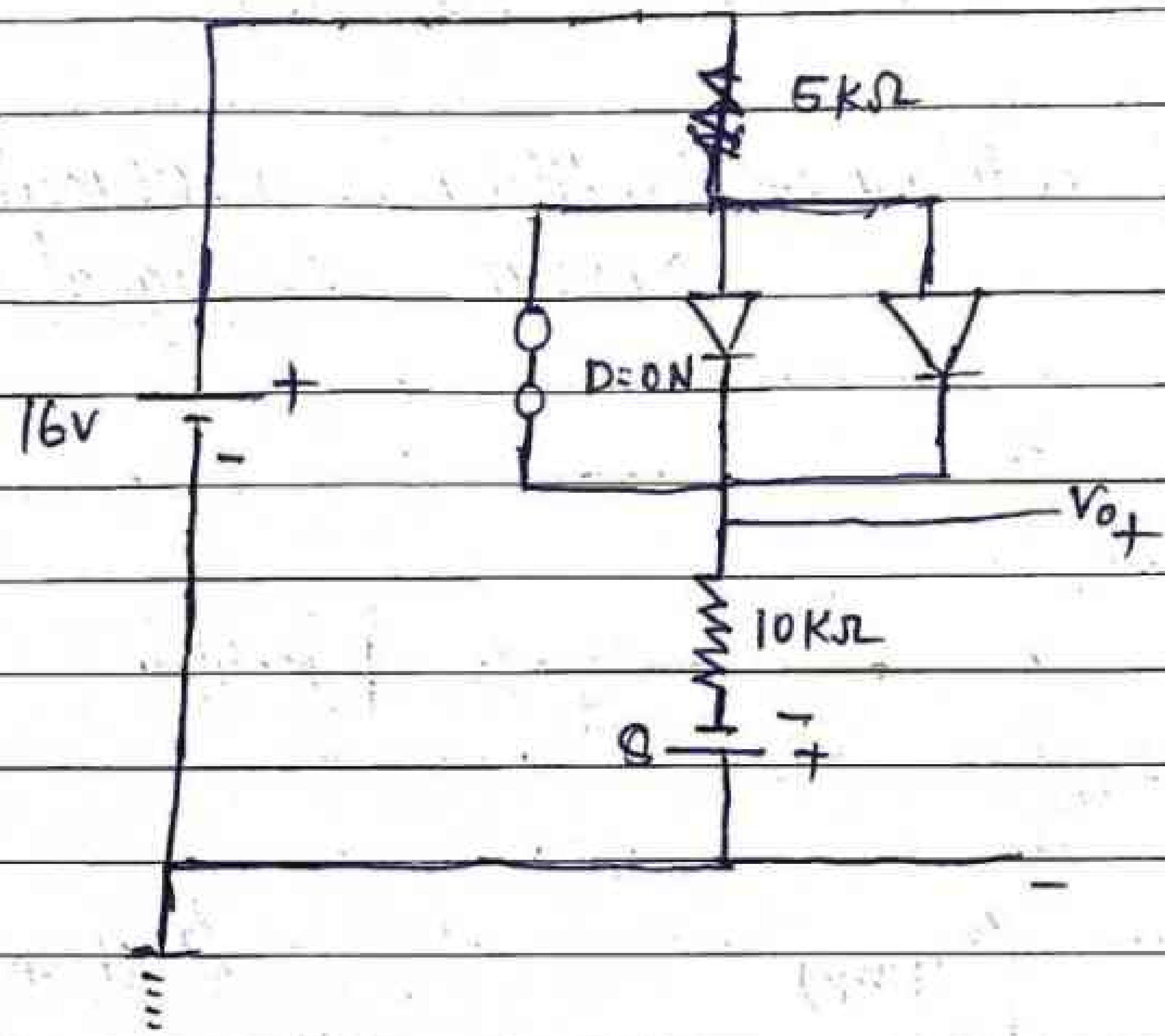




$$V_{DC\,(HWR)} = \frac{V_m}{\pi} = 0.318\,V_m \qquad V_{DC\,(FWR)} = \frac{2V_m}{\pi} = 0.636\,V_m$$

Que





Using KVL

$$16 - 5I - 10I + 8 = 0$$

$$15I = 24$$

$$I = \frac{24}{15} = 1.6mA$$

and

$$-10I + 8 + V_0 = 0$$

$$8 - 16 + V_0 = 0$$

$$V_0 = 8V$$ Ans

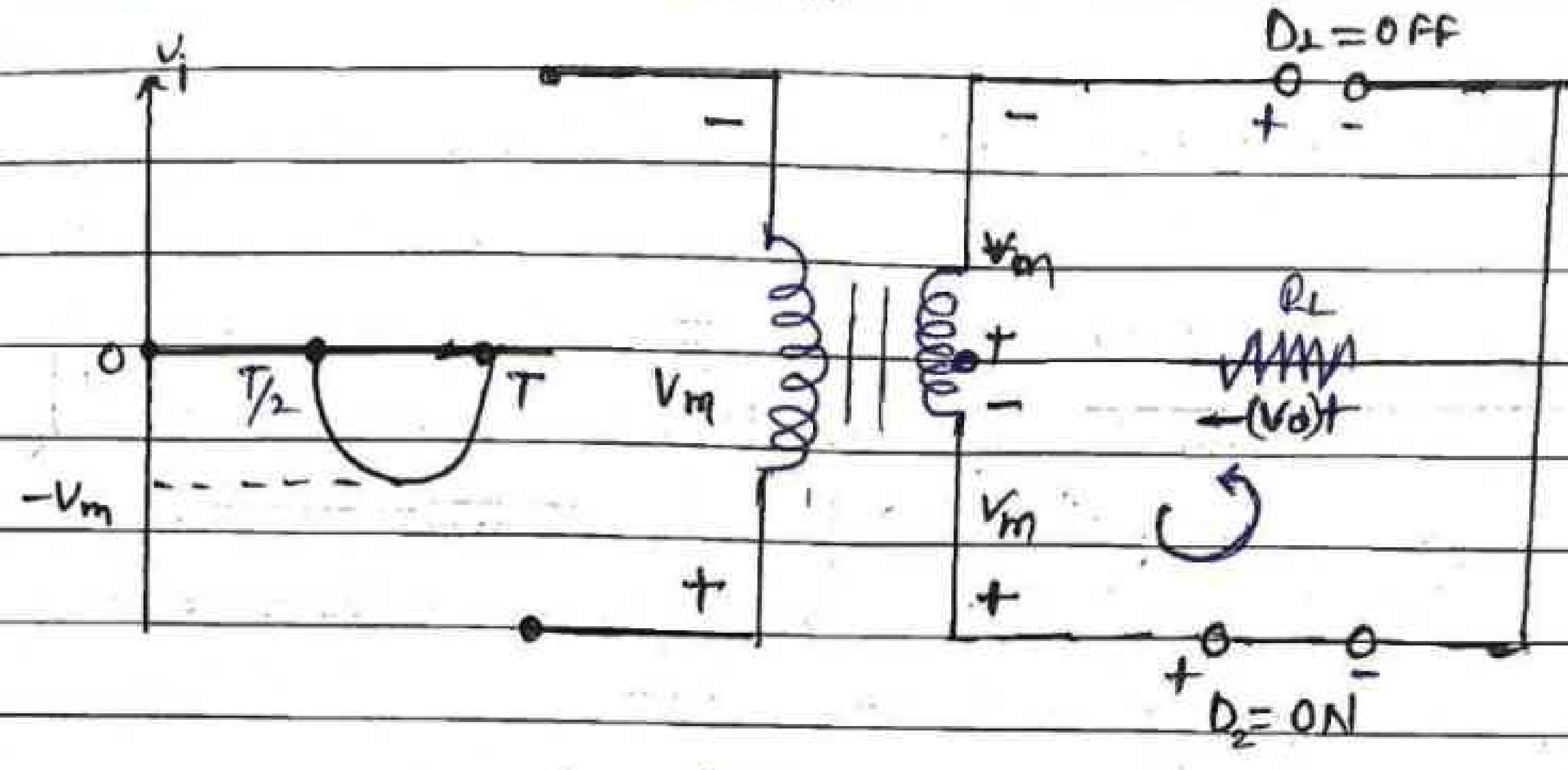
Page
Date

CASE-II During -ve Half cycle

$V_i = -V_m$

$D_1 = OFF$

$D_2 = ON$



Using KVL

$$V_m - V_o = 0$$

$$-V_o = -V_m$$

$$\boxed{V_o = V_m}$$

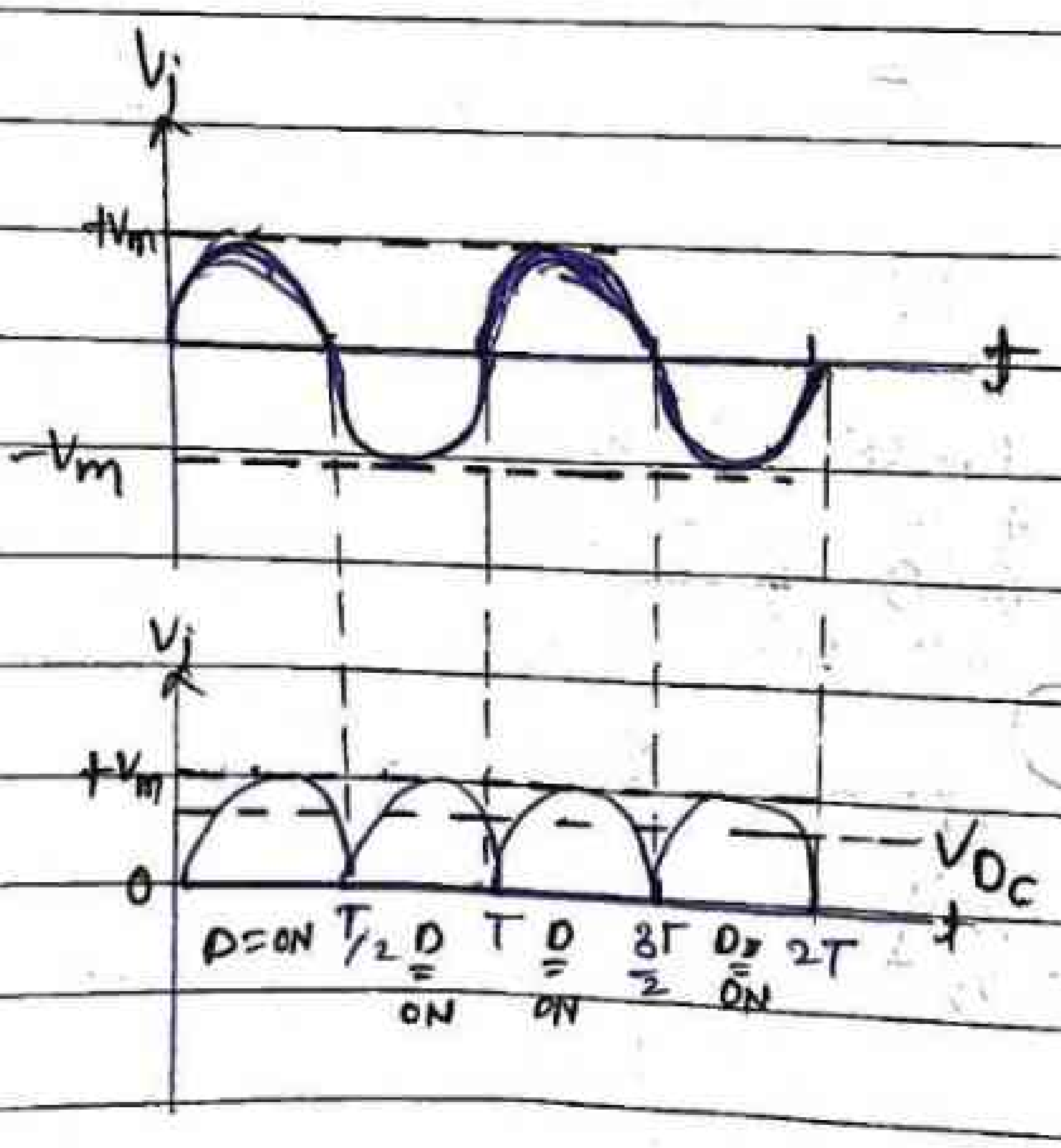
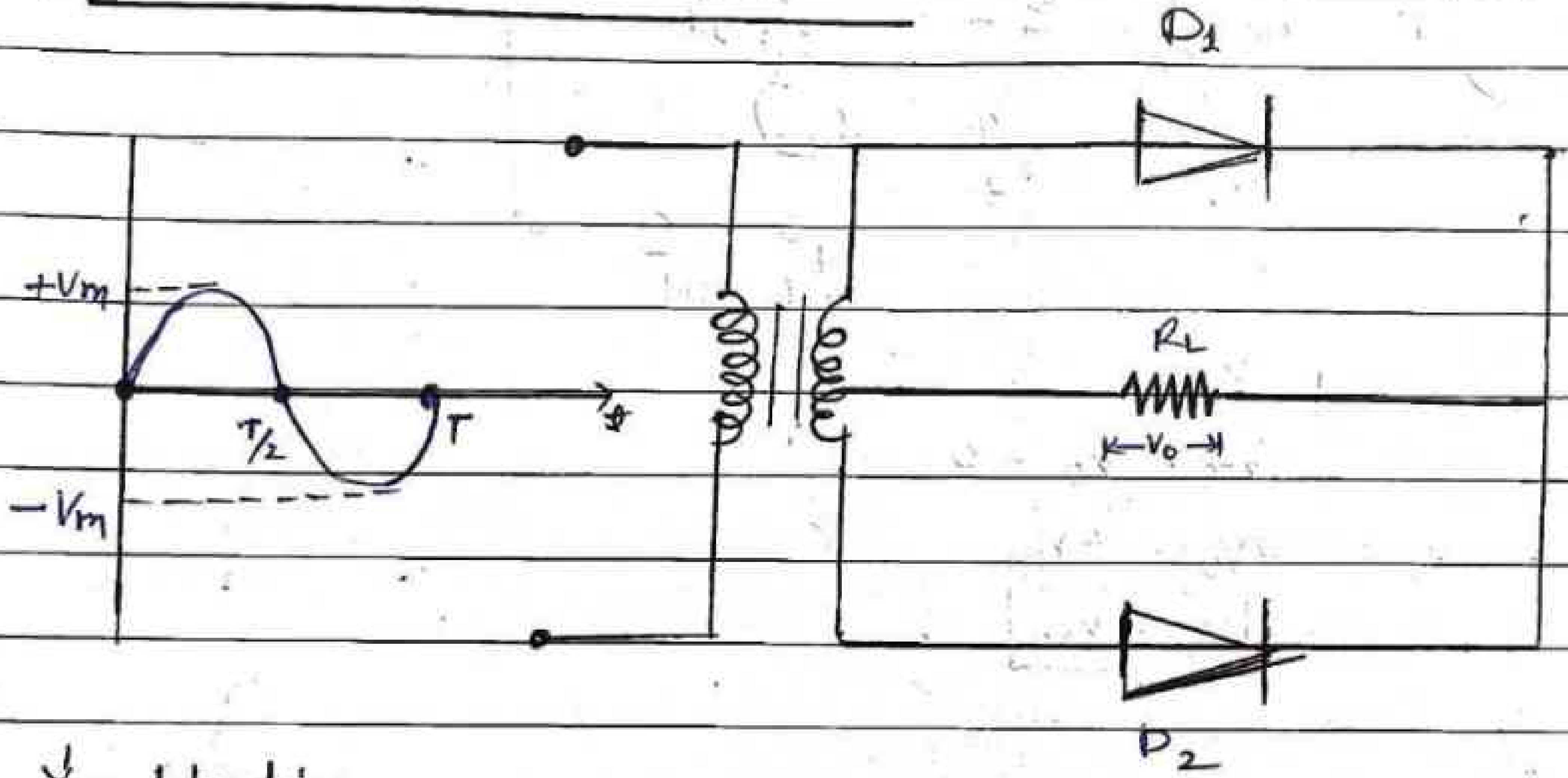


fig:- Input + output voltage wave from of CT-FWR

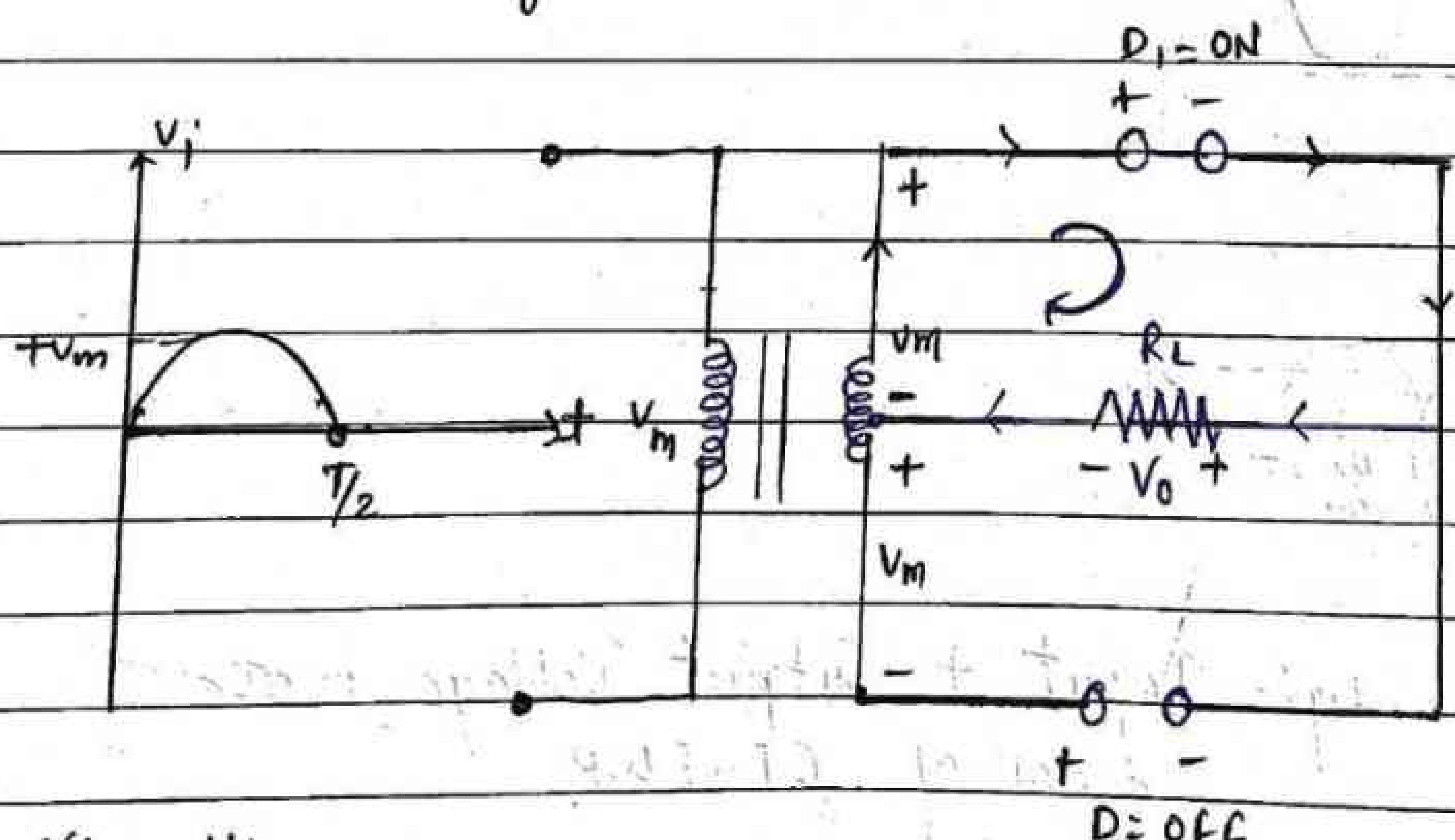
Full Wave Rectifier (F.W.R.)

A) Center-Tapped FWR (CT-FWR)



Working

* Case I : During +ve half cycle:



$V_i = +V_m$

$D_1 = ON$

$D_2 = OFF$

using KVL

$V_m - V_0 = 0$

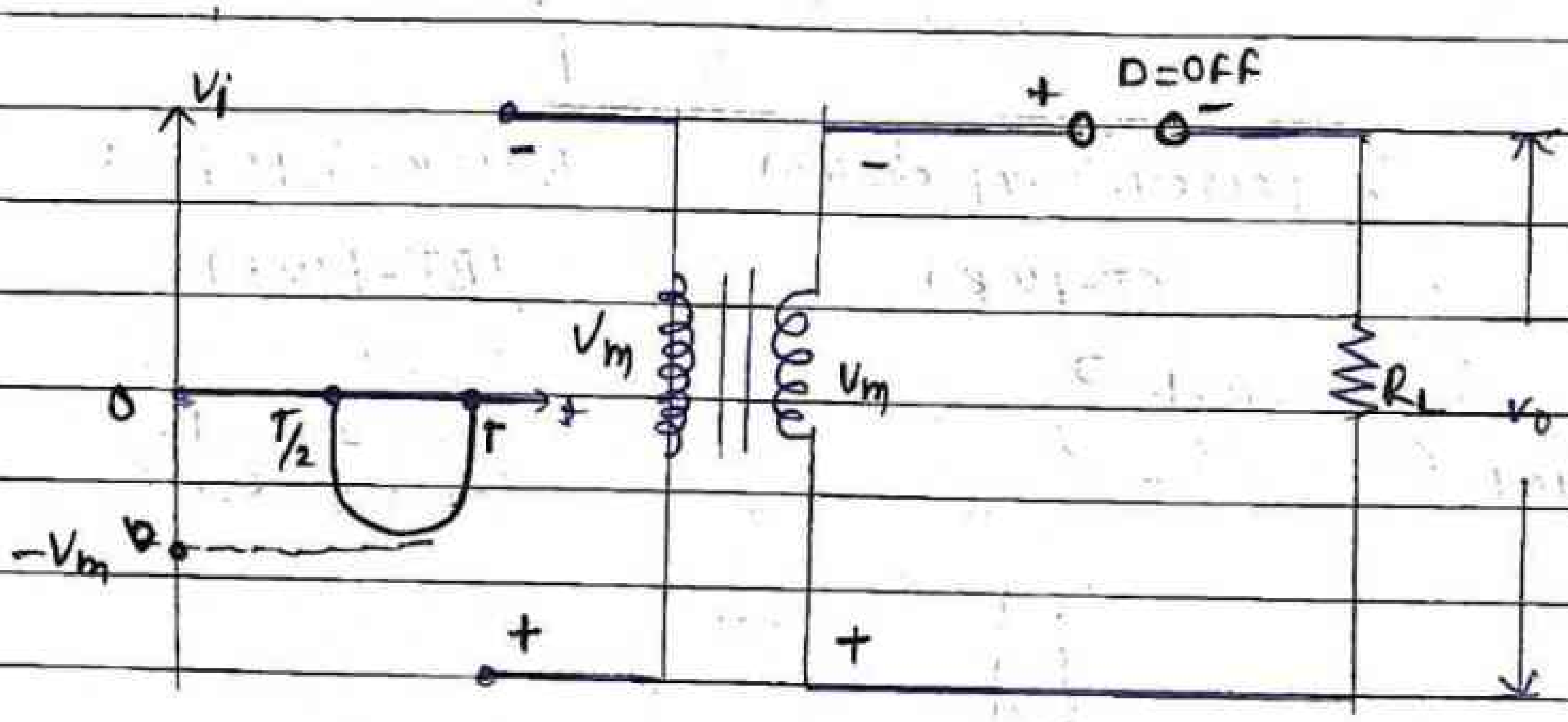
$+V_0 = +V_m$

$\boxed{V_0 = V_m}$

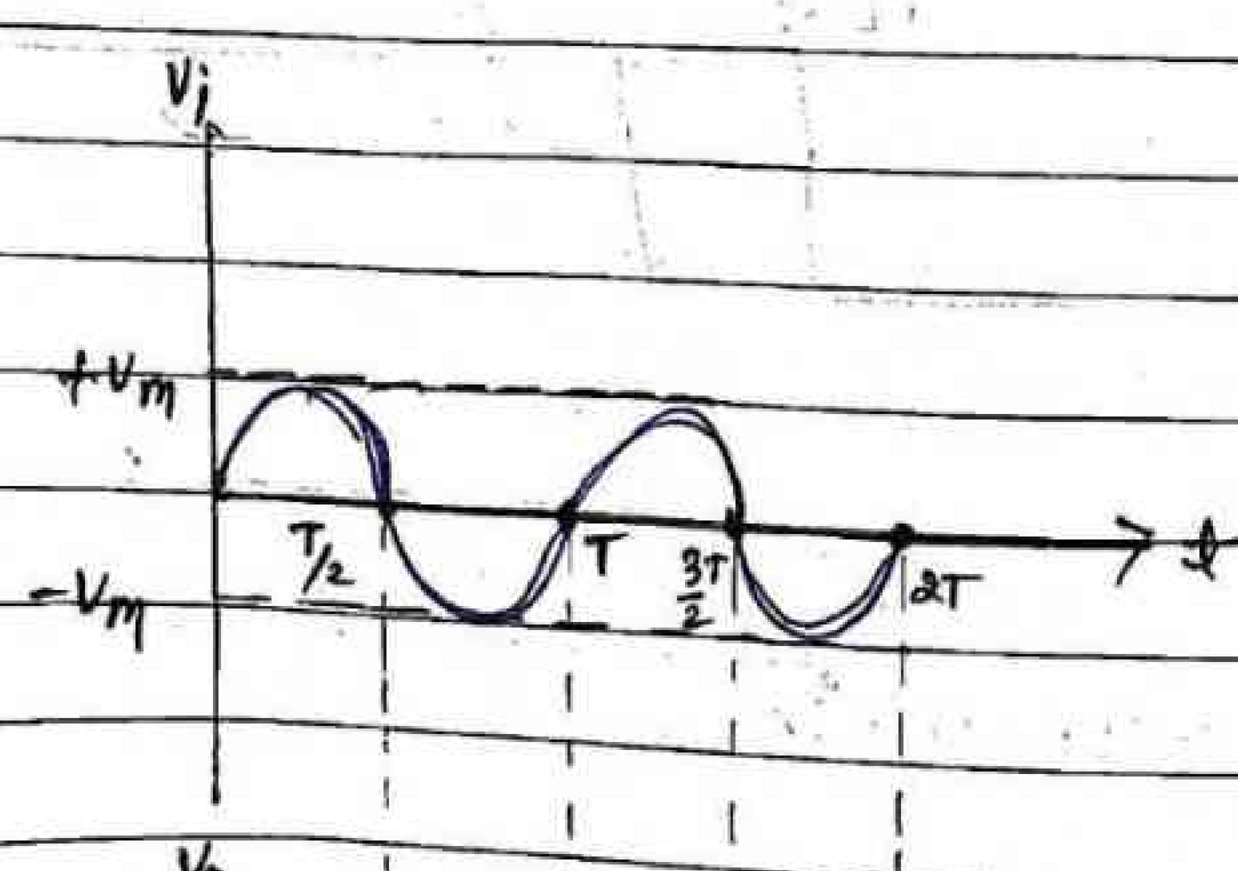
* Case-II :- During -ve half cycle:

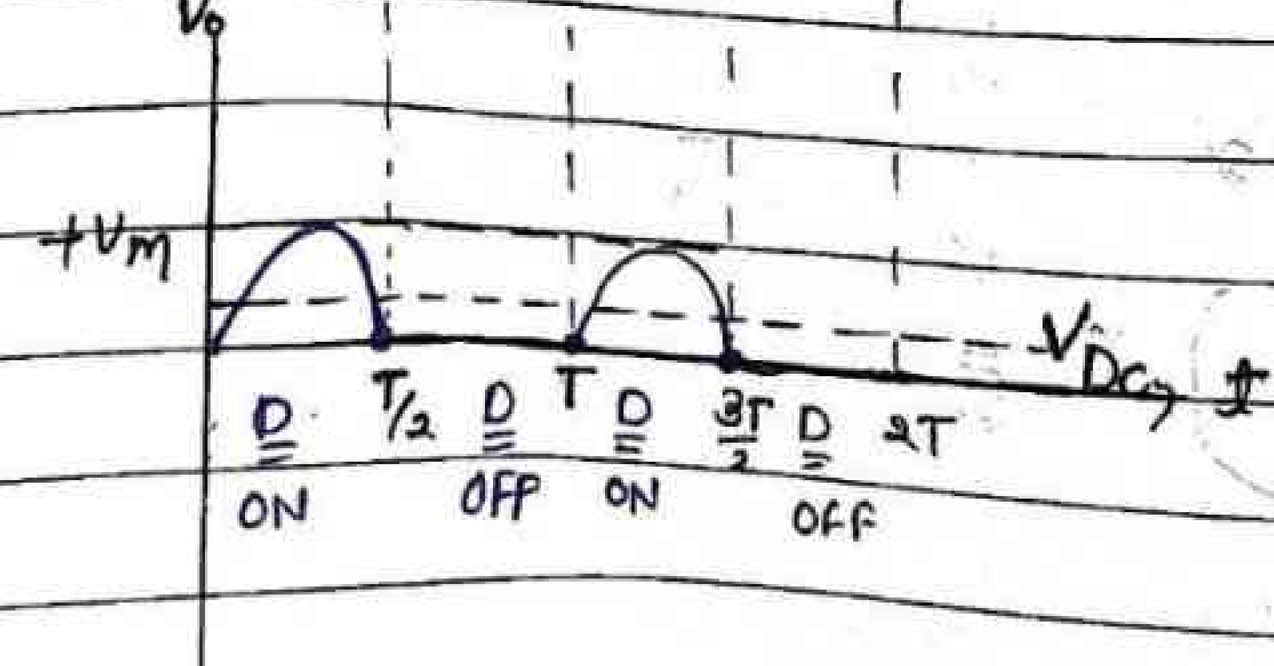
$$V_i = -V_m$$

$$D = OFF$$



$$\boxed{V_0 = 0V}$$





Page ______
Date ______

Ripple Factor (R.F.) :- It is define as the ratio of the r.m.s. value of the a.c. component of the output to the D.C. value of the output.

$$R.F. = \frac{\text{r.m.s value of a.c. component of the output}}{\text{D.C. value of the output}}$$

$$R.F. = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}}$$

0.3854

~~0.140~~

* For HWR

$$R.F._{HWR} = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}}$$

$\because V_{rms} = \frac{V_m}{2}$

$\because V_{DC} = \frac{V_m}{\pi}$

$$RF_{HWR} = \frac{\sqrt{\left(\frac{V_m}{2}\right)^2 - \left(\frac{V_m}{\pi}\right)^2}}{\frac{V_m}{\pi}}$$

$$= \frac{\sqrt{\frac{V_m^2}{4} - \frac{V_m^2}{\pi^2}}}{\frac{V_m}{\pi}}$$

$$= \frac{\sqrt{V_m^2\left(\frac{1}{4} - \frac{1}{\pi^2}\right)}}{\frac{V_m}{\pi}}$$

$$= \frac{V_m\sqrt{\left(\frac{1}{4} - \frac{1}{\pi^2}\right)}}{V_m/\pi}$$

$$= V_m \sqrt{1/4 - 1/\pi^2} \times \pi / V_m$$

$$= \sqrt{1/4 - \frac{1}{3.14^2}} \times 3.14 = 1.212330$$

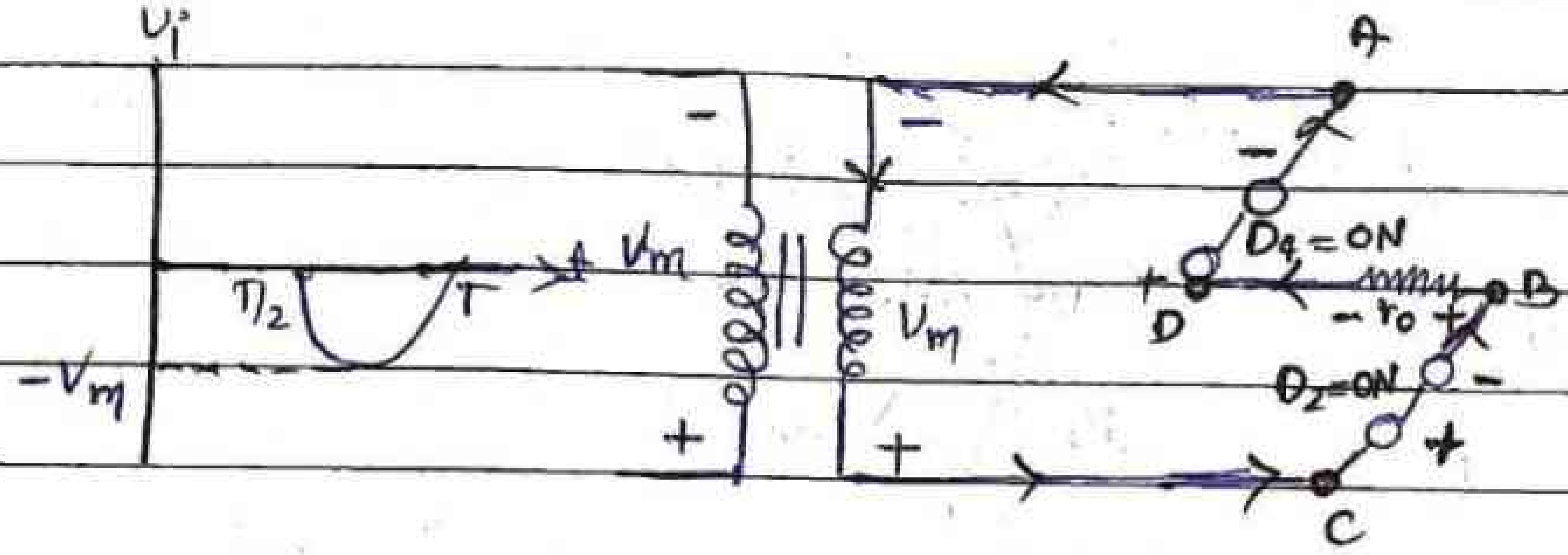
$RF_{HWR} = 1.21$

(or)

$R.F._{HWR} = 121\%$

Page
Date

Case - II During -ve half cycle.



$V_i = -V_m$

$D_1 = Off$

$D_2 = ON$

$D_3 = OFF$

$D_4 = ON$

using KVL

$V_m - V_0 = 0$

$+V_0 = +V_m$

$$\boxed{V_0 = V_m}$$

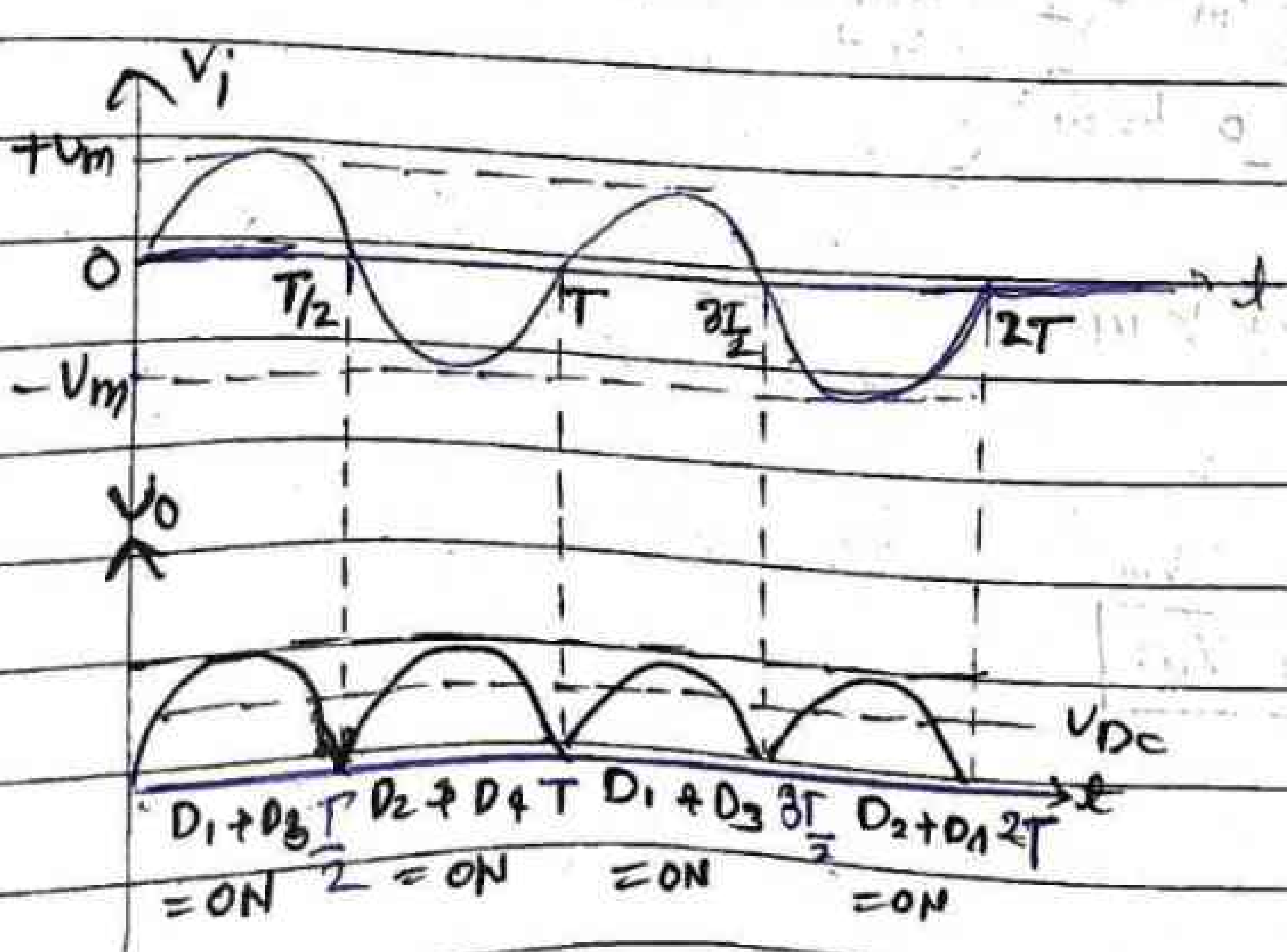
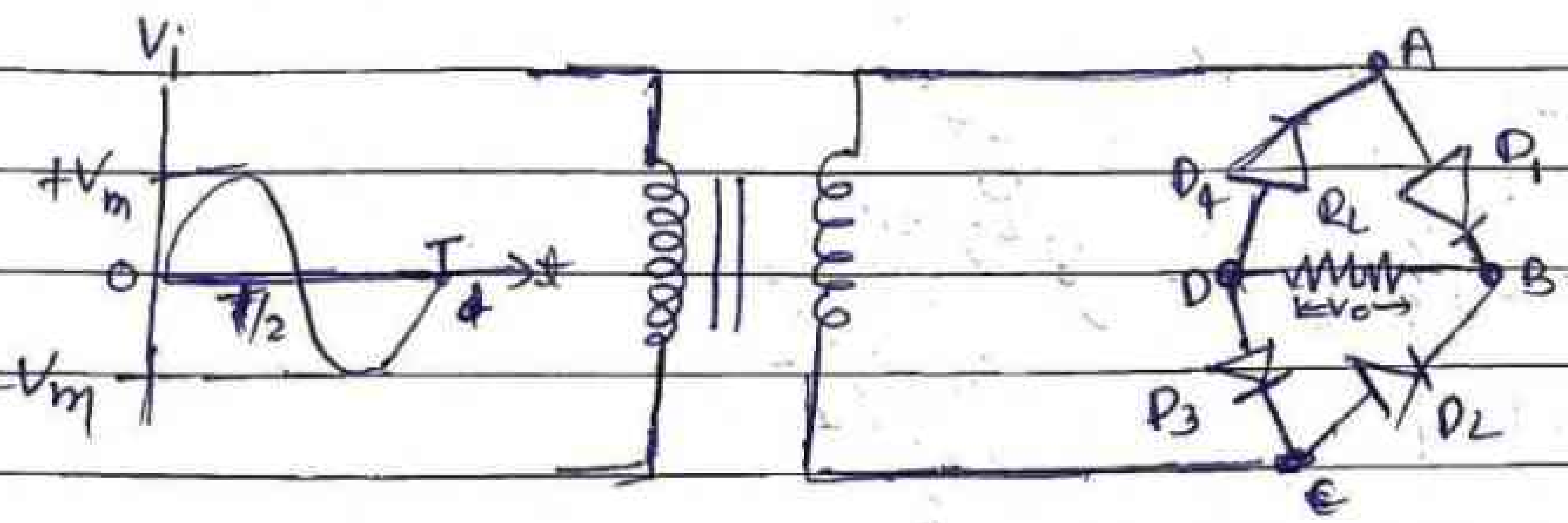


Fig :- Input & output Voltage waveform of BT-FWR

Page ______
Date ______

B. Bridge - type FWR (BT-FWR)



Working :-

~~Case-1 During~~ Case - 1 During +ve half cycle.

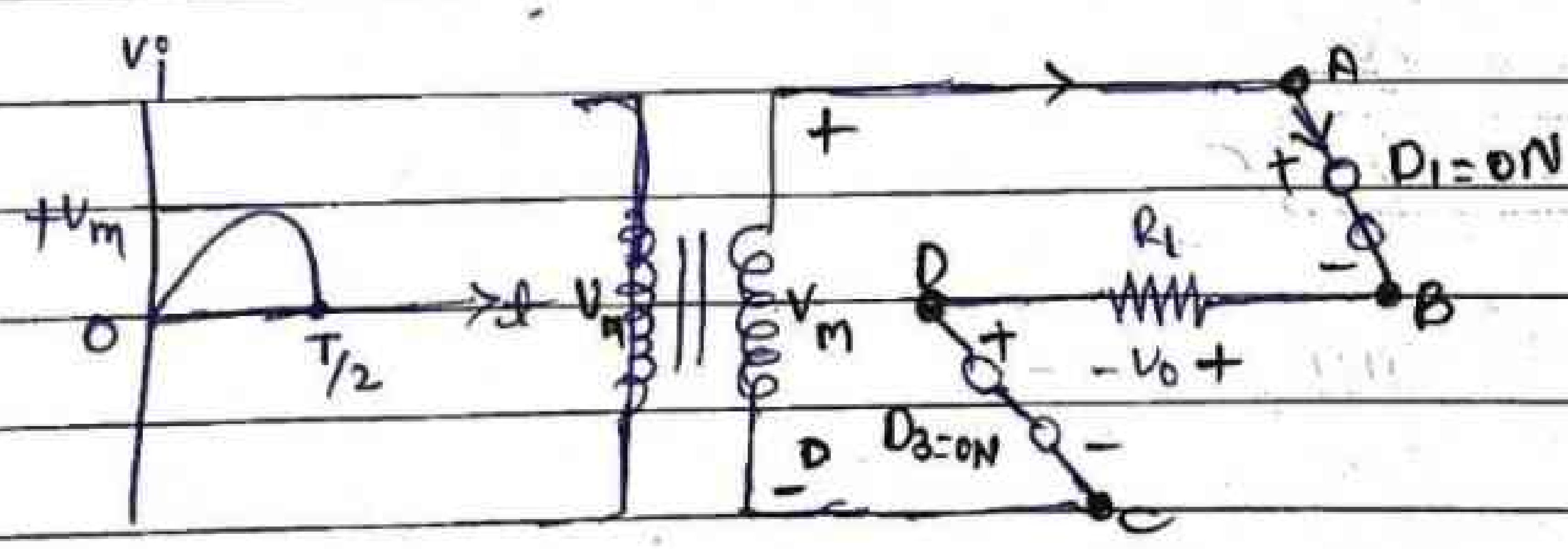
$V_i = +V_m$

$D_1 = ON$

$D_2 = OFF$

$D_3 = ON$

$D_3 = OFF$



using KVL

$V_m - V_0 = 0$

$+V_0 = +V_m$

$$\boxed{V_0 = V_m}$$

Page
Date

For F.W.R → (CT-FWR + BT-FWR)

As,

$$\eta_{FWR} = \frac{I^2_{DC} \cdot R_L}{I^2_{rms} \cdot R_L} \quad [As, (R_S + R_F) << R_L]$$

$$I_{DC} = \frac{2I_m}{\pi}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

$$\therefore \eta_{FWR} = \frac{\left(\frac{2I_m}{\pi}\right)^2 \cdot R_L}{\left(\frac{I_m}{\sqrt{2}}\right)^2 \cdot R_L} = \frac{\frac{4I_m^2}{\pi^2} \cdot R_L}{\frac{I_m^2}{2} \cdot R_L}$$

$$= \frac{4I_m^2 \cdot R_L}{\pi^2} \times \frac{2}{I_m^2 R_L} = \frac{8}{\pi^2} = \frac{8}{3.14^2} = 0.811391942$$

$$\boxed{\eta_{FWR} = 0.811} \quad \text{or} \quad \boxed{\eta_{FWR} = 81.1\%}$$

Page
Date 17/09/2024

Efficiency :- It is define as the ratio of output power to the input power. It is ~~depo~~ denoted by η and it is also known as rectification efficiency.

$$\eta = \frac{\text{out power}}{\text{input power}}$$

$$\therefore \eta = \frac{I^2_{DC} \cdot R_L}{I^2_{rms} \cdot R_L}$$

$$\eta = \frac{P_{DC}}{P_{ac}}$$

$P = VI$

$P = I R . I$

$P = I^2 R$

$$\eta = \frac{I^2_{Dc} \cdot R_L}{I^2_{rms} \cdot (R_S + R_F + R_L)}$$

As. $(R_S + R_F) << R_L$

* For HWR :-

As,

$$\eta_{HWR} = \frac{I^2_{DC} \cdot R_L}{I^2_{rms} \cdot R_L} \quad [As\,(R_S + R_F) << R_L]$$

$$I_{DC} = \frac{I_m}{\pi}$$

$$I_{rms} = \frac{I_m}{2}$$

$$\eta_{HWR} = \frac{(I_m/\pi)^2 \cdot R_L}{(I_m/2)^2 \cdot R_L} = \frac{I_m^2/\pi^2 \cdot R_L}{I_m^2/4 \cdot R_L} = \frac{4}{\pi^2} = 0.40569594$$

$$\eta_{HWR} = 0.406 \quad \text{or} \quad \eta_{HWR} = 40.6\%$$

Page
Date

For: FWR (CT-FWR + BT-FWR)

$$Rf_{FWR} = \frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$V_{DC} = \frac{2V_m}{\pi}$$

~~$$Rf_{FWR} = \sqrt{\left(\frac{V_m}{\sqrt{2}}\right)^2 - \left(\frac{2V_m}{\pi}\right)^2} \quad \sqrt{\frac{V_m^2}{2} - \frac{4V_m^2}{\pi^2}} \quad 2\pi/V_m$$~~ WRONG

$$\frac{\sqrt{(V_m/\sqrt{2})^2 - (2V_m/\pi)^2}}{2V_m/\pi} = \frac{\sqrt{V_m^2/2 - \frac{4V_m^2}{\pi^2}}}{\frac{2V_m}{\pi}}$$

$$= \frac{\sqrt{V_m^2\left(\frac{1}{2} - \frac{4}{\pi^2}\right)}}{\frac{2V_m}{\pi}} = V_m \sqrt{\left(\frac{1}{2} - \frac{4}{\pi^2}\right)} \times \frac{\pi}{2V_m}$$

$$= \sqrt{\frac{1}{2} - \frac{4}{3.14^2}} \times \frac{3.14}{2} \Rightarrow 0.482130687$$

$$\boxed{Rf_{FWR} = 0.482}$$

or

$$\boxed{Rf_{FWR} = 48.2\%}$$

$\frac{1.385}{2}$

Page
Date

For CT-FWR

As, $$TUF_{CT\text{-}FWR} = \frac{TUF_{primary} + TUF_{secondary}}{2} \quad \text{—— (1)}$$

$\because$ $TUF_{Primary} = 2 \times TUF_{HWR} = 2 \times 0.287 = 0.574$ —— (2)

and

$$TUF_{secondary} = \frac{V_{DC} \cdot I_{DC}}{V_{rms} \cdot I_{rm}} = \frac{\frac{2V_m}{\pi} \cdot \frac{2I_m}{\pi}}{\frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}}} = 0.811 \quad \text{—— (3)}$$

Now, using eqn (1) (2) & (3)

$$\therefore TUF_{CT\text{-}FWR} = \frac{0.574 + 0.811}{2} = 0.6925$$

$$\therefore \boxed{TUF_{CT\text{-}FWR} = 0.693}$$

$$\boxed{TUF_{CT\text{-}FWR} = 69.3\%}$$

Page________
Date________

For BT-FWR

As, $TUF_{BT-FWR} = \frac{V_{LDC} \cdot I_{LDC}}{V_{srms} \cdot I_{srms}}$ [∵ $(R_s + R_f) >> R_L$]

∵ $V_{LDC} = \frac{2V_m}{\pi}$, $I_{LDC} = \frac{2I_m}{\pi}$

$V_{srms} = \frac{V_m}{\sqrt{2}}$, $I_{srms} = \frac{I_m}{\sqrt{2}}$

$$TUF_{BT-FWR} = \frac{\frac{2V_m}{\pi} \cdot \frac{2I_m}{\pi}}{\frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}}} = \frac{\frac{4V_m I_m}{\pi^2}}{\frac{V_m I_m}{2}} = \frac{8}{\pi^2} = \frac{8}{3.14^2} = 0.811391942$$

∴ $TUF_{BT-FWR} = 0.811$

or

$TUF_{BT-FWR} = 81.1\%$

Peak Inverse Voltage (PIV)

It is the maximum reverse voltage across a diode with which a diode can ~~with~~ withstand without damaging to the junction itself.

* For HWR — $PIV = V_m$

* For CT-FWR — $PIV = 2V_m$

* For BT-FWR — $PIV = V_m$

Page ______
Date ______

* ~~Transformation~~ Transformer Utilization Factor (TUF) :-

TUF indicates that "how well the input transformer is being utilized". It is defined as the ratio of D.C. Power available across the load to the ac power rating of the secondary coil of the transformer.

$$TUF = \frac{\text{D.C. power available across the load}}{\text{a.c. power rating of secondary coil of the transformer}}$$

$$\boxed{TUF = \frac{V_{LDC} \cdot I_{LDC}}{V_{S rms} \cdot I_{S rms}}} \quad \left[As, (R_S + R_f) << R_L\right]$$

For HWR :-

$$As. \; TUF_{HWR} = \frac{V_{LDC} \cdot I_{LDC}}{V_{S rms} \cdot I_{S rms}} \quad \left[\because (R_S + R_f) << R_L\right]$$

$$\because V_{LDC} = \frac{V_m}{\pi}, \; I_{LDC} = \frac{I_m}{\pi}$$

$$* \; V_{S rms} = \frac{V_m}{\sqrt{2}}, \; I_{S rms} = \frac{I_m}{2}$$

$$\therefore TUF_{HWR} = \frac{\frac{V_m}{\pi} \cdot \frac{I_m}{\pi}}{\frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{2}} = \frac{\frac{V_m I_m}{\pi^2}}{\frac{V_m I_m}{2\sqrt{2}}}$$

$$TUF_{HWR} = \frac{V_m I_m}{\pi^2} \times \frac{2\sqrt{2}}{V_m I_m} =$$

$$= \frac{2\sqrt{2}}{\pi^2} = \frac{2\sqrt{2}}{3.14^2} = 0.286870372$$

$$\therefore \boxed{TUF_{HWR} = 0.287}$$

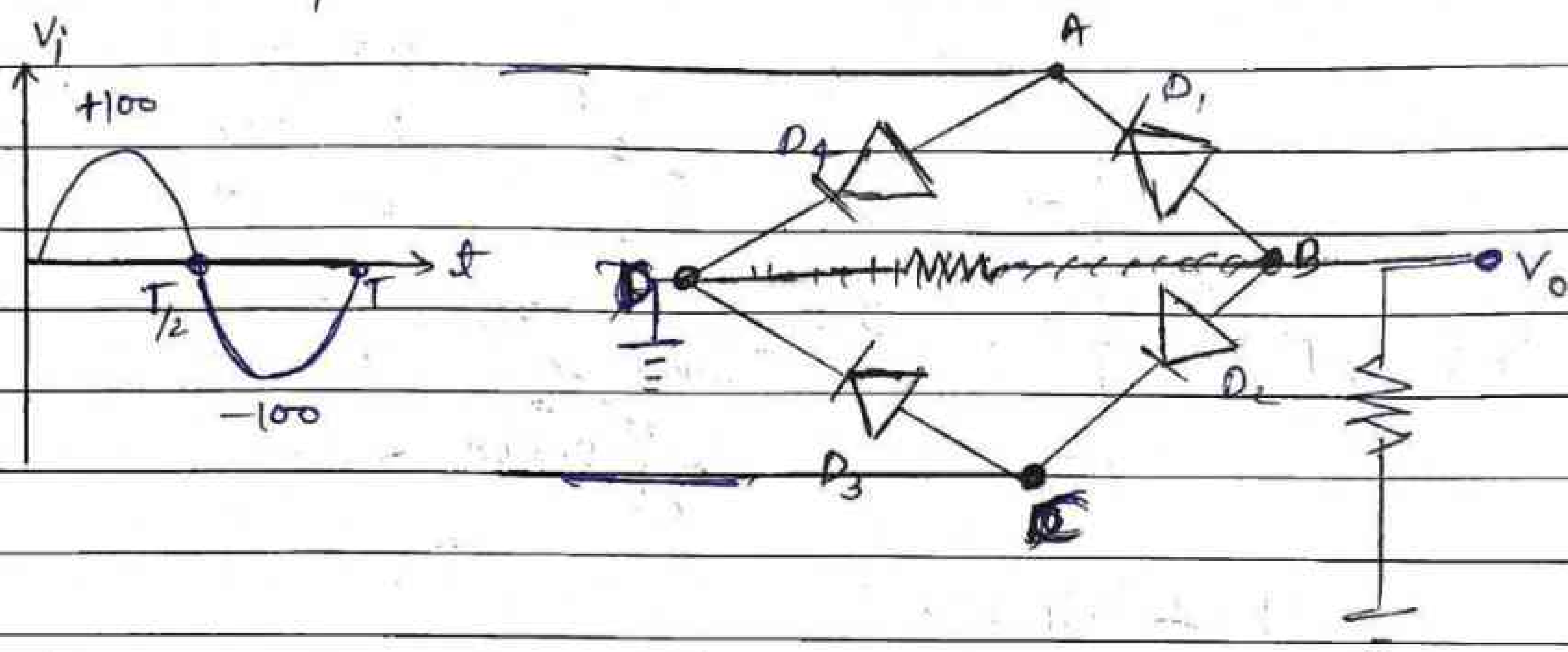
or

$$\boxed{TUF_{HWR} = 28.7\%}$$

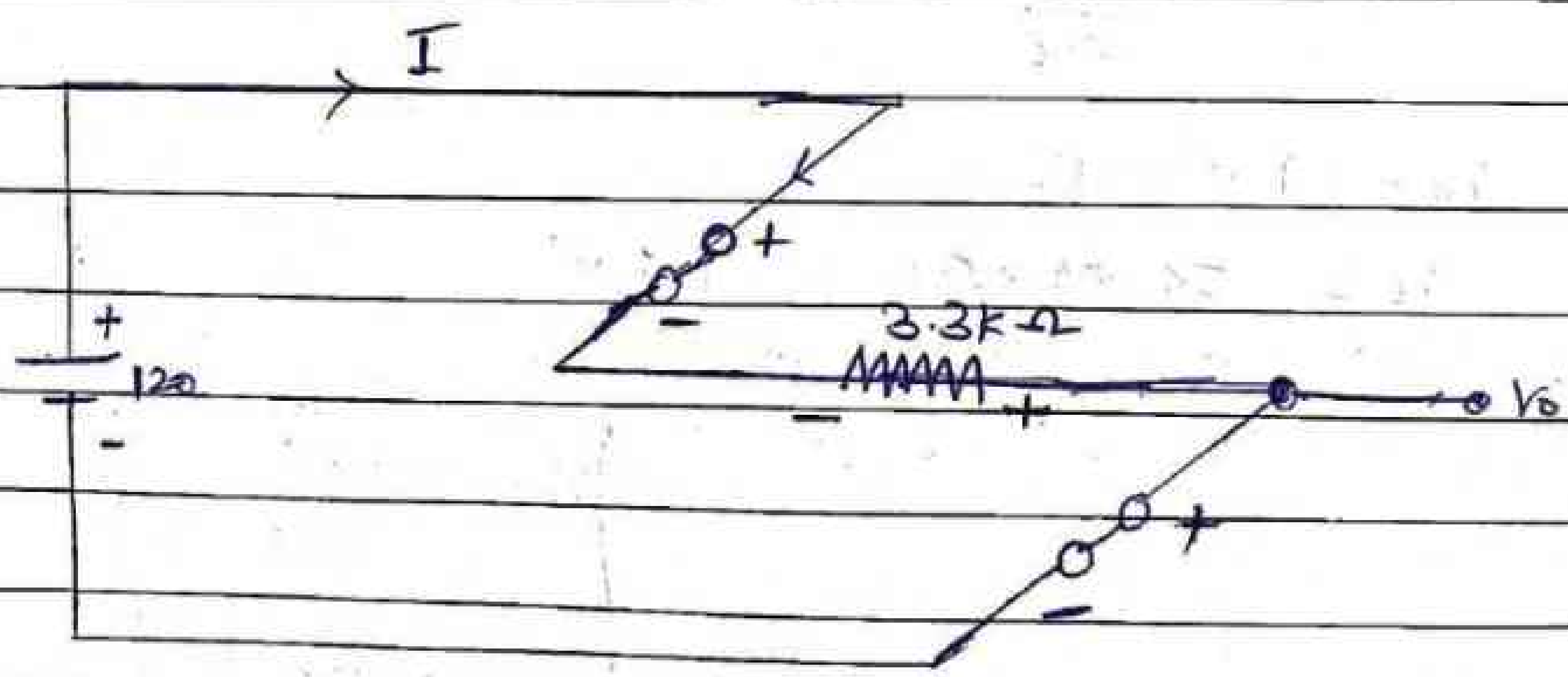
Page ______

Date ______

Que- Determine the output voltage and draw its output wave form :-



Solⁿ → During +ve Half ~~wave~~ cycle.



$$120 + 3.3I = 0$$

$$I = \frac{120}{3.3}$$

$$\boxed{I = 30.3\ mA}$$

then V_o = $V_o = 3.3 \times I$

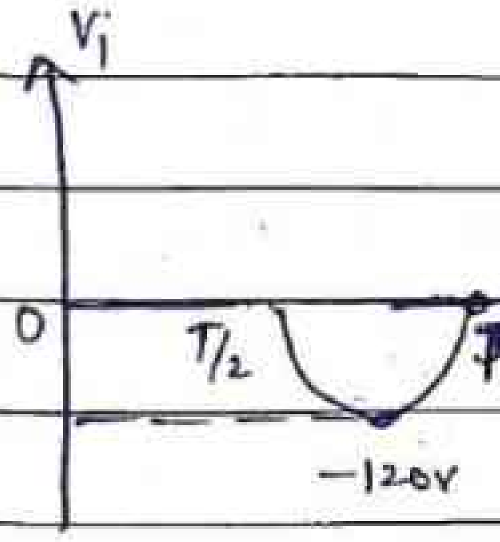
$$3.3 \times 30.3$$

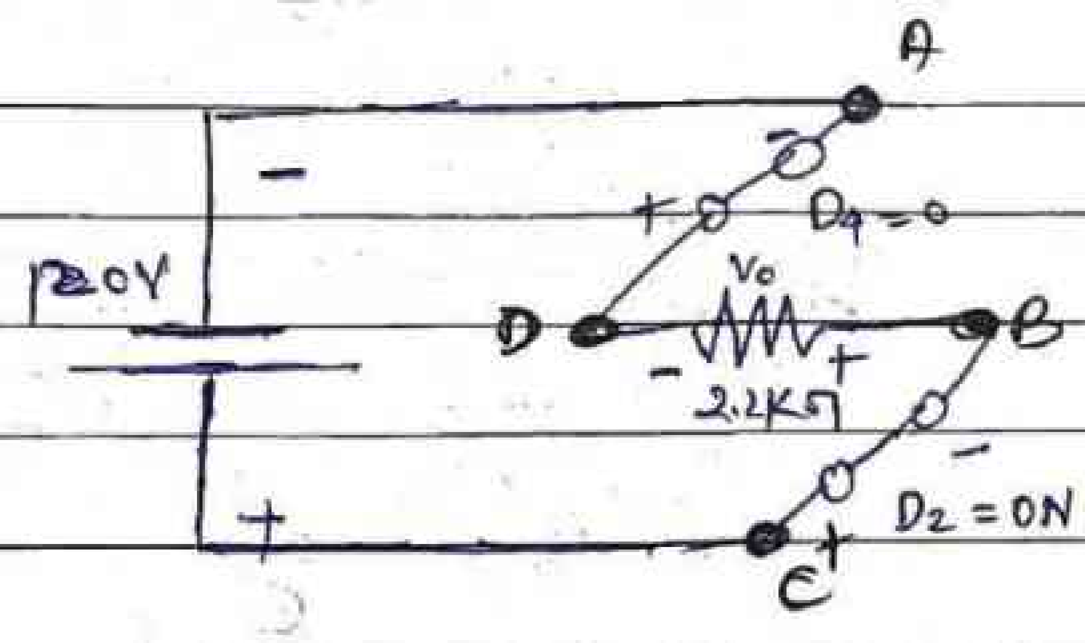
$$V_o = 99.99V$$

$$\boxed{V_o = \simeq 100V}$$

Page ______
Date ______

Case - II During -ve half cycle.





$V_1 = -120V$
$D_1 = OFF$
$D_2 = ON$
$D_3 = OFF$
$D_4 = ON$

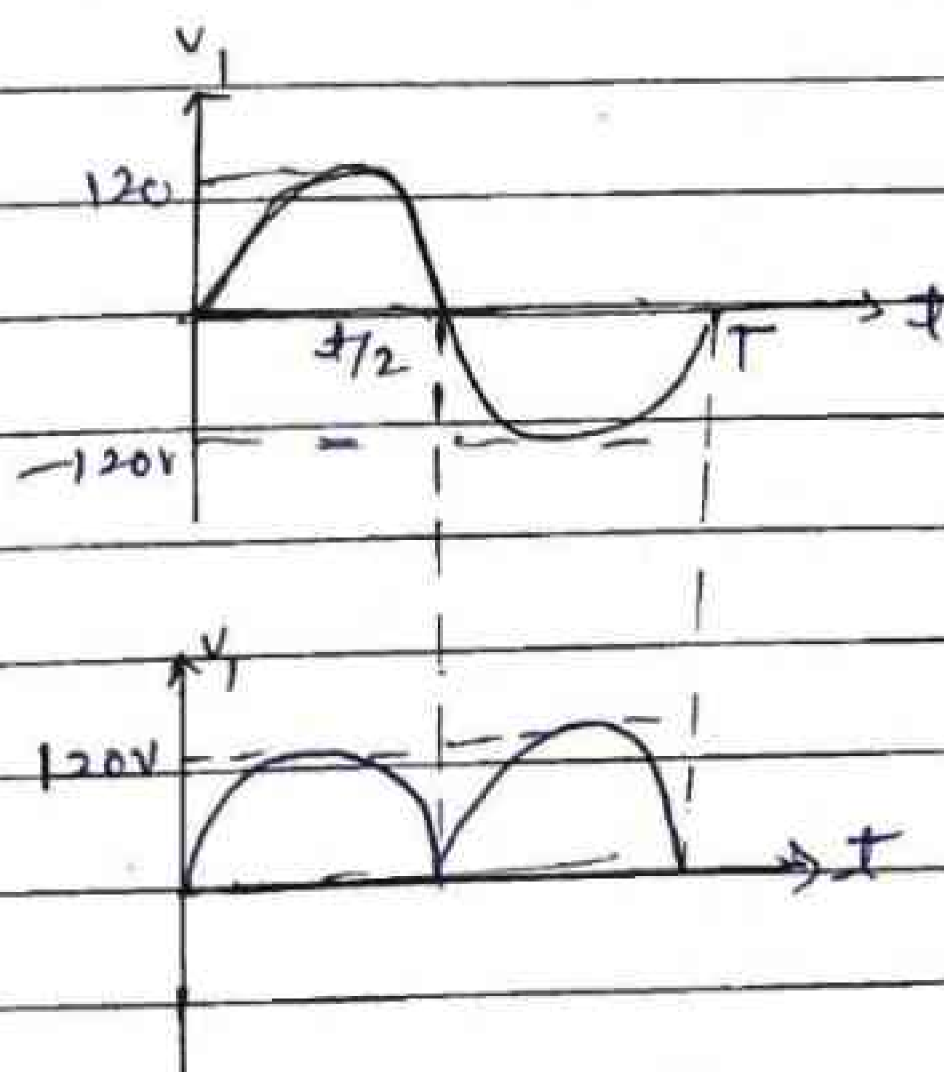
$120 + 2.2I = 0$

$+2.2I = +120$

$I = \frac{120}{2.2} = 54.54$

$V_0 = I \times 2.2K$

$V_0 = 54.54 \times 2.2 = 120V$



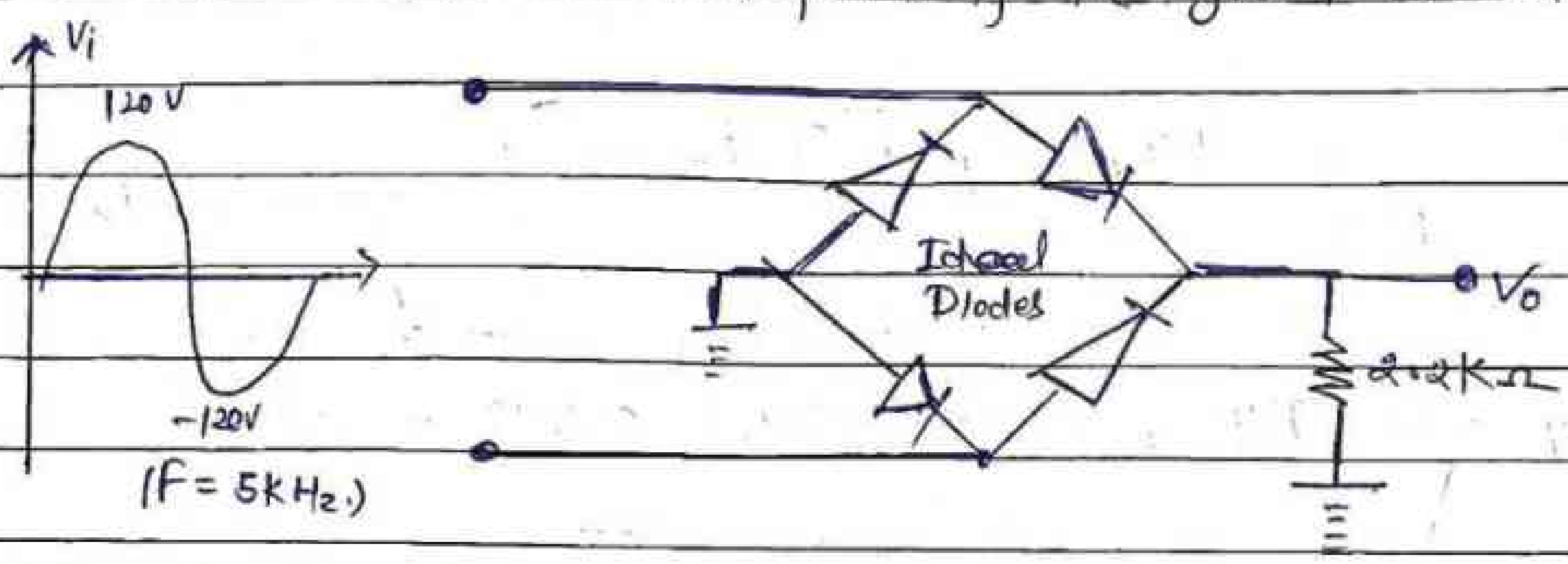
$V_{0c} = \frac{240}{3.14}$

$= 76.43$

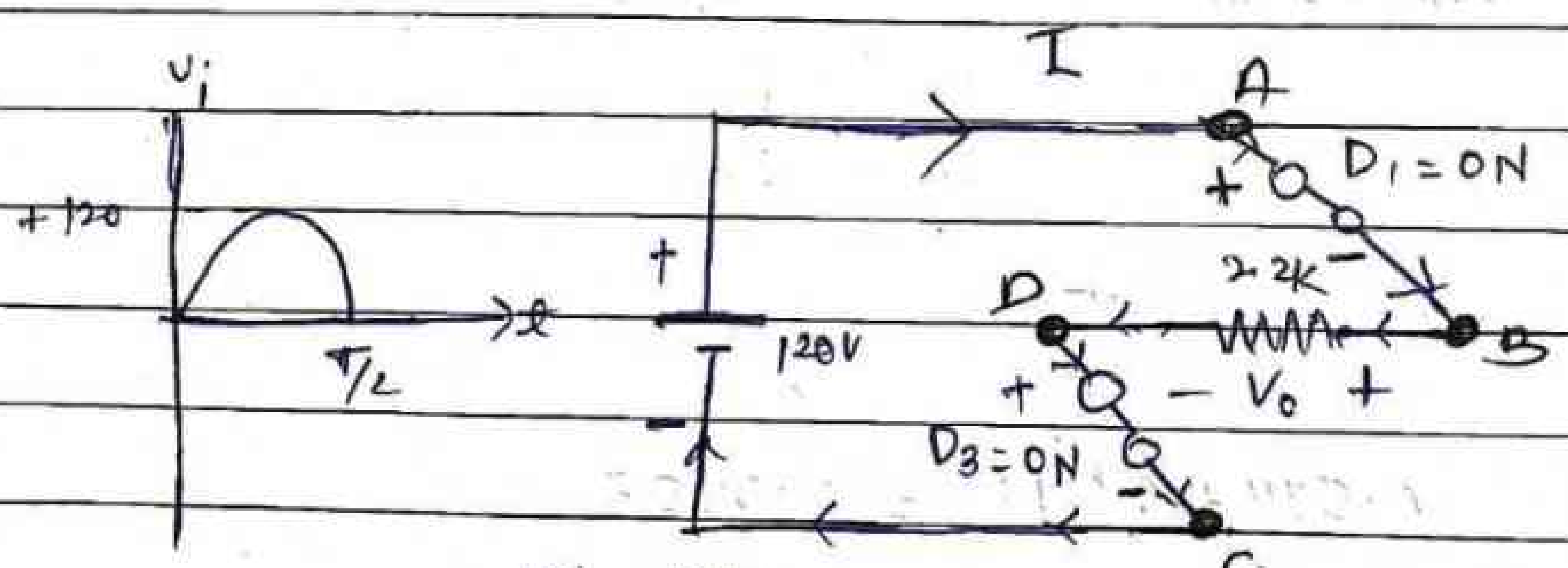
Page ______

Date ______

Ques → Sketch the V_0 waveform of the given circuit.



Sol^n ⇒ Case I : During +ve Half Cycle :-



$V_i = +120V$

$D_1 = ON$

$D_2 = OFF$

$D_3 = ON$

$D_4 = OFF$

using KVL

$$120 - 2.2I = 0$$

$$+2.2I = +120$$

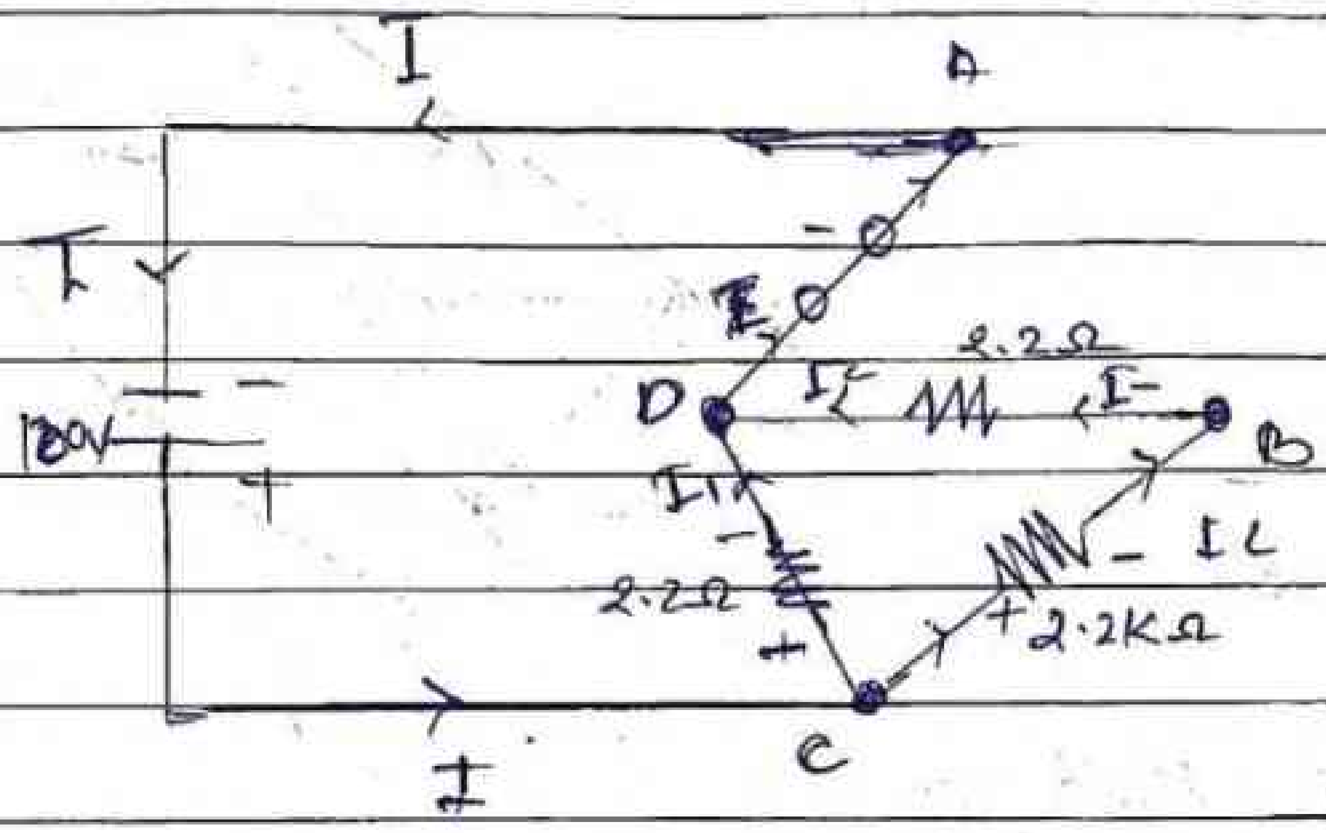
$$I = \frac{120}{2.2} = 54.54mA$$

and

$$V_0 = 2.2 \times I = 2.2 \times 54.54 = 120V$$

Page ______
Date ______

Case II During -ve Half cycle :-



$= (2.2 + 2.2) \| 2.2$

$4.4 \| 2.2$

using KVL

$$I = \frac{100}{1.46} = 68.49 \text{ mA}$$

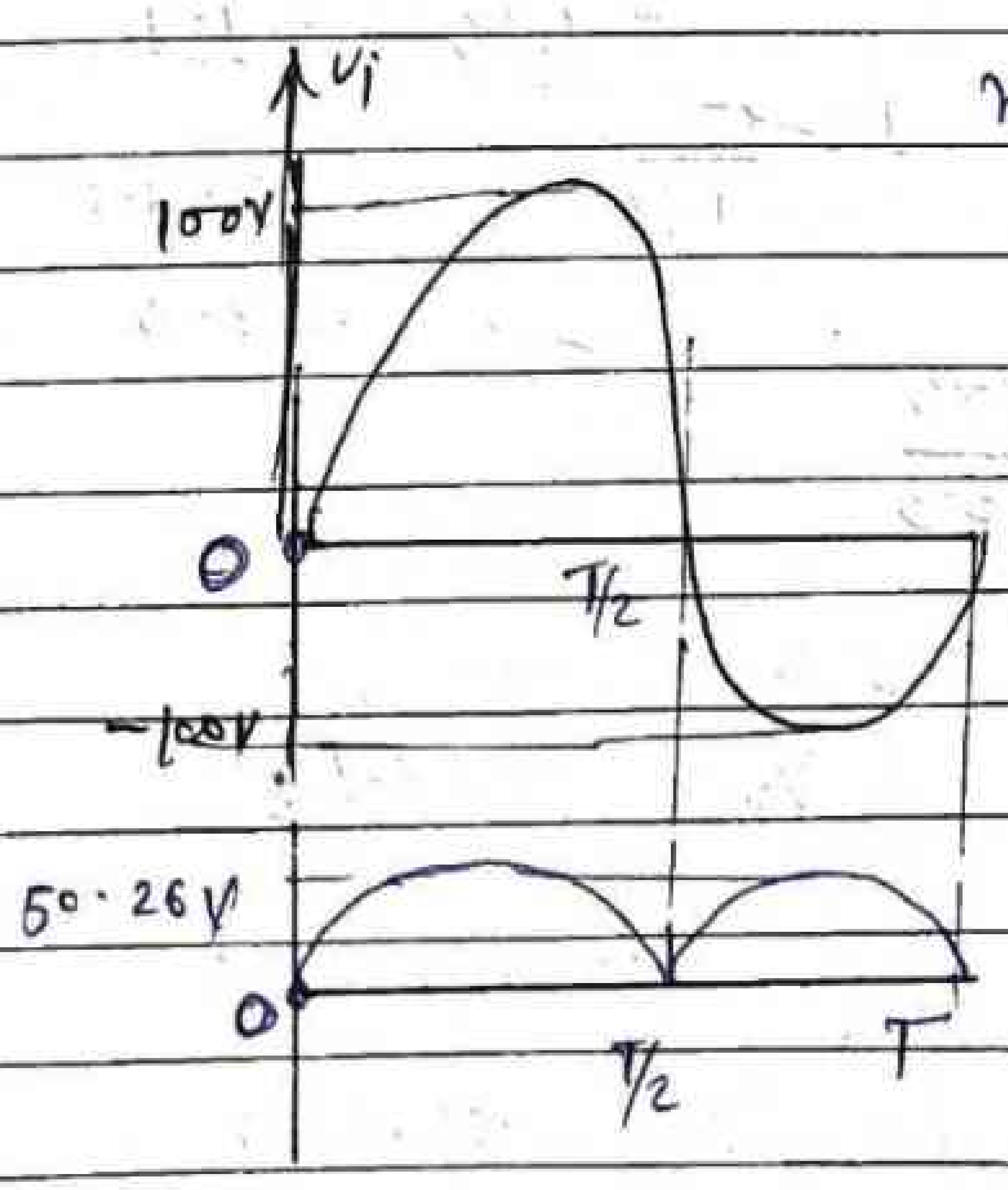
$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

using CDR

$R = \frac{R_1 R_2}{R_1 + R_2}$ $\quad I2 = \frac{I \times 2.2}{(4.4 + 2.2 + 2.2)}$

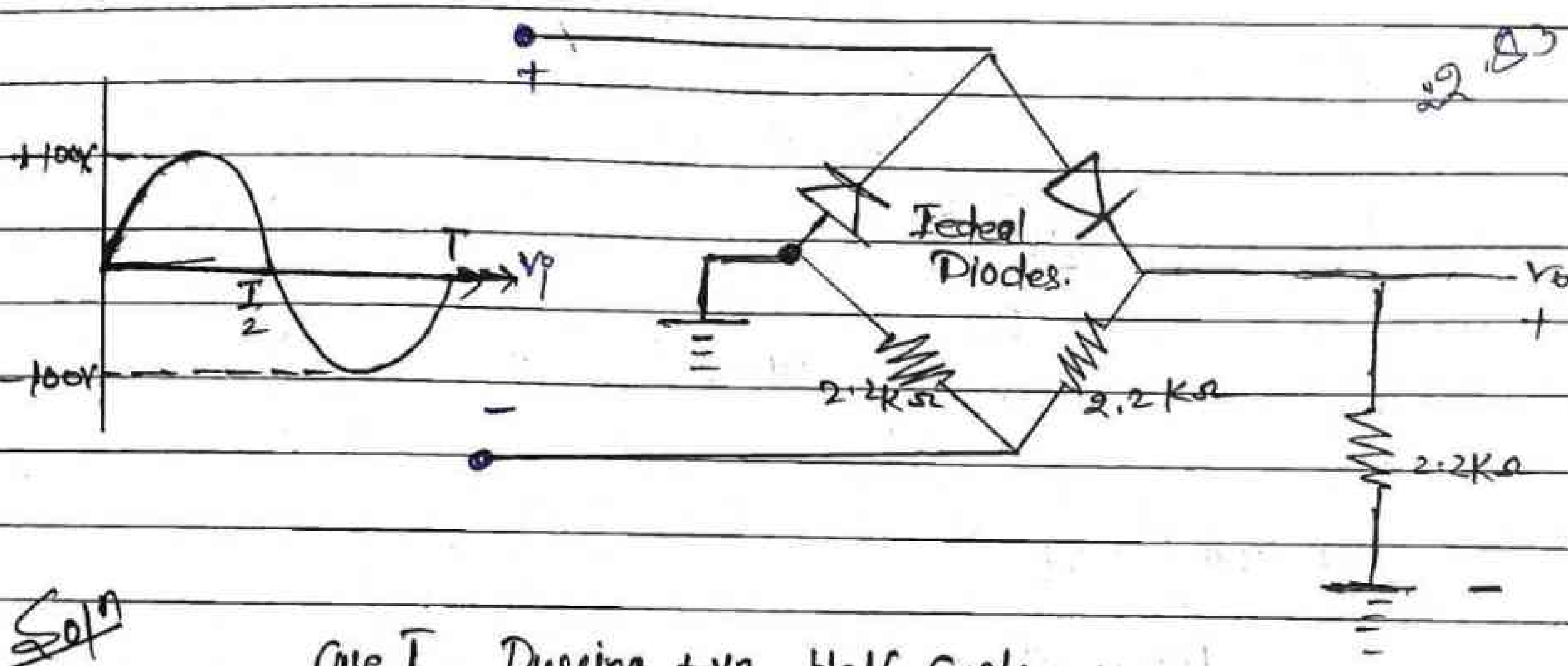
$$I_L = 68.49 \times \frac{2.2}{6.6} = 22.83 \text{ Am}$$

$V_o = 50.226$ V



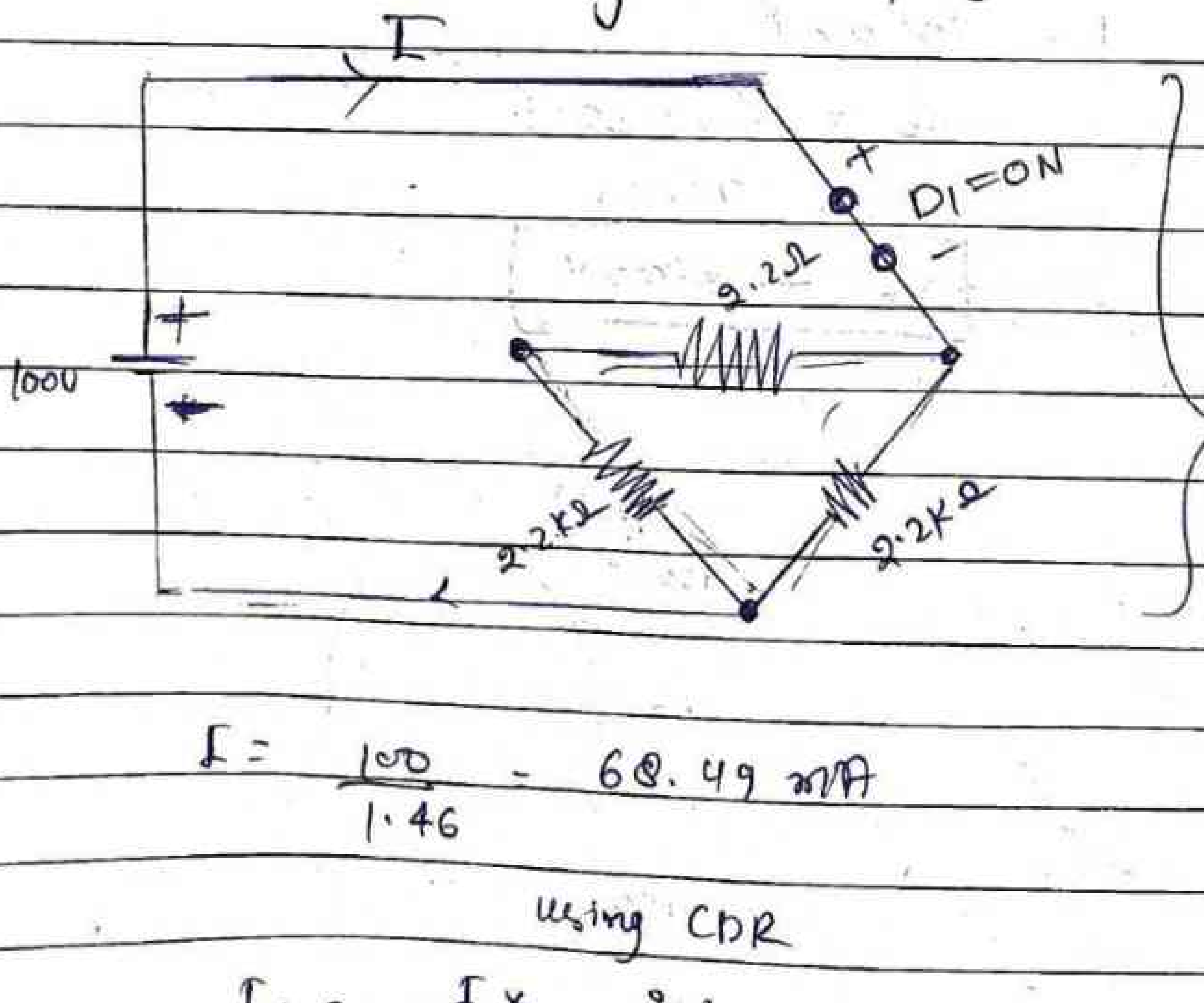
Page
Date

Sketch the vo waveform of the given network.



Solⁿ

Case I During +ve Half Cycle



$R_{eq} = (2.2+2.2) \parallel 2.2$

$4.4 \parallel 2.2$

$\frac{4.4 \times 2.2}{4.4+2.2} = 1.46\Omega$

$I = \frac{100}{1.46} = 68.49\ mA$

using CDR

$I_1 = I \times \frac{2.2}{(2.2+2.2+2.2)}$

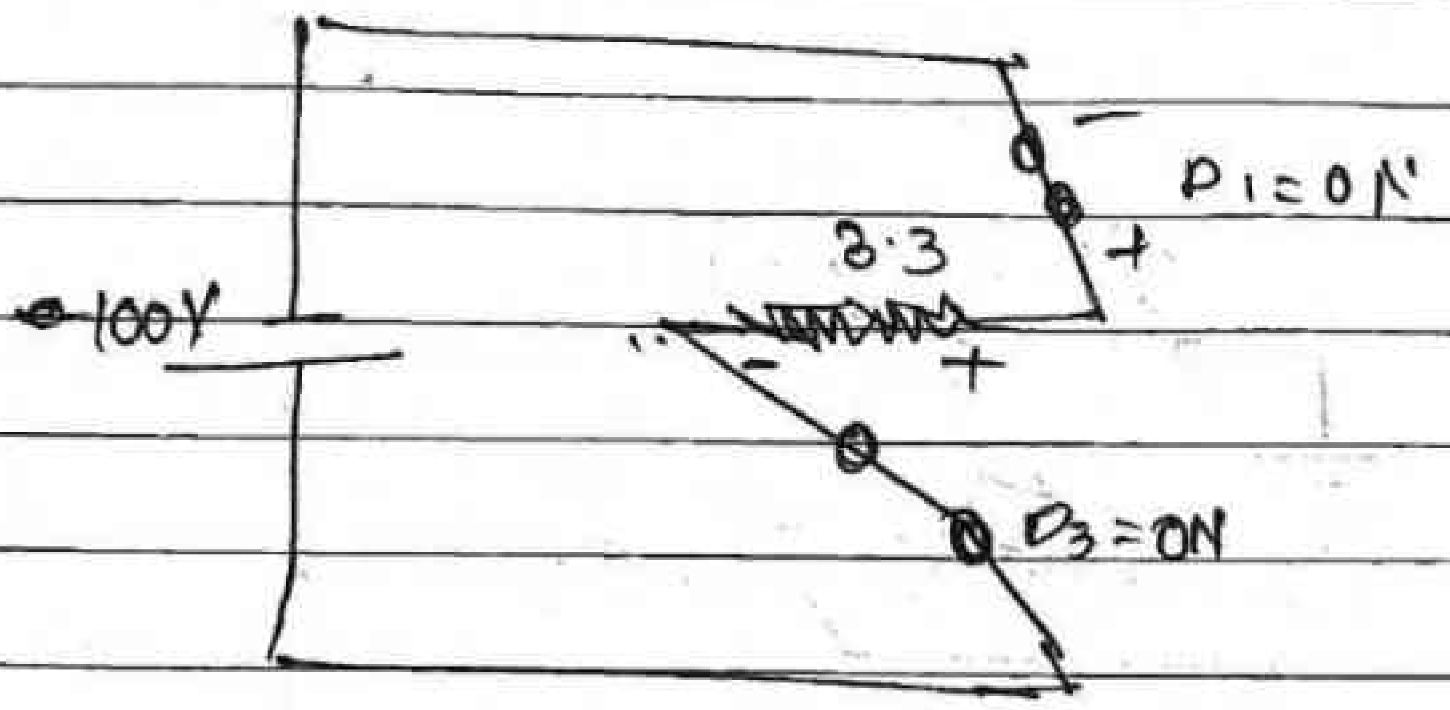
$I_1 = 68.49 \times \frac{2.2}{6.6} = 22.83\ mA$

$\therefore V_o = 2.2 \times I_1 = 2.2 \times 22.83$

$V_o = 50.226\ V$

Page ______
Date ______

Case II during -ve half cycle.



by using KVL

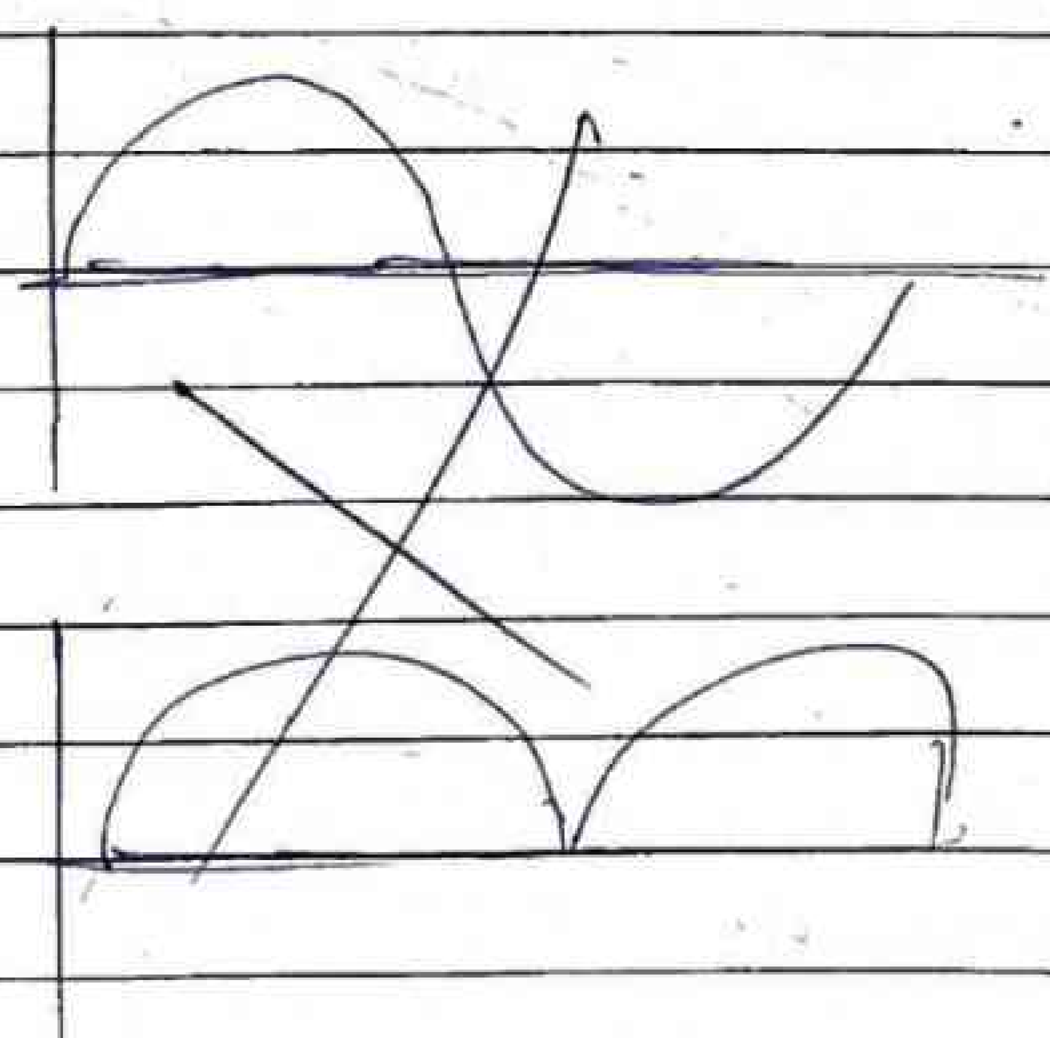
$100 - 3.3I = 0$

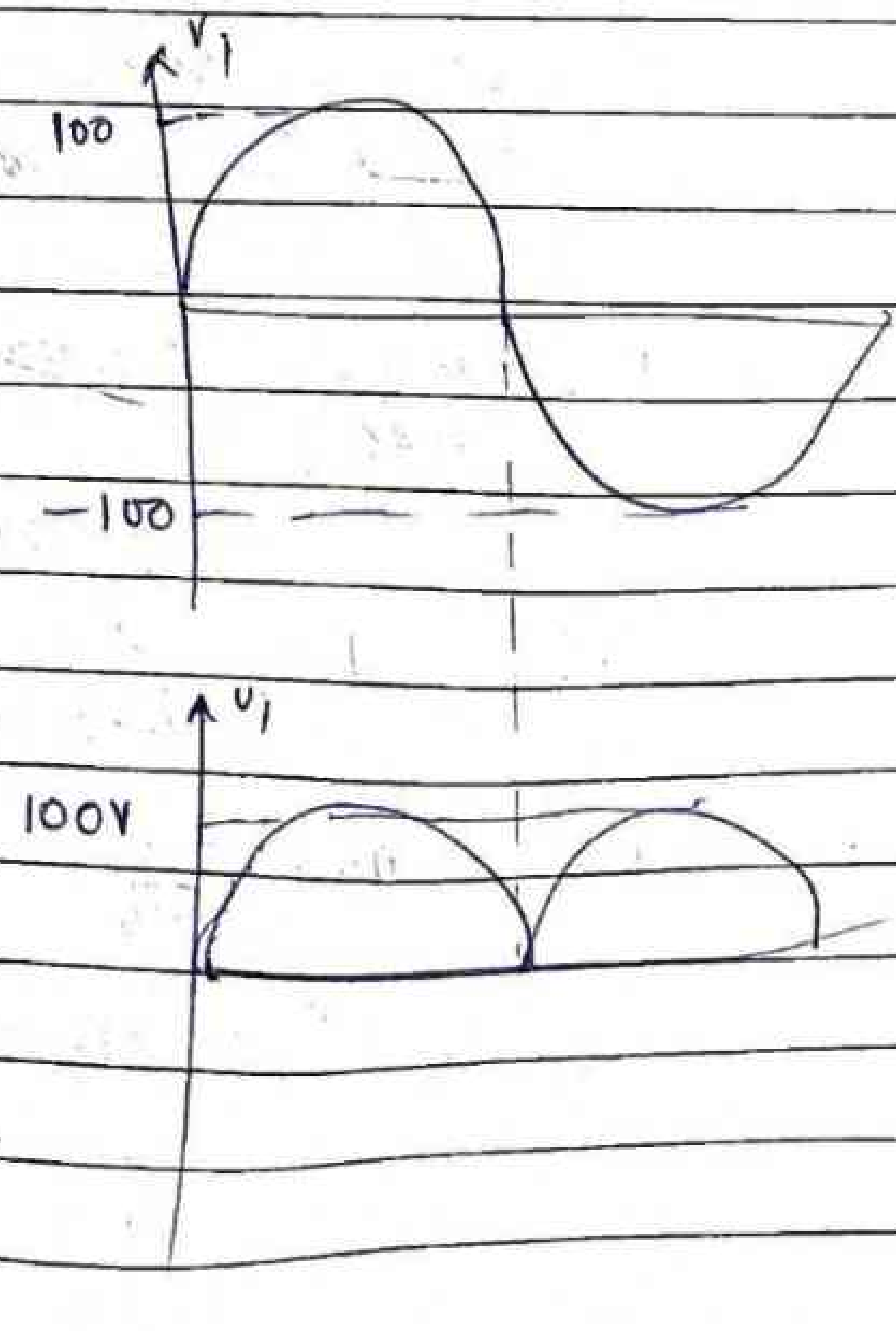
$I = 30.3mA$

then V_o = $V_o = 3.3 \times 30.3$

$= 99.99$

$V_o \simeq 100V$





Page

Date

V.V Imp

Que :- In the bridge rectifier circuit, the secondary voltage $V_s = 100 \sin 50 t$ and load resistance is 1KΩ calculate i) DC current ii) RMS value of current iii) Efficiency (iv) Ripple factor — 0.482
→ 0.811

Sol^n

$V_m = I_m R_L$

$I_m = \frac{100}{1}$

$I_m = 100mA$

(i) $I_{DC} = \frac{2 \times 100}{3.14} = 63.69 mA$

(ii) $Rms = \frac{I_m}{\sqrt{2}} = \frac{100}{\sqrt{2}} = 70.71$

(iii) $\frac{I_{DC}^2 \times R_L}{I_{rms}^2 \times R_L} = \frac{(63.69)^2 \times 1}{\frac{I_m}{\sqrt{2}}} \Rightarrow \frac{(63.69)^2 \times \sqrt{2}}{100} \Rightarrow \frac{5736.63}{100}$

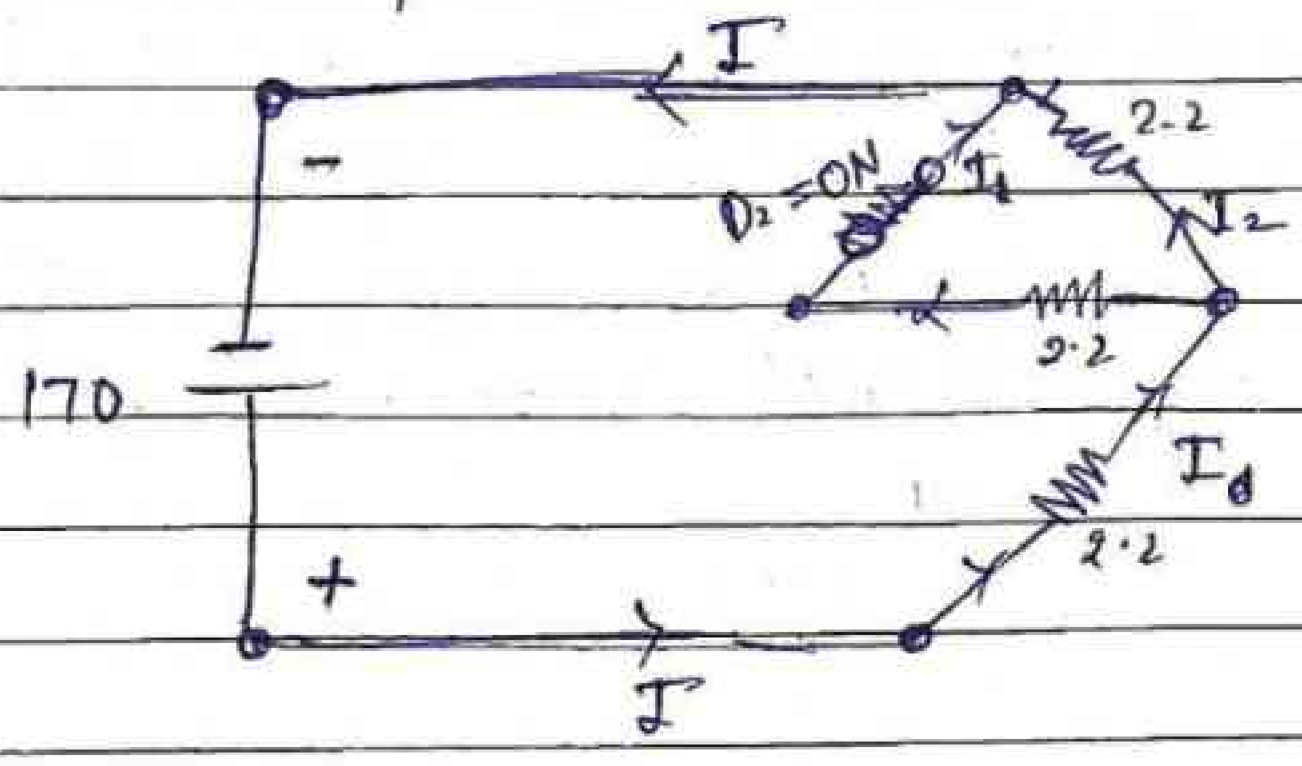
⇒

(iv) $\frac{\sqrt{V_{rms}^2 - V_{DC}^2}}{V_{DC}}$

$\frac{\sqrt{\left(\frac{V_m}{\sqrt{2}}\right)^2 - \left(\frac{2V_m}{\pi}\right)^2}}{\frac{2V_m}{\pi}} \Rightarrow \frac{\sqrt{\frac{V_m^2}{2} - \frac{4V_m^2}{\pi^2}}}{\frac{2V_m}{\pi}}$

$\frac{\sqrt{V_m^2 \left(\frac{1}{2} - \frac{4}{\pi^2}\right)}}{\frac{2V_m}{\pi}}$

During -ve Half cycle.



$$R_{eq} = 2.2 \| 2.2 + 2.2$$

$$\frac{2.2 \times 2.2}{2.2 + 2.2} + 2.2$$

$$1.1 + 2.2$$

$$R_{eq} = 3.3$$

$$I = \frac{170}{3.3} = 51.51$$

$$I_2 = \frac{51.51 \times 2.2}{(2.2 + 2.2)}$$

$$= \frac{51.51 \times 2.2}{4.4}$$

$$51.56 \times 0.5 = 25.755$$

$$I_2 = 25.755$$

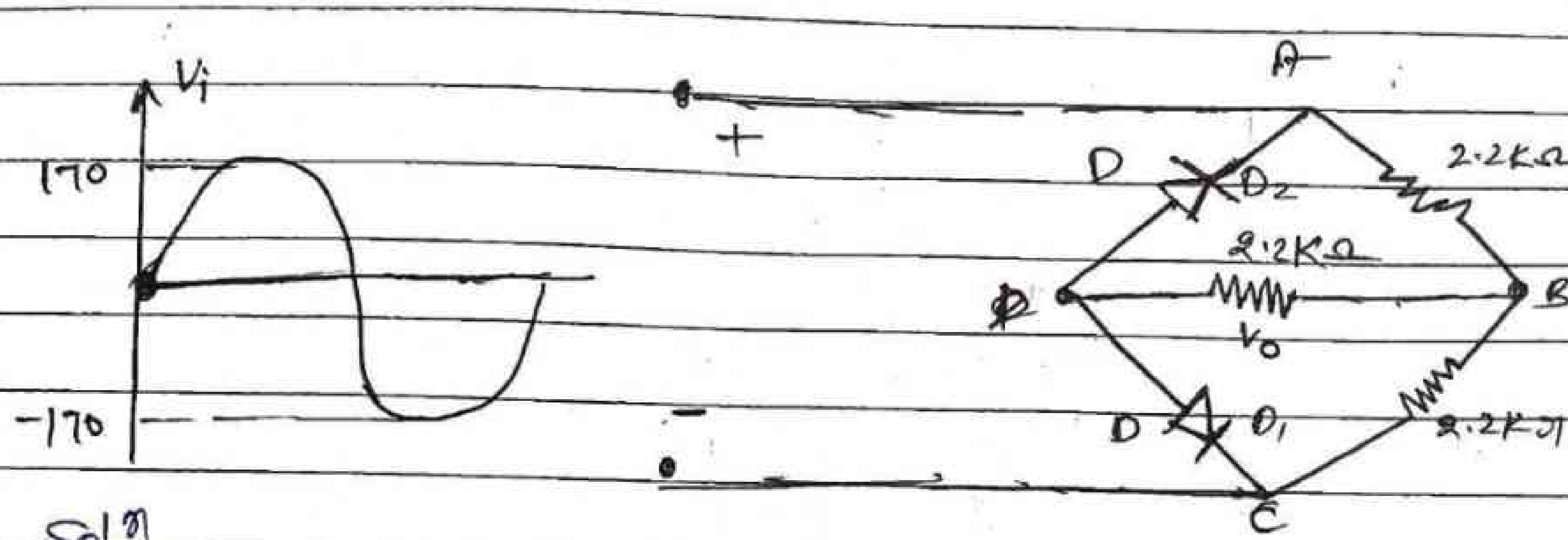
$$V_0 = I_2 \times 2.2$$

$$= 25.755 \times 2.2$$

$$= 56.66\,V$$

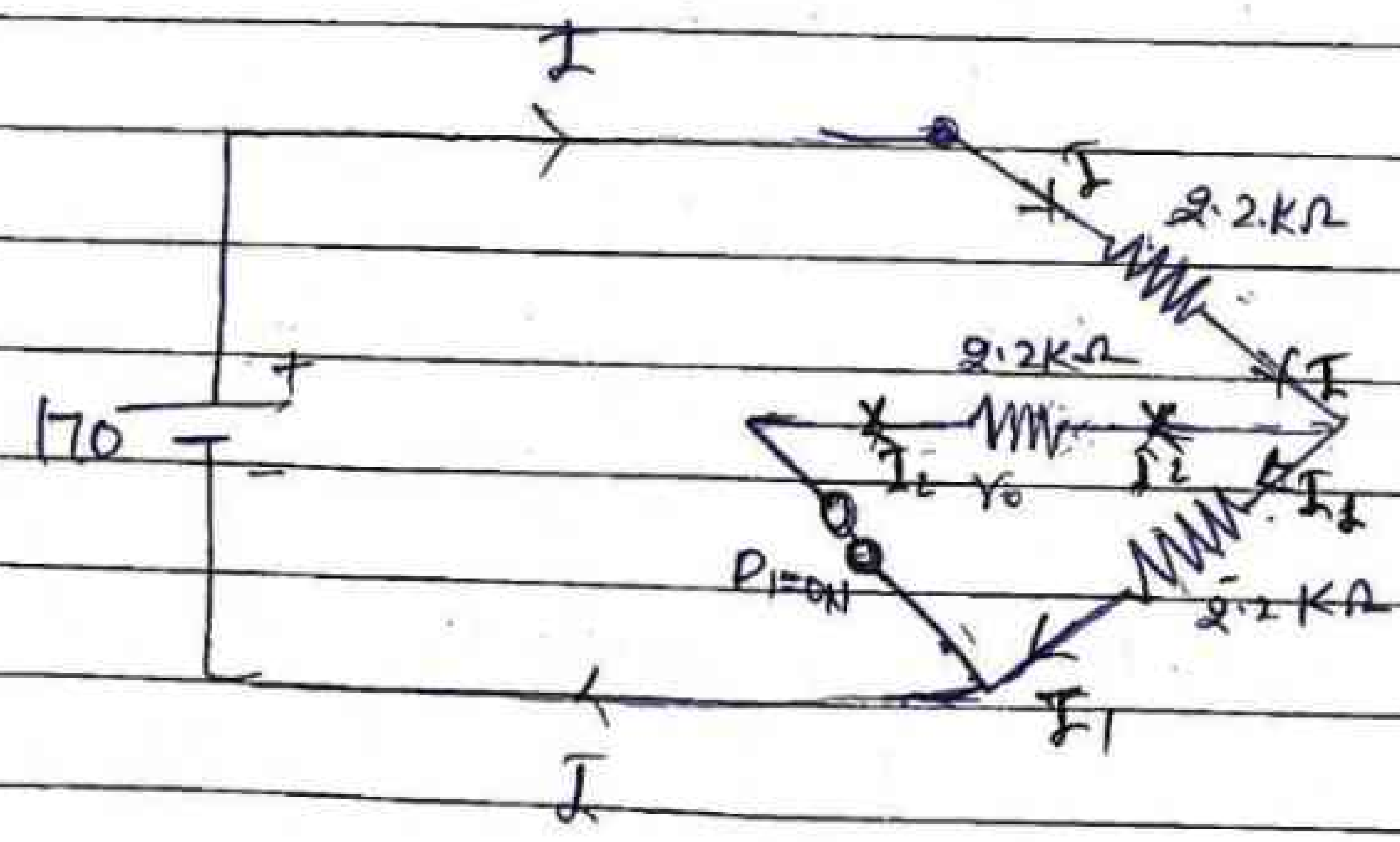
Page ______
Date ______

Que



Sol^n

During +ve Half cycle -



$R_{eq} = 2.2 || 2.2$

$= \frac{2.2 \times 2.2}{4.4}$

$(2.2) || 2.2$

$= 1.1$

$= 2.2 + 1.1$

$= 3.3$

$V_i = 170$

$D_1 = ON$

$D_2 = OFF$

$I = \frac{170}{3.3}$

$I_1 = \frac{51.51 \times 2.2}{(2.2 + 2.2)}$

$= \frac{51.51 \times 2.2}{4.4}$

$= 25.755$

$V_0 = 2.2 \times I_1$

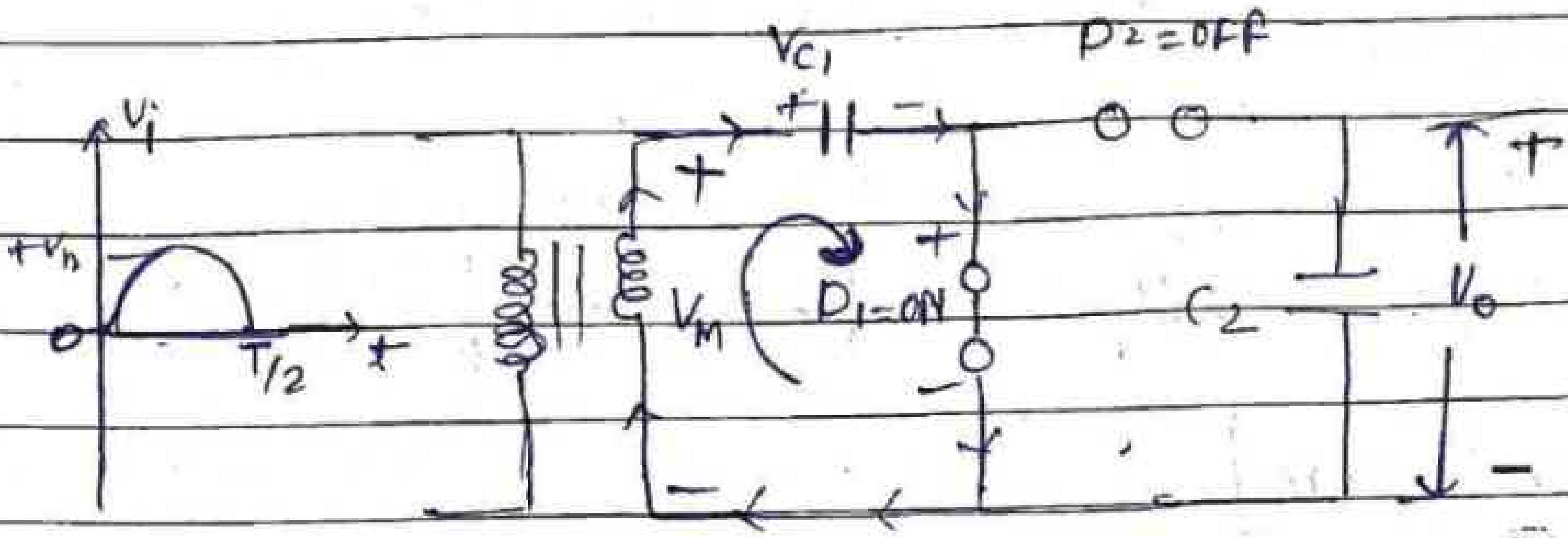
2.2×25.755

$V_0 = 56.661 V$

Page

Date

CASE – I During +ve Half cycle.



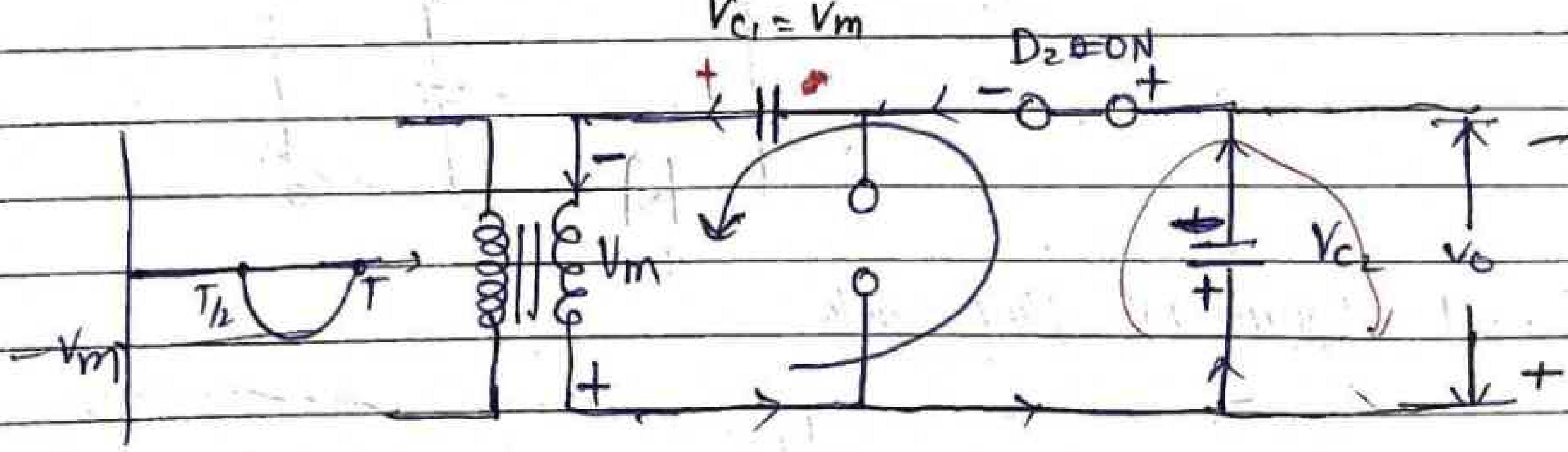
using KVL

$V_m - V_{c_1} = 0$ and $\boxed{V_o = 0\,V}$

$+V_{c_1} = +V_m$

$\boxed{V_{c_1} = V_m}$

Case – II During –ve Half cycle.



using KVL

$V_m - V_{C_2} = 0$

$\boxed{V_{C_2} = V_m}$

$V_m = V_{c2} + V_{c1}$, V_n

$\therefore V_{c1} = V_n$

$2V_m = V_{c2}$

$-V_{c2} + V_o = 0$

$V_o = V_{c2}$

$\therefore V_{c2} = 2V_m$

$V_o = 2V_m$

Page
Date

Voltage multiplier :-

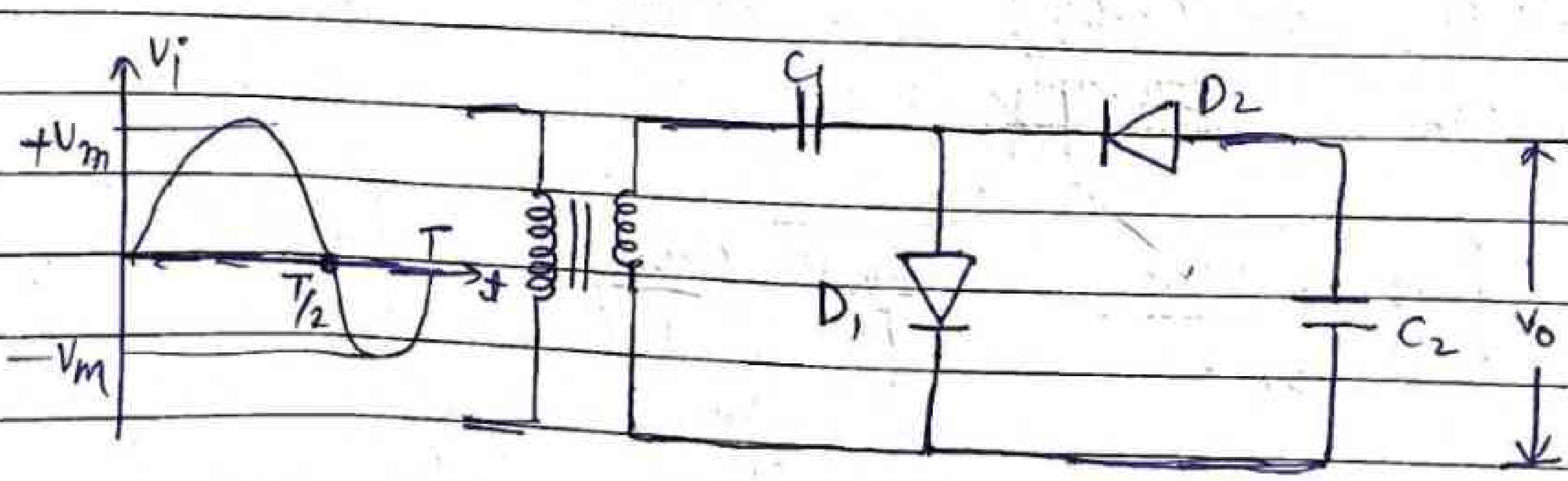
A circuit is known as voltage multiplier, if it's output voltage is proportional to n- times of applied input voltage.

V_i ⟶ [Voltage multiplier] ⟶ [$V_o = nV_i$]

* if $n = 2$ then, $V_o = 2V_i$ ⇒ Voltage doubler — Half wave voltage doubler & Full wave voltage doubler
* If $n = 3$ then $V_o = 3V_i$ ⟶ Voltage tripler
* if $n = 4$ then $V_o = 4V_i$ ⇒ Voltage Quadrupler.

Voltage Doubler :-

(A) Half Wave voltage Doubler (HWVD)



Page ______

Date ______

$$\frac{V_m\sqrt{\left(\frac{1}{2}-\frac{4}{\pi^2}\right)}}{\frac{2V_m}{\pi}}$$

$$\sqrt{\frac{1}{4}-\frac{4}{\pi^2}}\times\pi \Rightarrow \sqrt{\frac{1}{2}-\frac{4}{(3.14)^2}}\times 3.14$$

$$\frac{\sqrt{\frac{1}{2}-\frac{4}{\pi^2}}}{10}\times 3.14 \Rightarrow \sqrt{\frac{1}{2}-\frac{4}{(3.14)^2}}\times 3.14$$

$$\frac{0.3064}{100}\times 3.14$$

$$RF = 9.62$$

Rms → Following

(iii) $\frac{I_{DC}^2\times R_L}{I_{rms}^2\times R_L} \Rightarrow \frac{(63.69)^2}{(70.71)^2} \Rightarrow 0.811$

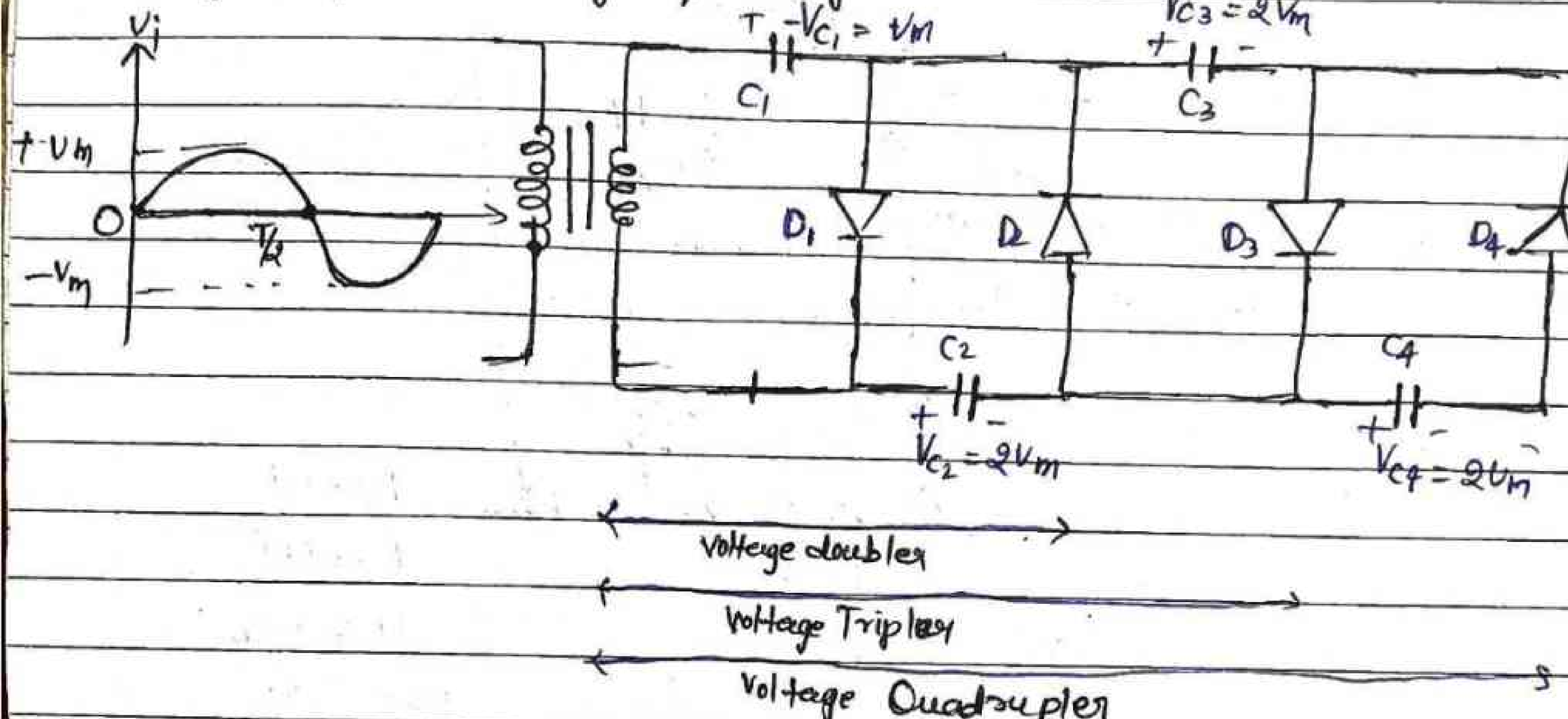
(iv) R.F $\frac{\sqrt{V_{rms}^2-V_{DC}^2}}{V_{DC}} = \frac{\sqrt{\left(\frac{V_m}{\sqrt{2}}\right)^2-\left(\frac{2V_m}{\pi}\right)^2}}{\frac{2V_m}{\pi}} = \frac{\sqrt{\left(\frac{100}{\sqrt{2}}\right)^2-\left(\frac{200}{3.14}\right)^2}}{\frac{200}{3.14}}$

$$\frac{\frac{10000}{2}-\frac{40000}{9.85}}{\frac{200}{3.14}}$$

Page

Date

* Voltage Tripler + Voltage quadrupler :-



* Working #

During +Half cycle, Diode (D_1) conducts (forwards) and the capacitors (C_1) charges up to V_m Due to the transformer secondary voltage ($+V_m$). And During the (-)ve half cycle, Diod (D_2) conducts and the capacitor C_2 charges upto $2V_m$. Due to the transformer secondary voltage (V_m). And V_{C_1}

During the (+)ve half cycle, Diode D_3 conducts and the capacitors C_3 charges up to $2V_m$ due to V_{C_2}. and during the negative half cycle, Diode D_4 conducts and the capacitor C_4 charges upto $2V_m$ due to the V_{C_3}

* Voltage Doubler

$V_o = V_{C_2}$

$\boxed{V_o = 2V_m}$

* Voltage Tripler

$V_o = V_{C_1} + V_{C_3}$

$V_o = V_m + 2V_m$

$\boxed{V_o = 3V_m}$

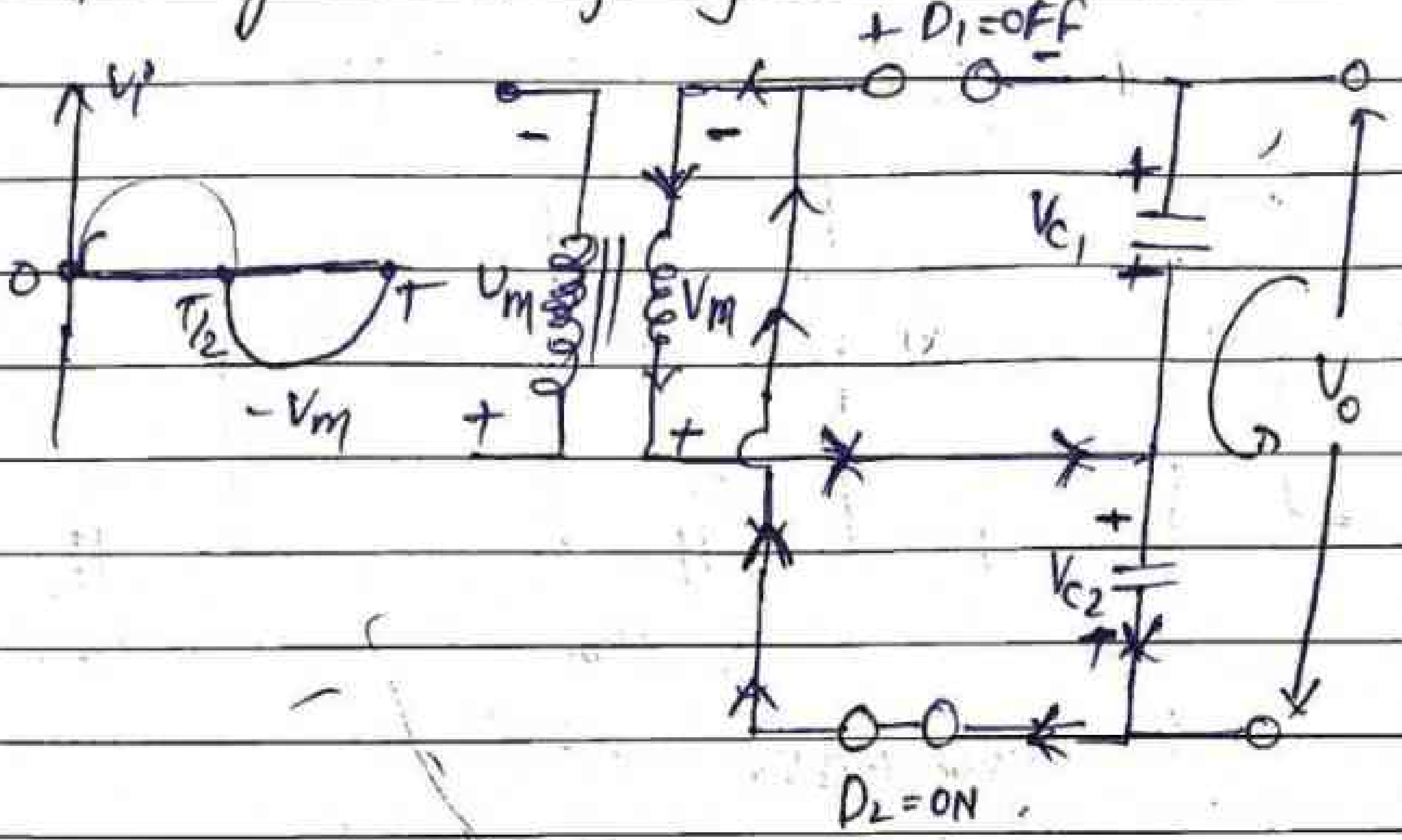
* Voltage Quadrupler

$V_o = V_{C_2} + V_{C_4}$

$V_o = 2V_m + 2V_m$

$\boxed{V_o = 4V_m}$

During -ve Half cycle -



D_2 = ON
D_1 = OFF
$V_1 = -V_m$

using KVL

$+V_m - V_{C_2} + V_m = 0$

$V_m + V_m = V_{C_2}$

$2V_m = V_{C_2}$

~~$-V_{C_2} + V_{C_1} + V_0 = 0$~~

$V_0 = V_{C_2} - V_{C_1}$

$V_0 = 2V_m - V_m$

$\boxed{V_0 = V_m}$

using KVL

$+V_m - V_{C_2} = 0$

$\boxed{V_{C_2} = V_m}$

$V_0 = V_{C_1} + V_{C_2}$

$\because V_{C_1} = V_m$

$V_{C_2} = V_m$

$\boxed{V_0 = 2V_m}$

using KVL

$V_m - V_{c2} + V_{c1} = 0$

$\therefore V_{c1} = V_m$

$V_m - V_{c2} + V_m = 0$

$\boxed{V_{c2} = 2V_m}$

and

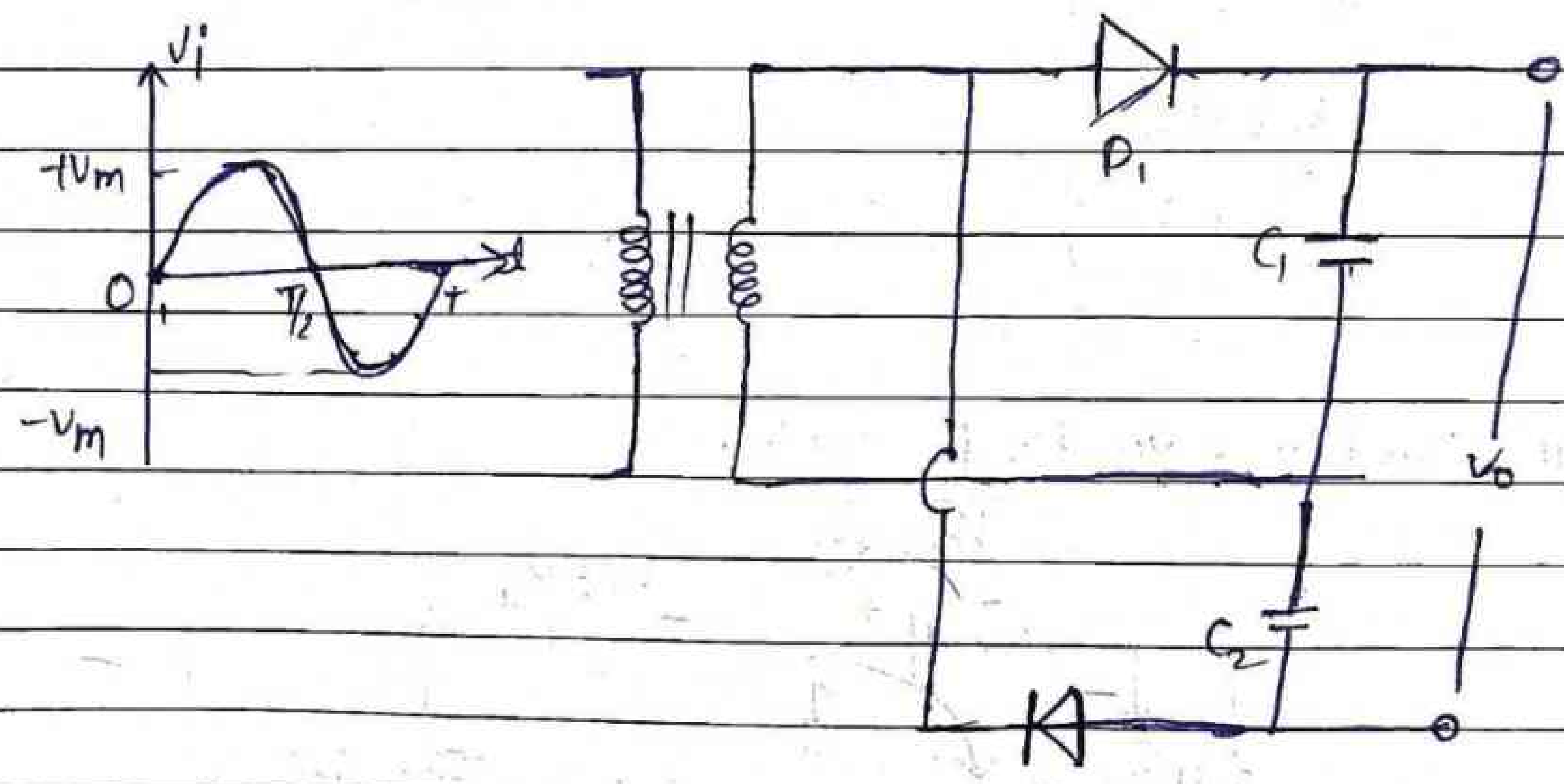
$-V_{c2} + V_0 = 0$

$V_0 = V_{c2}$

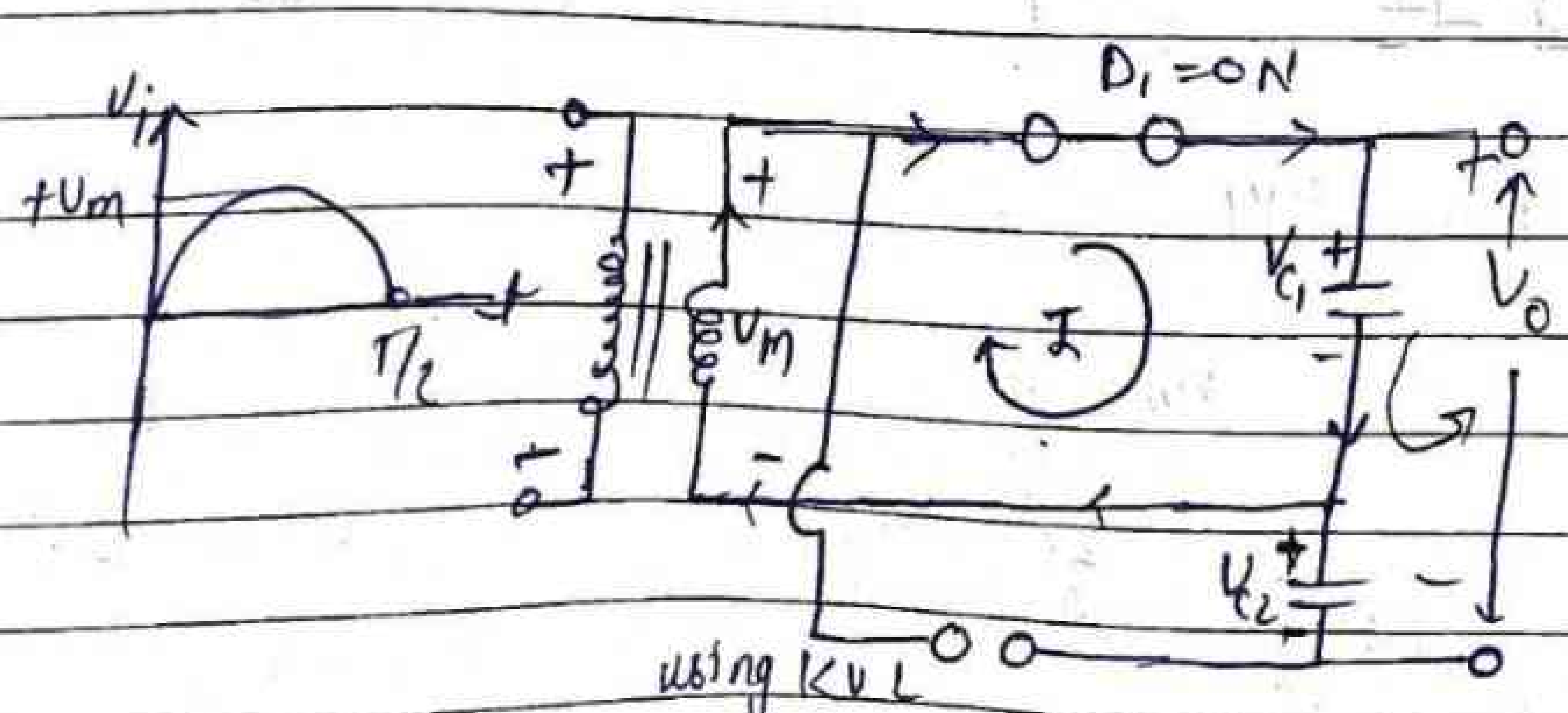
$\therefore V_{c2} = 2V_m$

$\boxed{V_0 = 2V_m}$

(B) Full wave voltage doubler. (FWVD):



Case-I → Durin +ve Half Cycle



$D_1 = ON$

$V_i = +V_m$

$D_2 = off$

and $V_0 = V_{c1} + V_{c2}$

using KVL

$V_m - V_{c1} = 0$

$\boxed{V_{c1} = V_m}$

$\therefore V_{c1} = V_m$

$V_{c2} = 0$

~~$V_0 = 0$~~

$\therefore \boxed{V_0 = V_m}$

Page ____
Date ____

* **Varactor Diode** or **Varicap Diode** :- These diodes are semiconductor, voltage dependent and voltage variable capacitor diode.

Varactor Diode is also known as varicap Diode because its internal capasitance varries with respect to change in reverse bias voltage.

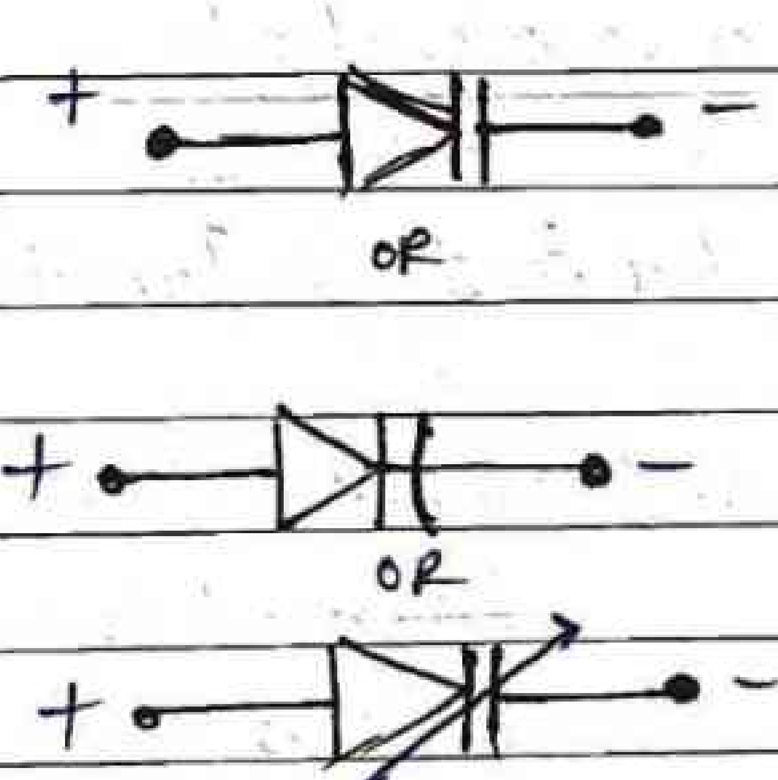


Fig- Symbol

There mode of operation depends upon the capacitance that exist's when the element is revers biased.

Under reverse bias condition, the transition capacitance is observe it is denoted by (C_T) and is approximately given by C_T =

$$C_T = \frac{K}{(V_K + V_R)^n}$$

where, K = constant

V_K = Knee voltage

V_R = Reverse bias voltage

n = $\frac{1}{2}$ (For alloy junction

$\frac{1}{3}$ (for Diffused Junction)

Page
Date

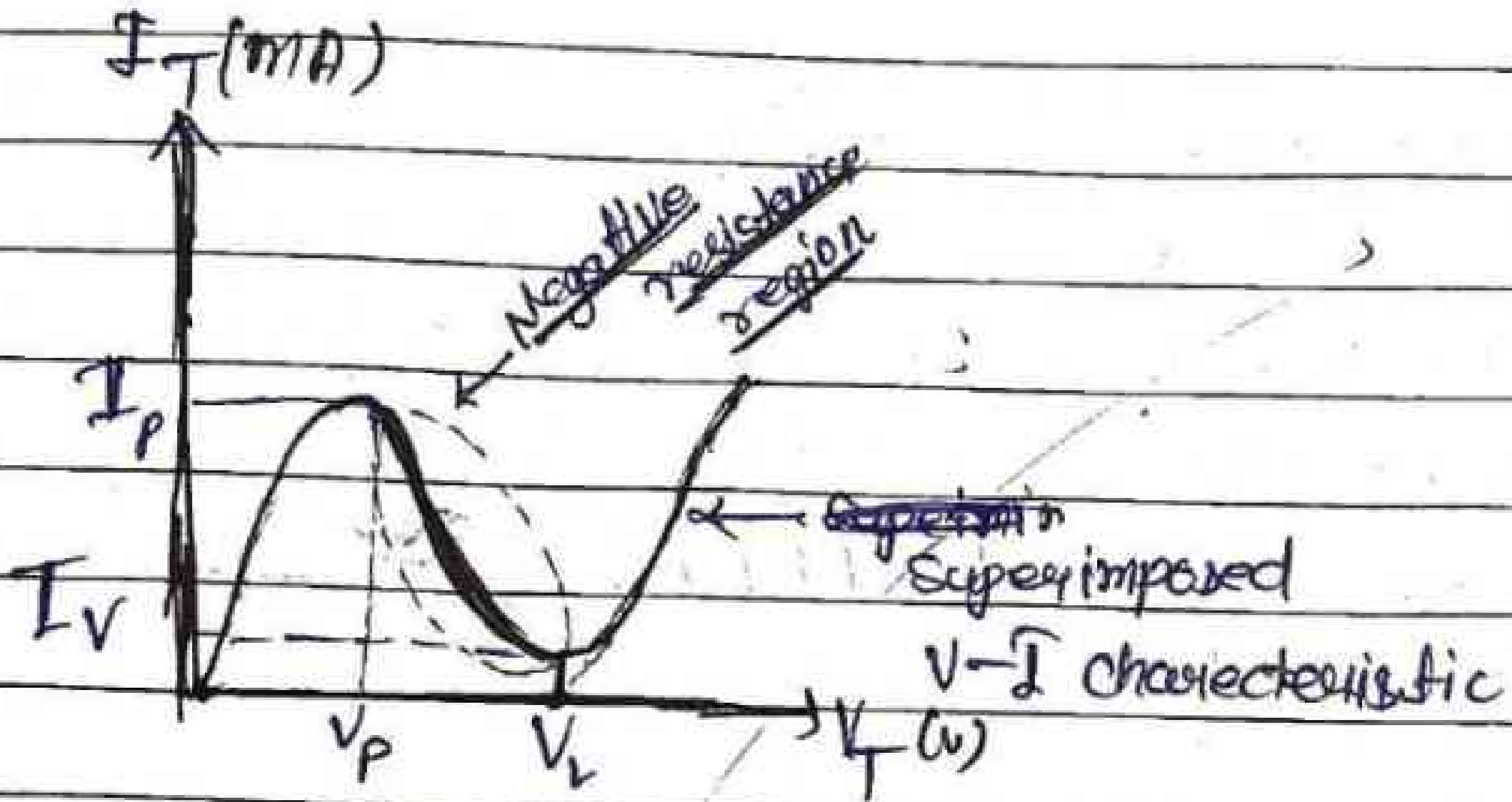


fig :- V–I Charecteristic of Tunnel Diode.

Advantages of Tunnel Diode :-

① - It oprates at a very high switching speed.

② It is easy oprate

(iii) It has low power ~~D.C~~ desipation

Disadvantage of Tunnel Diodes.

① Limited Voltage range.

(ii) Limited Current capacity

(iii) It is sensitive to tempr changes,

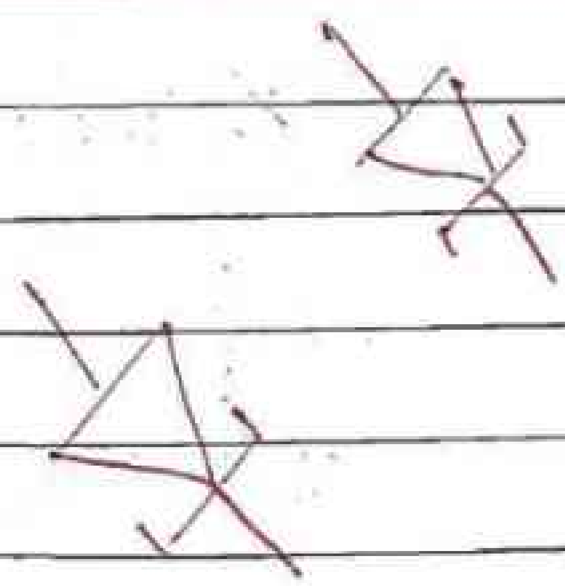
Applications of Tunnel Diodes.

① It is use as very fast switching device in computer.
② In High frequency osscillators
③ In ~~Amplification~~ Amplifiers.

Page ______

Date ______

Special Purpose Diodes :-



→ Tunnel Diode
→ Varactor Diode
→ Light emitting Diode (LED)
→ Photo diode.

* **Tunnel Diode :-** The Tunnel diode was first introduced by "Leo Esaki". It has a negative resistance region. i.e. and increase in terminal voltage ~~of~~ will cause a reduction in the diode current.

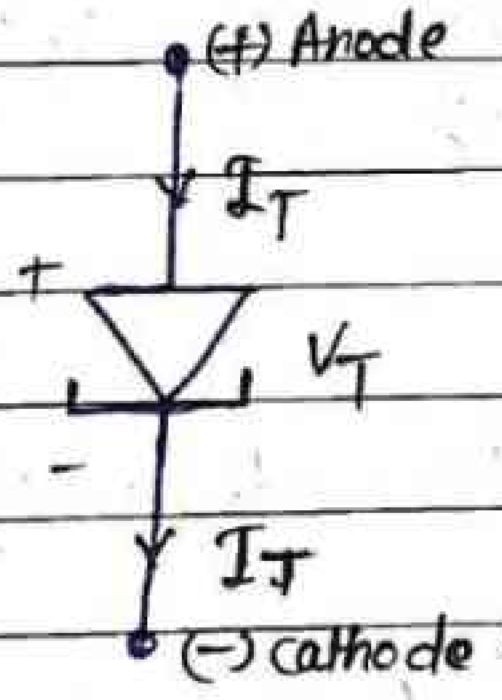


fig – Symbol of Tunnel diode

The ~~to~~ Tunnel Diode is fabricated by dopping the semiconductor material that will form p-n junction ~~d~~ at a level ~~too~~ hundred to thousand times more then the dopping level of a typical semiconductor diode. As a result the width of a depleation reagion will greatly reduced of the order of $\left(\frac{1}{100}\right)$ times the width of a typical semiconductor diode.

The Tunnel Diode Negative resistance region ~~by~~ lies b/w 0.1 Valt and 0.3 Valt

Page ______

Date ______

The main semiconductor material used for the manufacturing we to manufactured LEDs are

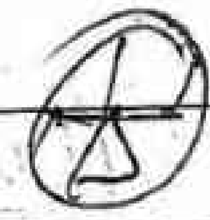
i) Aluminium, gallium, indium, phosphide, alloy. (Al, Ga In. P) (Y. O. R) — colour
ii) Indium, gallium, nitrite, alloy. (In Ga N) (B. G. U.V.) — colour
iii) Aluminium galium, arsenite (Al, Ga, As) (R. I.R.) — colour

- (Al Ga, In, P) are used to operate yellow, orange and red high brightness LEDs.
- InGaN-Alloy are used to obtain Blue, Green, Ultra Voilet high brightness LEDs and

Al Ga, As are used to obtain Red and Infrared brightness LEDs. → Imp

- The Voltage Drop across a conducting LED is 1.2V to 1.3V

Advantages of ~~Led~~: LED =

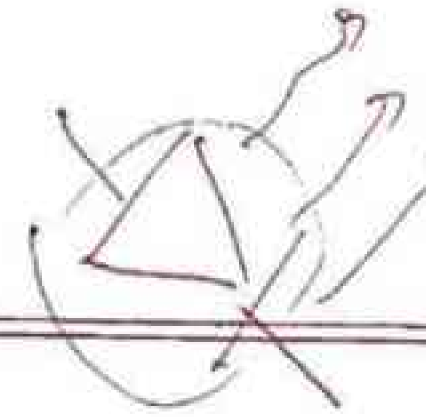


i) Small size and light weight.
ii) They are available in different spectral colours.

Dis advantge of LED :- (I) Over ~~fl~~ current may damage it easily.
(II) Blue colour LED may be harmful for eyes.

Application of LED :-

1. In seven-segment display
2. In digital watches.
3. In camera flashes.
4. In Traffic light
5. In optocuplers.



Page 9457363505 [redacted]
Date

* Lighting emitting Diode (LED) :-

An LED is used to convert electrical signal into visible light. An LED emits lights when an electrical signal is applied to it. For proper operation of LED, it is necessary to forward biased it.

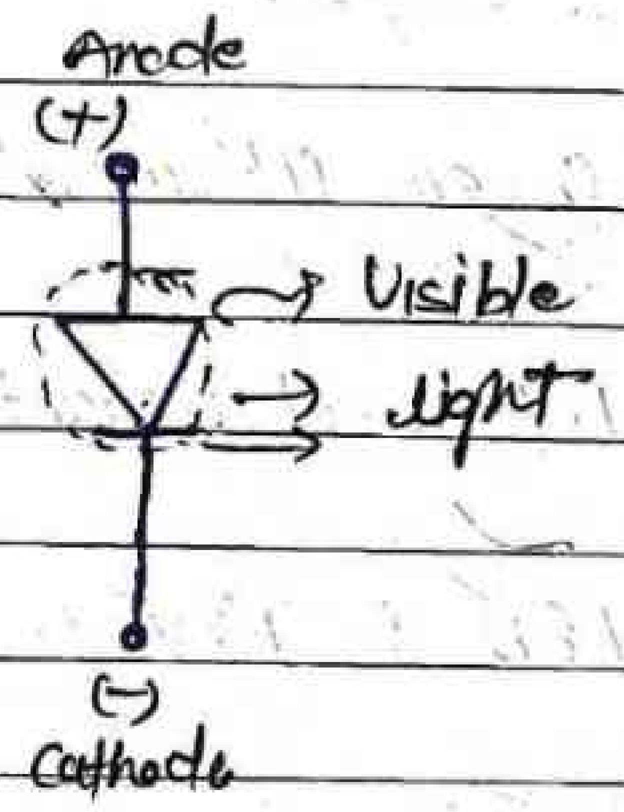


Fig :- Symbol of LED

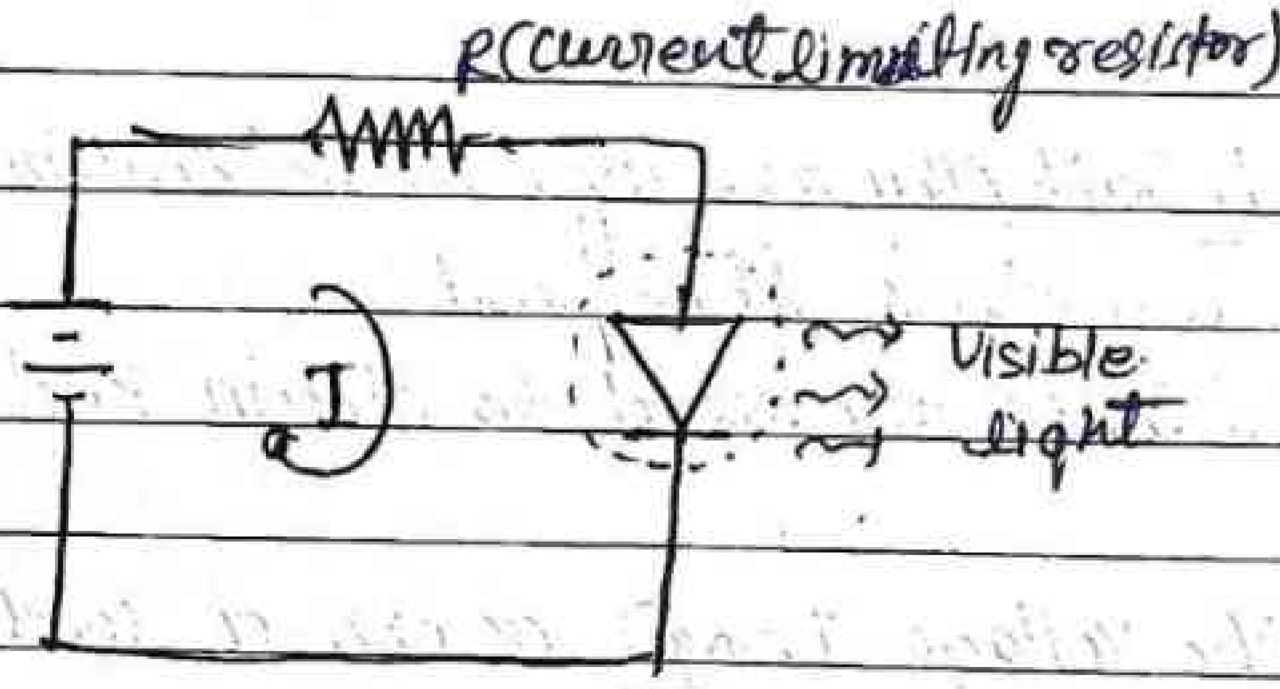


Fig: Forward biasing of LED

LEDs works on the principle of Electroluminescene (ie. the generation of light through and electrical operation) on passing current through the diode, the majority charge carriers and the minority charge carriers recombinse at the junction. On recombination, the energy is released in terms of photons.

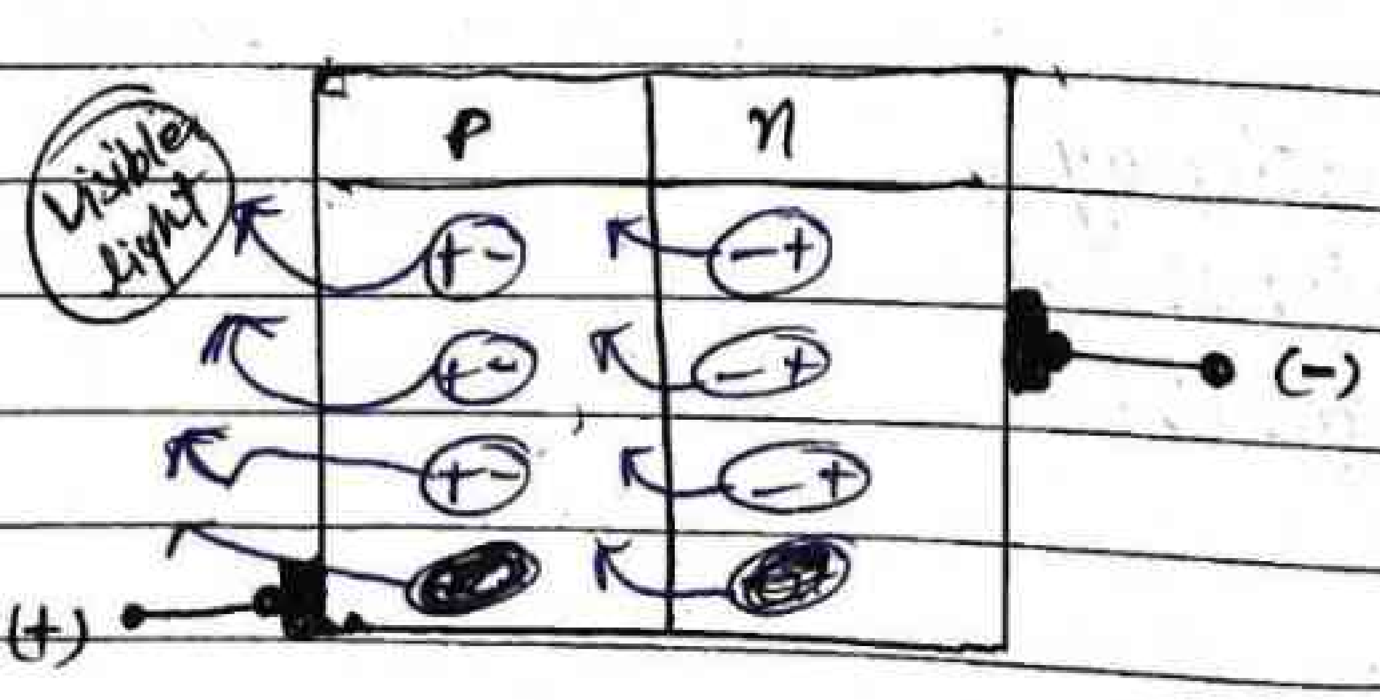
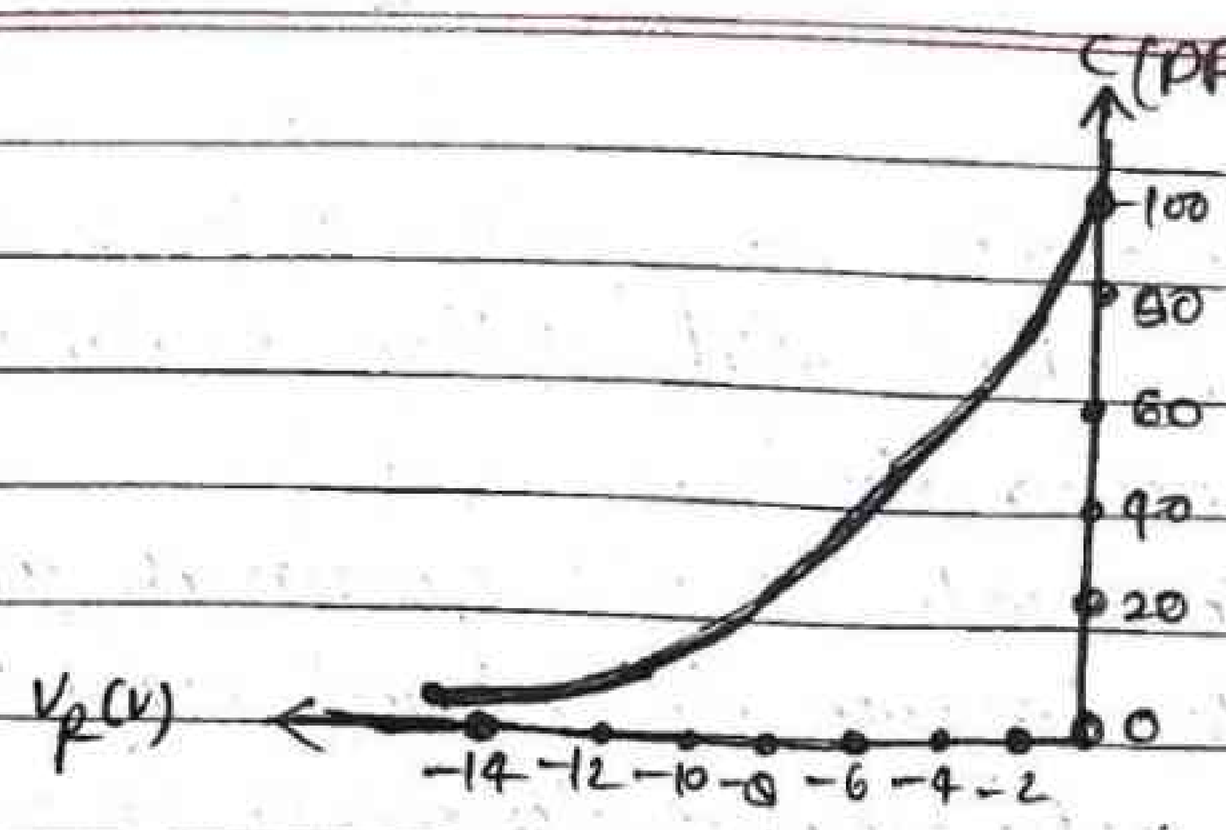


Fig :- Process of Electroluminescene in LED

Page________
Date________



As, $\left[C_T = \frac{\epsilon A}{W}\right]$

Fig :- Capacitance Vs Reverse bias voltage across a varactor diode

Advantages of Varactor diodes :- ① low cost ② Portability ③ Realiability

Disadvantage of Varactor diode :- ① Varactor diode is specialy designed to work in reverse biased mode.

Applications of Varactor Diodes :- i) In radio frequency (RF) circuit
ii) In voltage controlled oscillator (VCO)
iii) In Fm generation.

Page
Date

Advantage of photo diode:-

1) High frequency response
It can be use as variable resistance device.
It has lower noise

Disadvantages :-

(1) It has rapid increases in dark current with change in temperature.

(2) It has small active area.

Application of photo diode :-

(1) In Barcode Scanners.

(2) In optical Fiber Communication

(3) In smoke ~~door~~ ditector

(4) In Solar pannel.

Page
Date

The characteristic of the photo diodes ~~are~~ are:-

(A) Quantum Efficiency(η):- As the Quantum efficiency is:

$$\eta = \frac{I_p \cdot h\nu}{q \cdot P_{op}}$$

Where.

I_p = photo current
$h\nu$ = photo energy
q = free electronic charge
P_{op} = optical incident power.

(B) Responsivity (R):- As the property is

$$R = \frac{I_p}{P_{op}} \quad \text{--- (1)}$$

$\because$ $$\eta = \frac{I_p \cdot h\nu}{q \cdot P_{op}}$$

$\therefore$ $$\frac{I_p}{P_{op}} = \frac{\eta \cdot q}{h\nu} \quad \text{--- (2)}$$

using eqn (1) and (2)

$$R = \frac{\eta \cdot q}{h\nu}$$

photodiode can be oprerated in photo conductive mode and photo volatic mode.

Page
Date

~~Photo Did~~

Photo Diode :- Basically Photo diodes are efficient light detector's. The working function of photo diode is just opposite to the working function of LED. In the sence that photo diode converts ~~into~~ lights in ~~too~~ electrical signal.

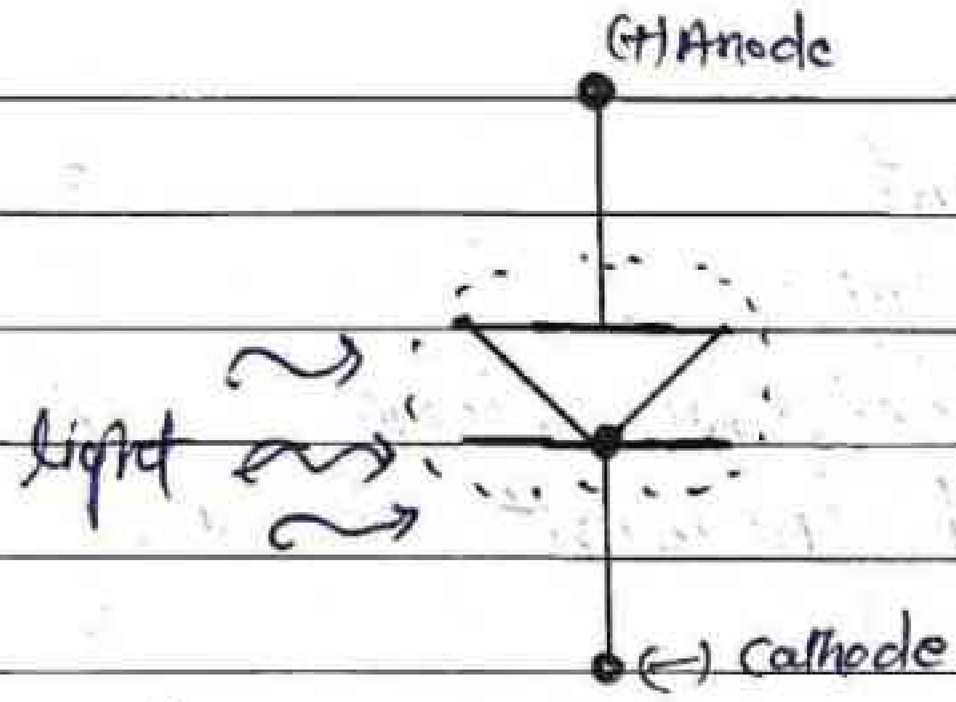


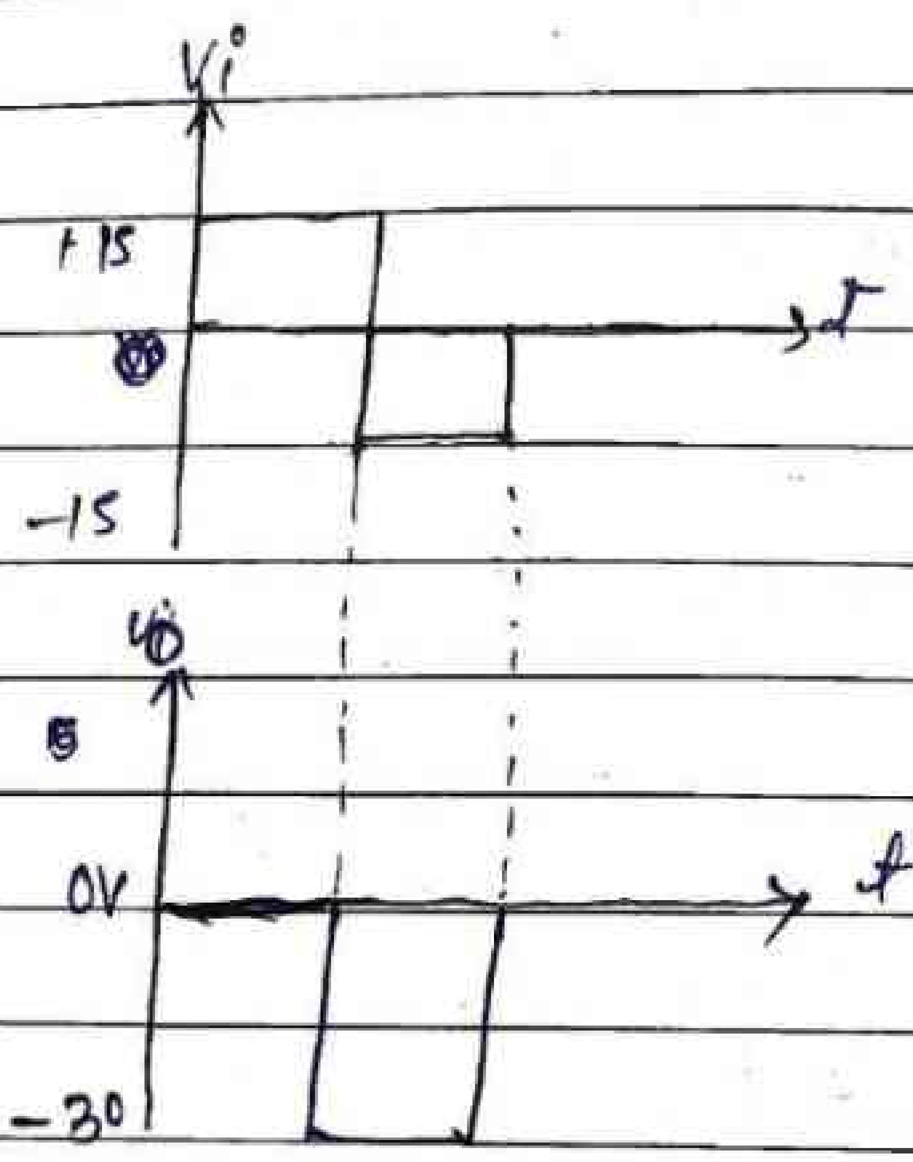
Fig:- Symbol of photo diode.

~~Pto~~ Photo diode are manufatured by using Semiconductor materials such as silicon, Germanium and Indium gallium arsenide usually. there are various types of photo diode such as.

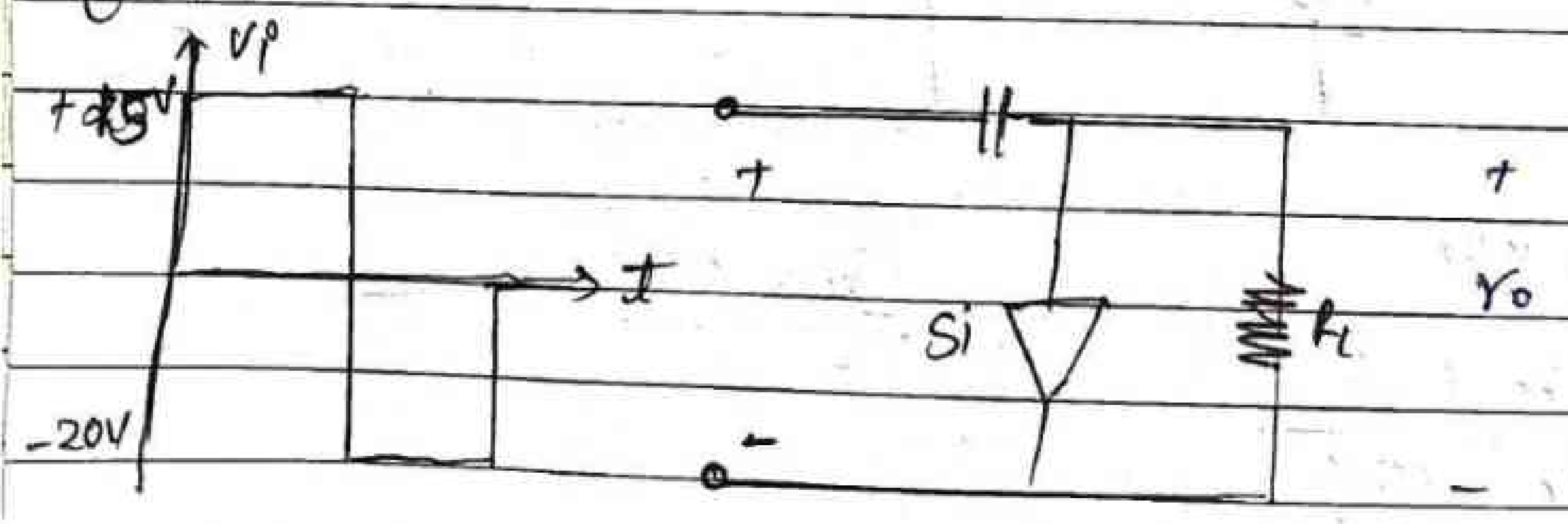
(i) p-n Photo diode
(ii) p-i-n Photo diode
(iii) schottky photo diode
(iv) Avalanche photo diode.

This types of photo diodes provides the following features and are widly used for the detection of exitance of entencity, position and colour of the light

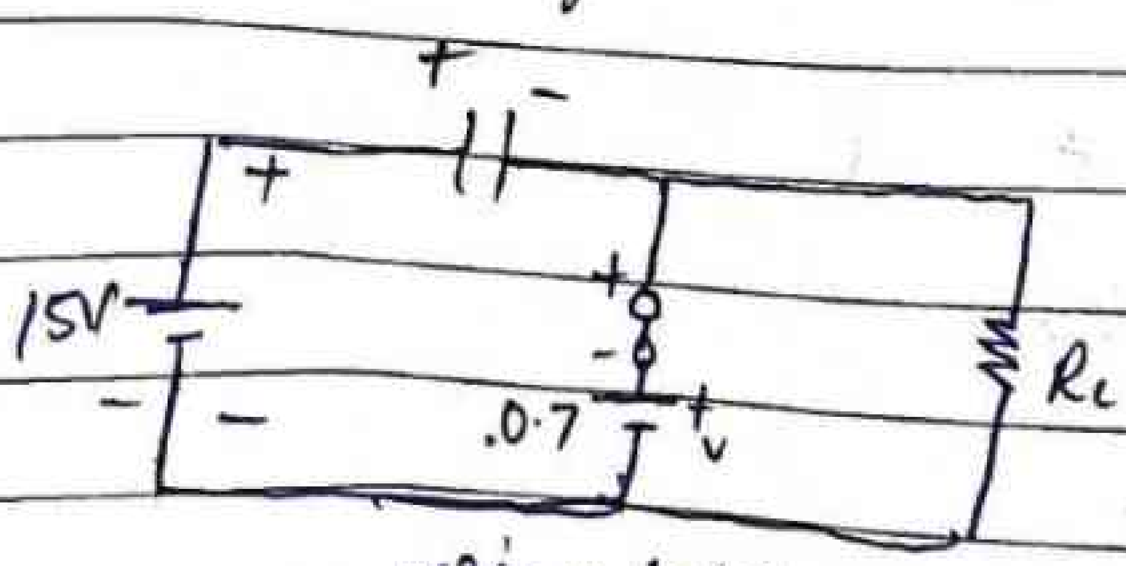
Waveform :



Ques :-



Case I → During +15V half cycle



using KVL

$15 - V_{C0} - 0.7 = 0$

$V_C = 14.3$

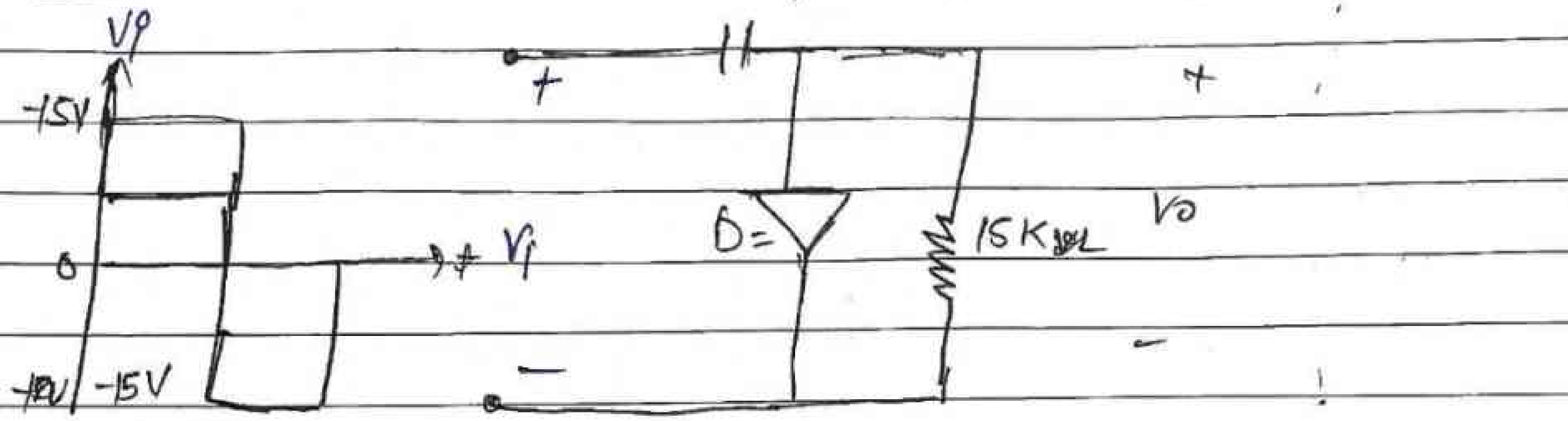
$-0.7 + V_0 = 0$

$V_0 = 0.7$

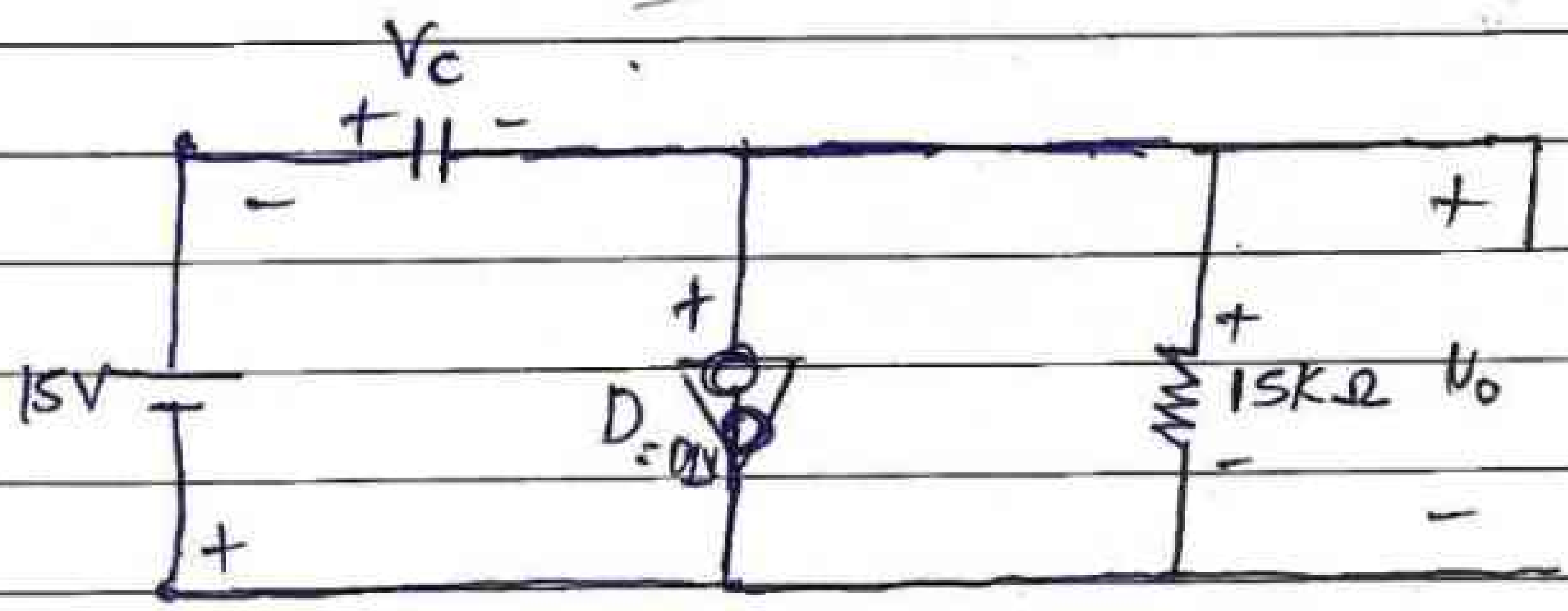
Page ________

Date ________

Que Sketch the Vo waveform for the given circuit



Soln Case - I - +ve half cycle



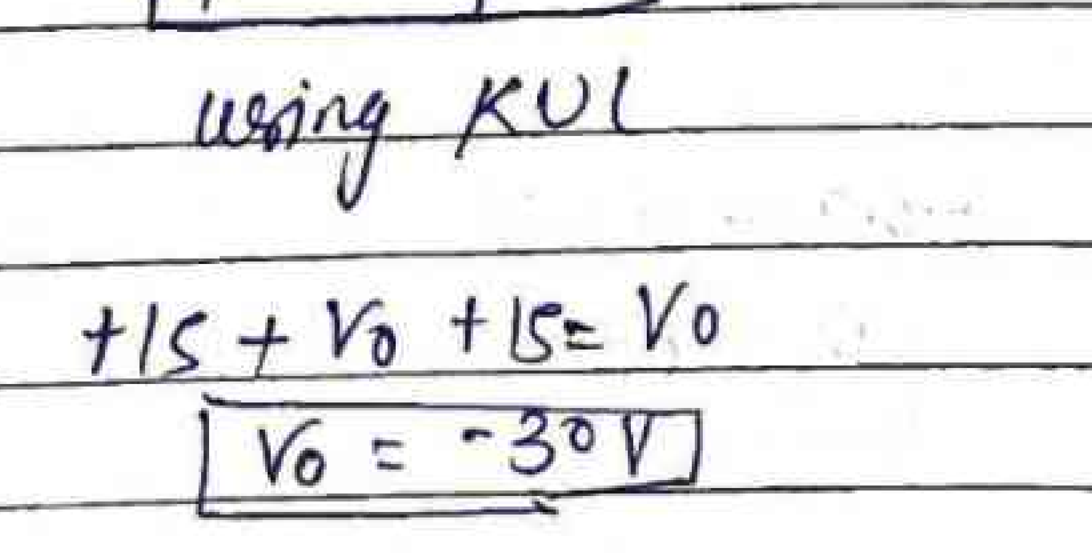
Using KVL

$15 - V_c = 0$

$V_c = 15V$

$V_o = 0V$

Case - II - -ve half cycle



using KVL

$+15 + V_o + 15 = V_o$

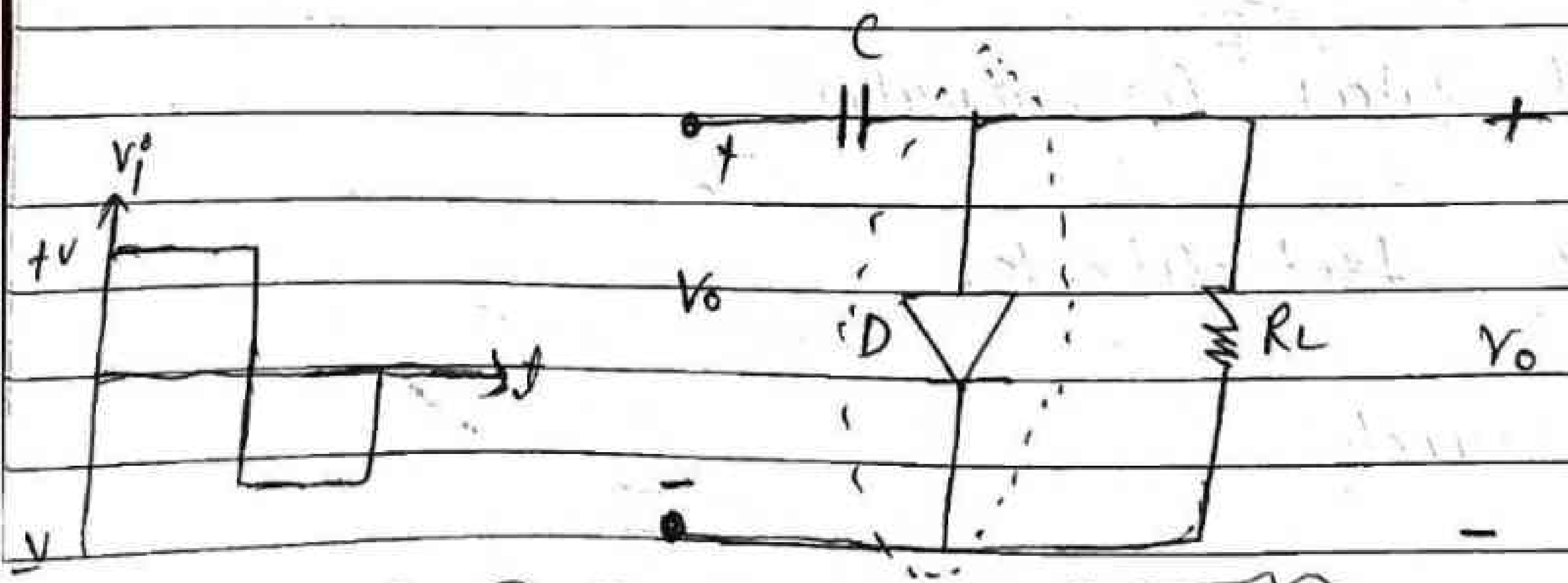
$V_o = -30V$

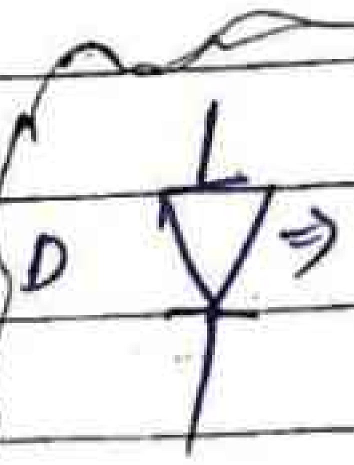
अगर diode नीचे का है तो पहला case-I +ve half cycle liya jayege

और Diode अगर ऊपर को लगा हो तो पहले निगेटिव हाल्फ साईकल पहले लगेगा।

Clamper or Level Shifter –: clamper is an electric circuit that fixes either the positive or the negative peak excursion of a signal to a new defined voltage by adding a variable positive or negative D.C. voltage to it.

Clamper



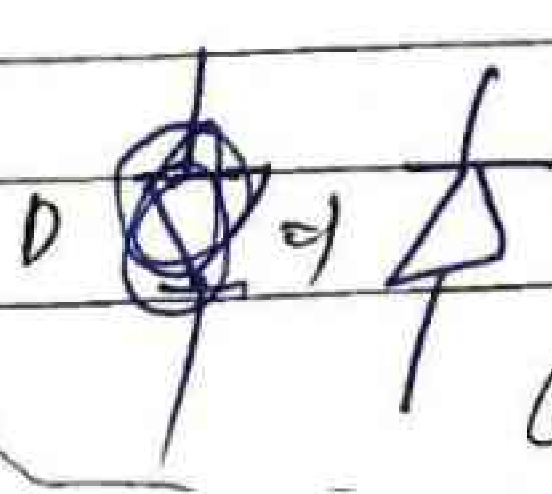


Case I = +ve half cycle : D = ON

V_C = ? : V_0 = ?

Case II = –ve half cycle : D = OFF

V_0 = ?



Case I = –ve half cycle : D = ON

V_C = ? V_0 = ?

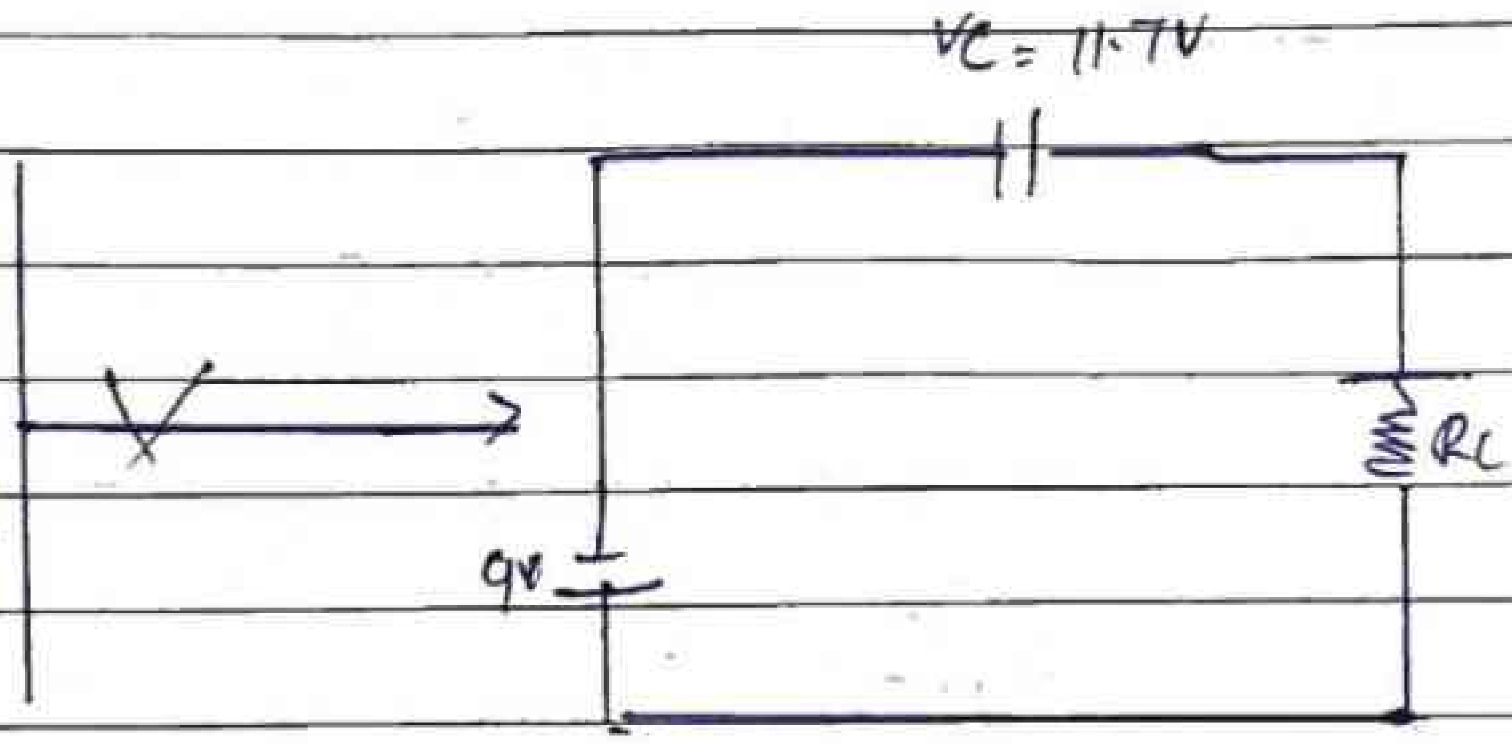
Case II = +ve half cycle : D = OFF

V_0 = ?

Page ______

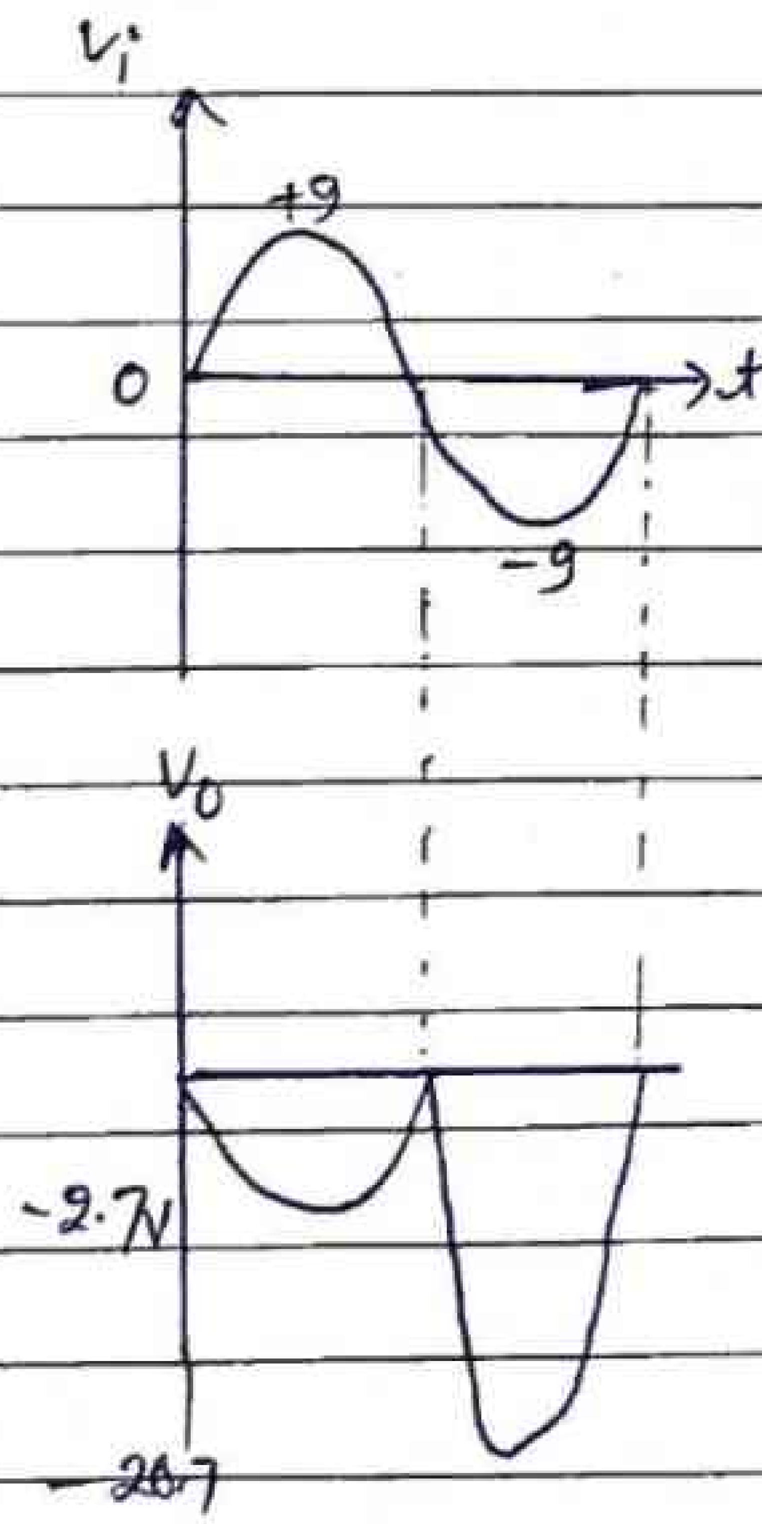
Date ______

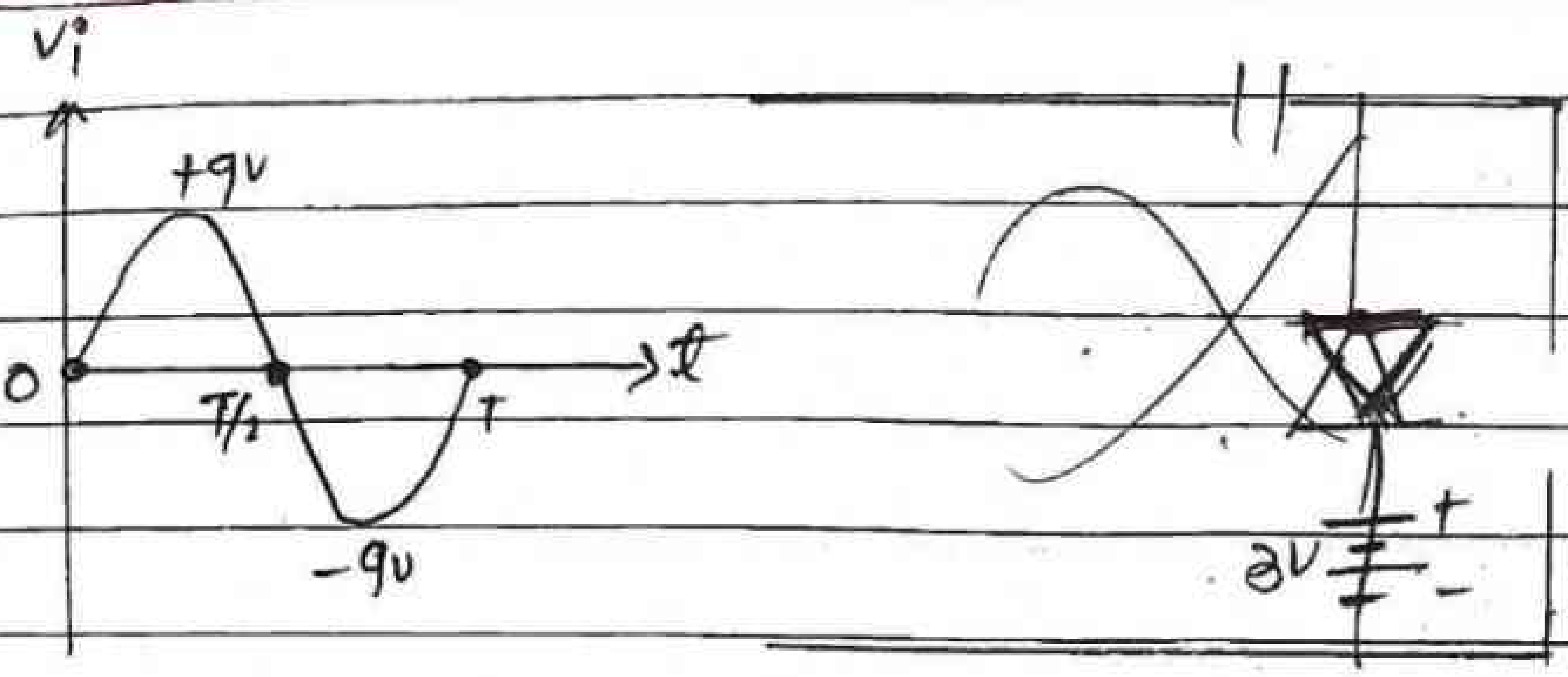
Case-II During ~~[struck out]~~ -ve half cycle

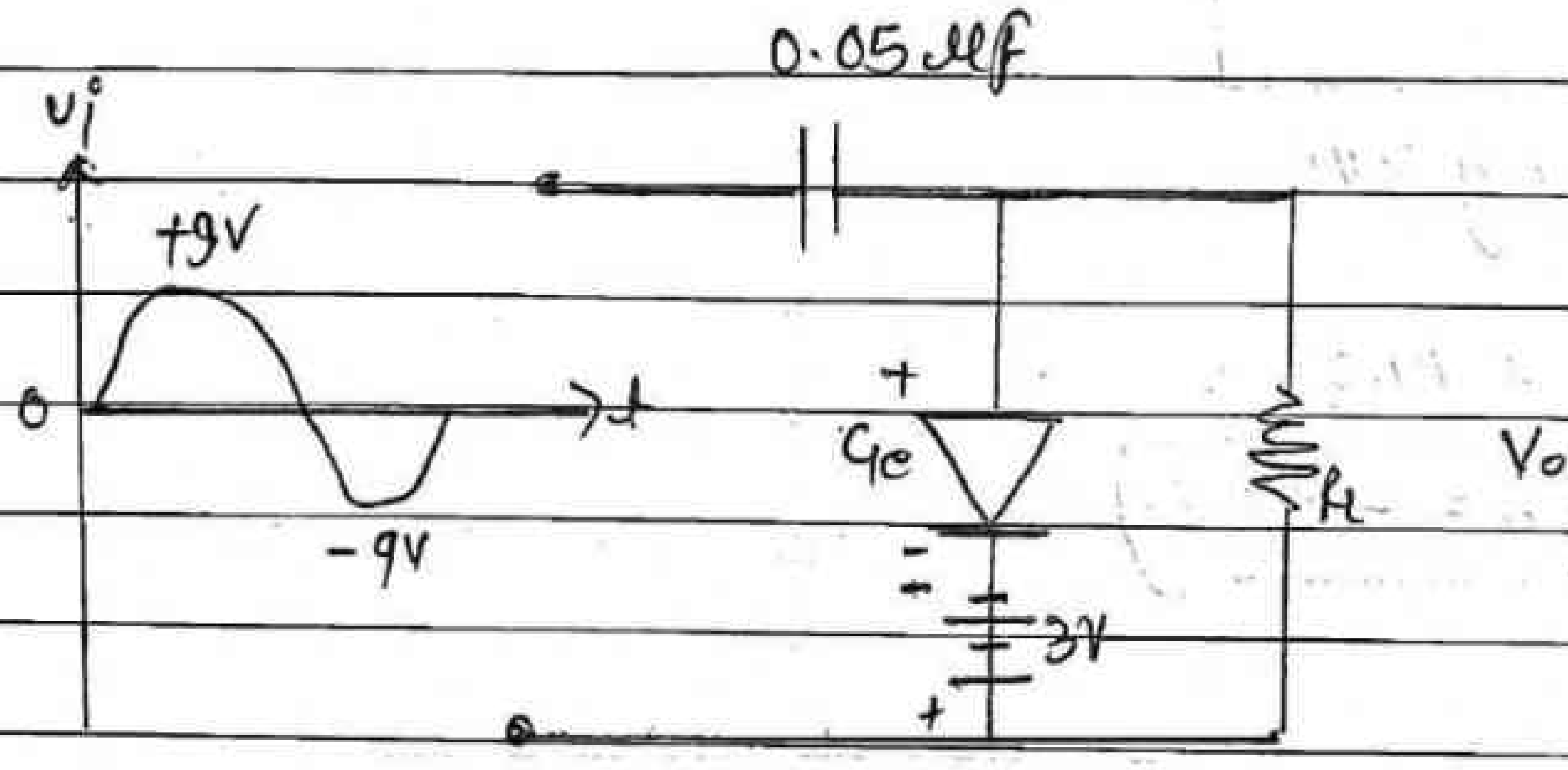


$9 + v_o + 11.7$

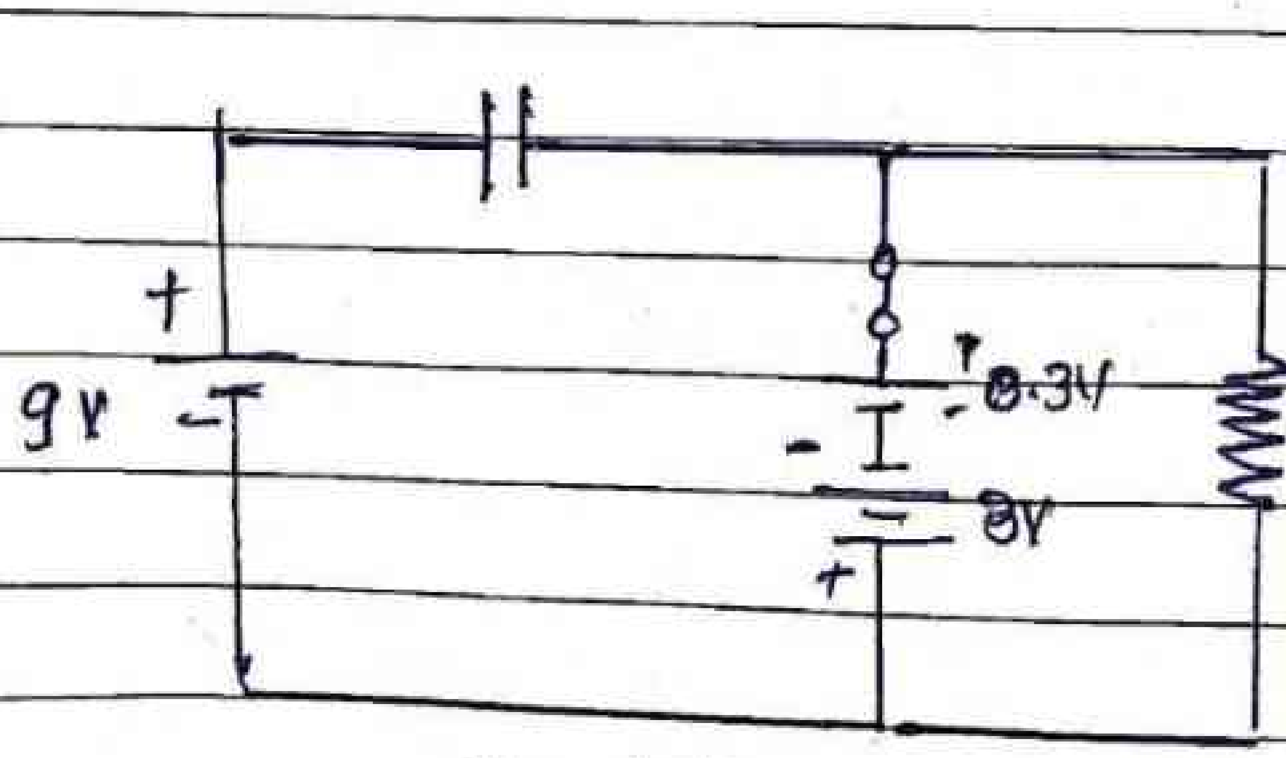
$\boxed{V_o = -20.7}$







Sol^n



using KVL

$$9 + V_c - 0.3 + 3v = 0$$

$$V_c = 11.7\ V$$

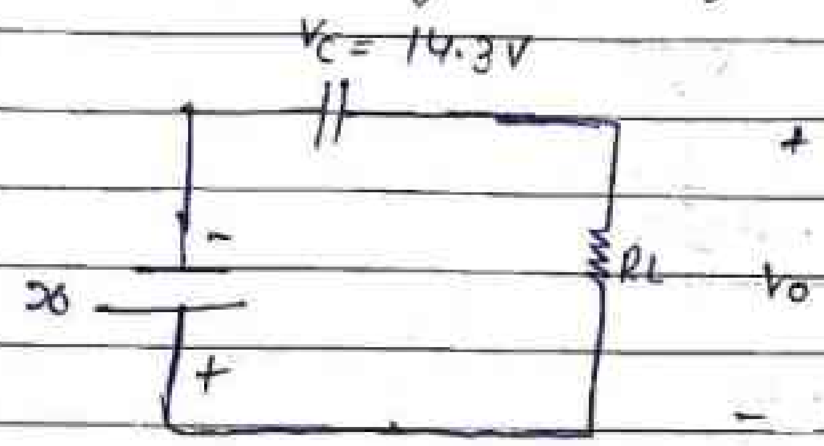
$$+3 + 0.3 = -V_o$$

$$V_o = -2.7$$

Page ____

Date ____

Case II During +20 half cycle

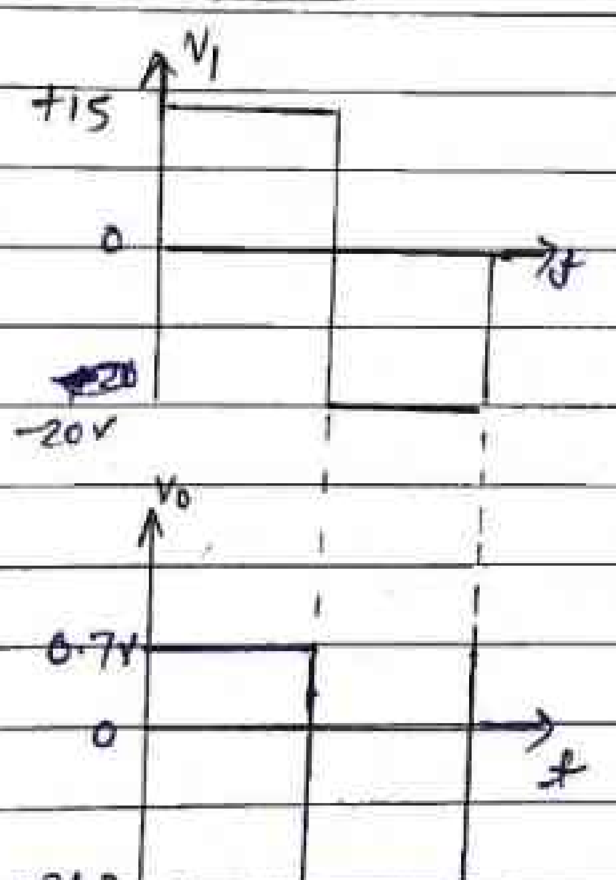


using KVL

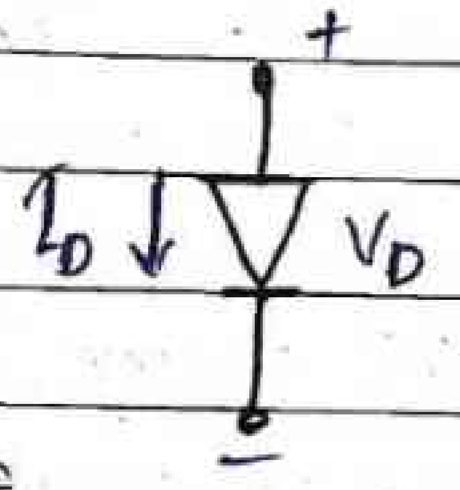
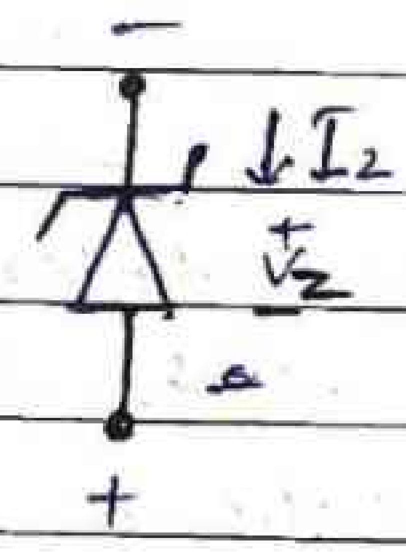
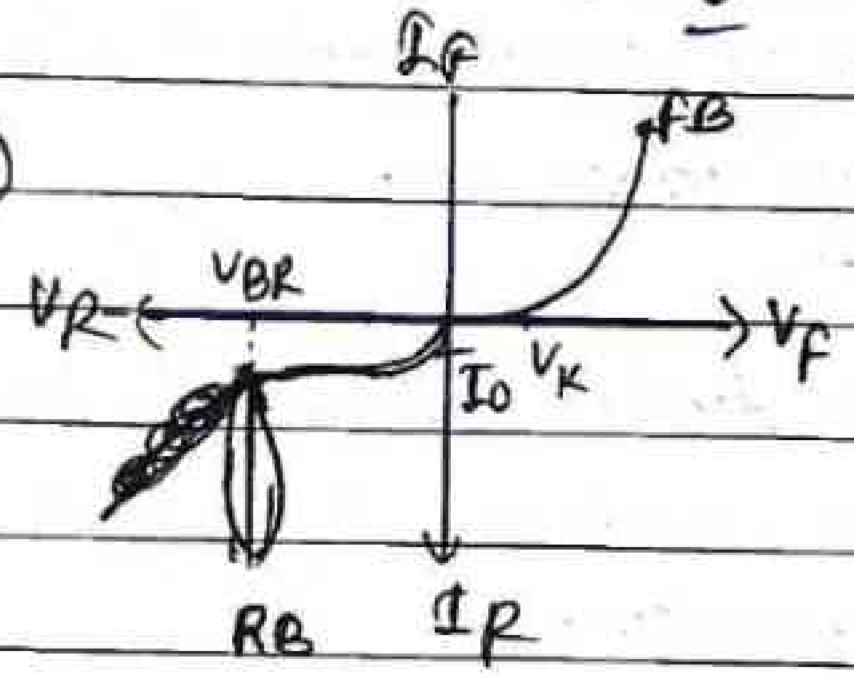
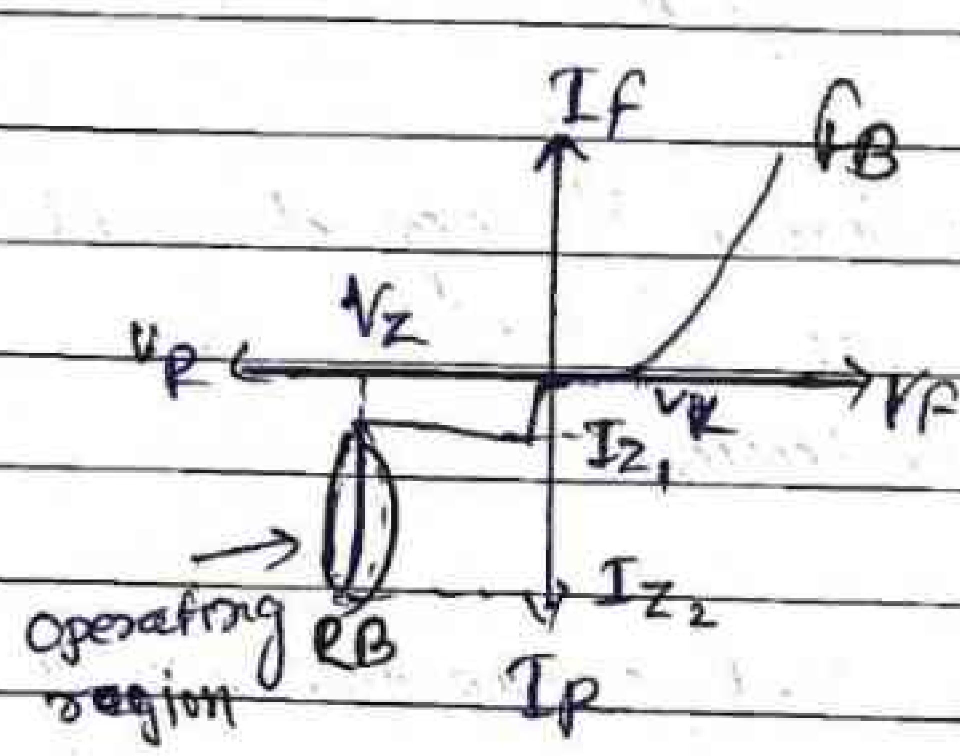
$20 + V_o + 14.3 =$

$\boxed{V_o = -34.3}$

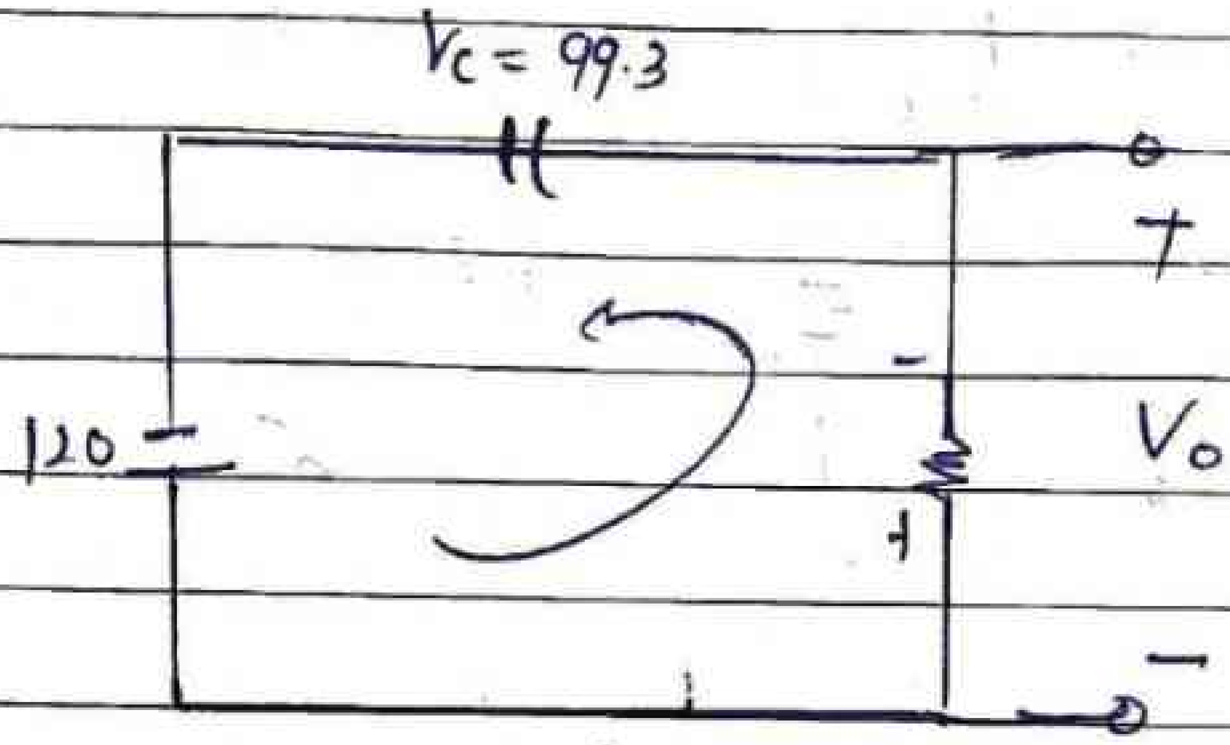
Waveform



Que :- Given Difference between p-n junction diode and zenor diode.

P-n junction diode	Zenor diode
1) it operates only in forward bias condition	1) it operates in reverse bias condition.
2) Symbol 	2) Symbol 
③ 	③ 
④ Application → Rectifiers → Voltage multipliers → clamper circuits → clipper	④ Application. → Voltage regulator (shunt regulator) → Protection circuits → Voltage limiters.

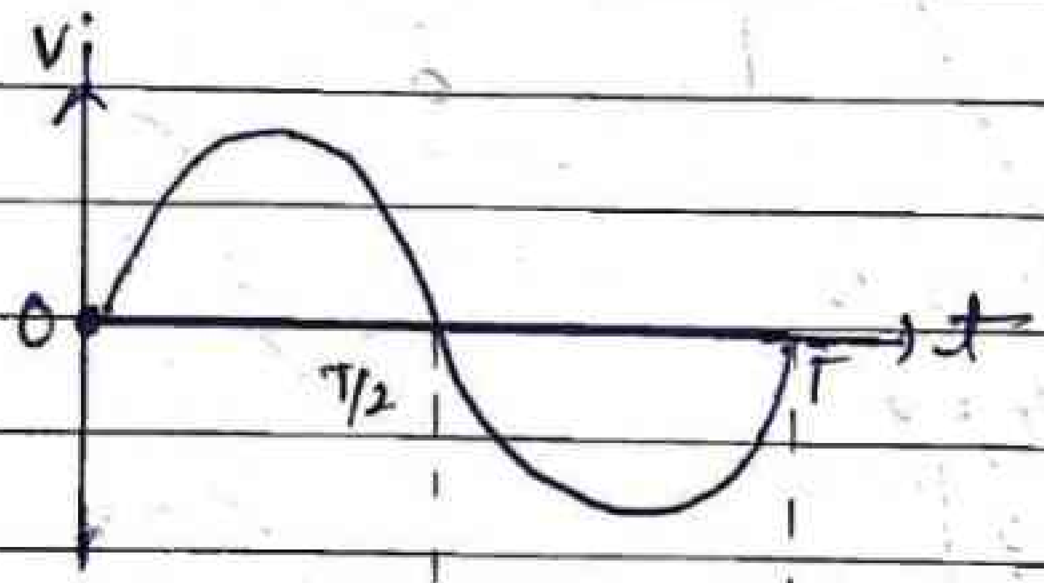
During -ve half cycle:-

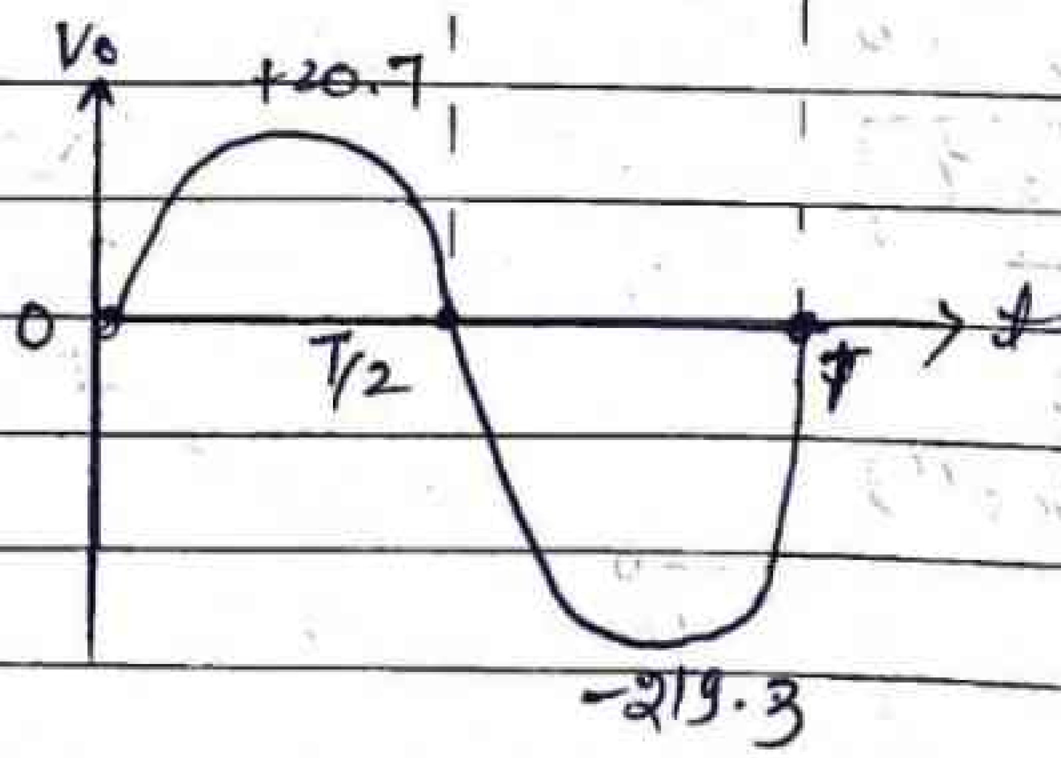


using KVL

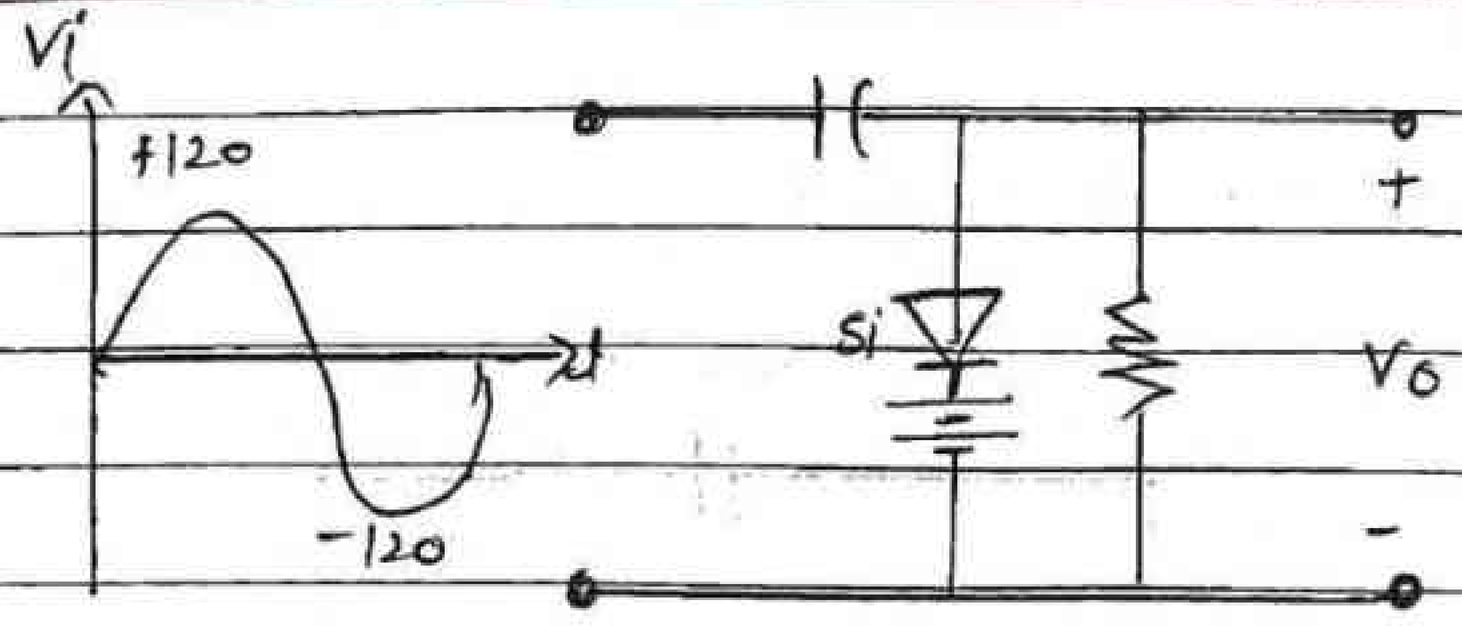
$$120 + V_0 + 99.3 = 0$$

$$\boxed{V_0 = -219.3}$$

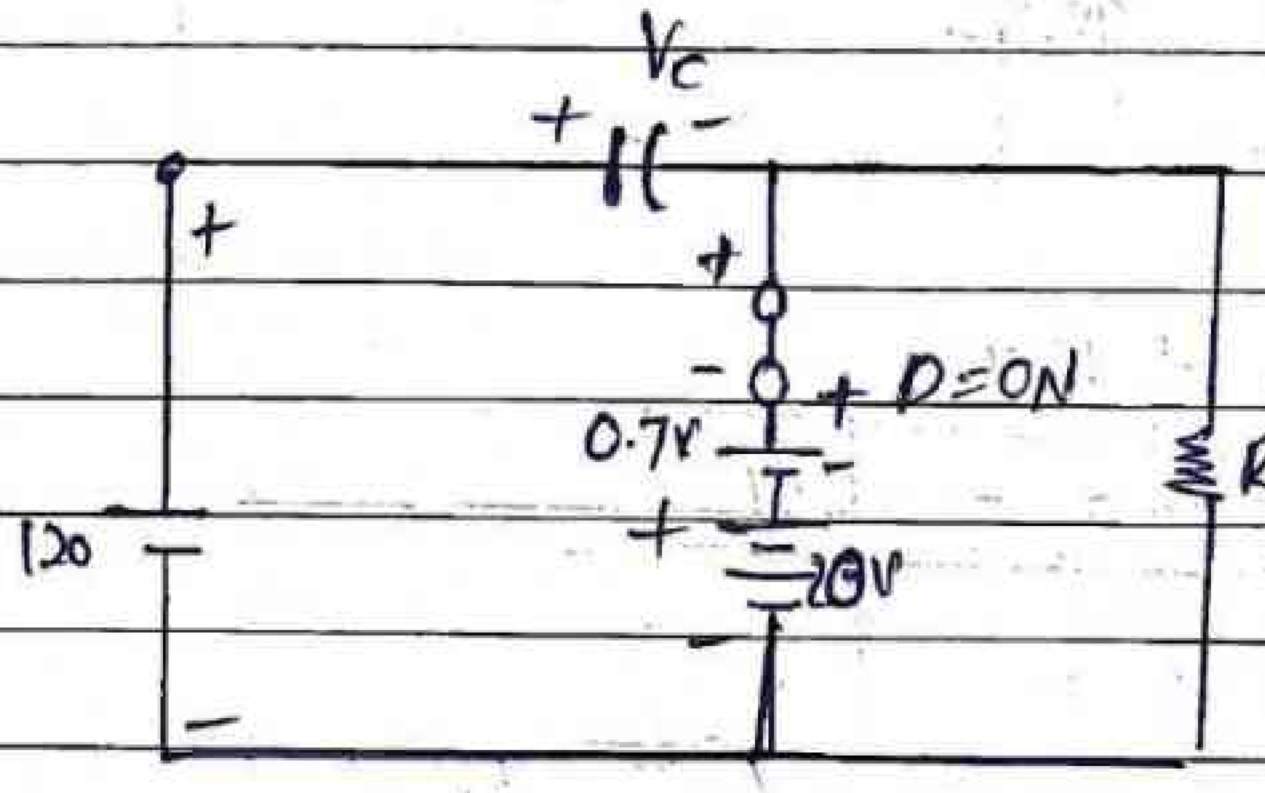




Page
Date



Sol^n During +ve half cycle.



using KVL

$120 - V_c - 0.7 - 20 = 0$

~~$+V_c = +120 + 20.7$~~

~~$V_c =$~~

$V_c = 120 - 20.7$

$V_c = 99.3$

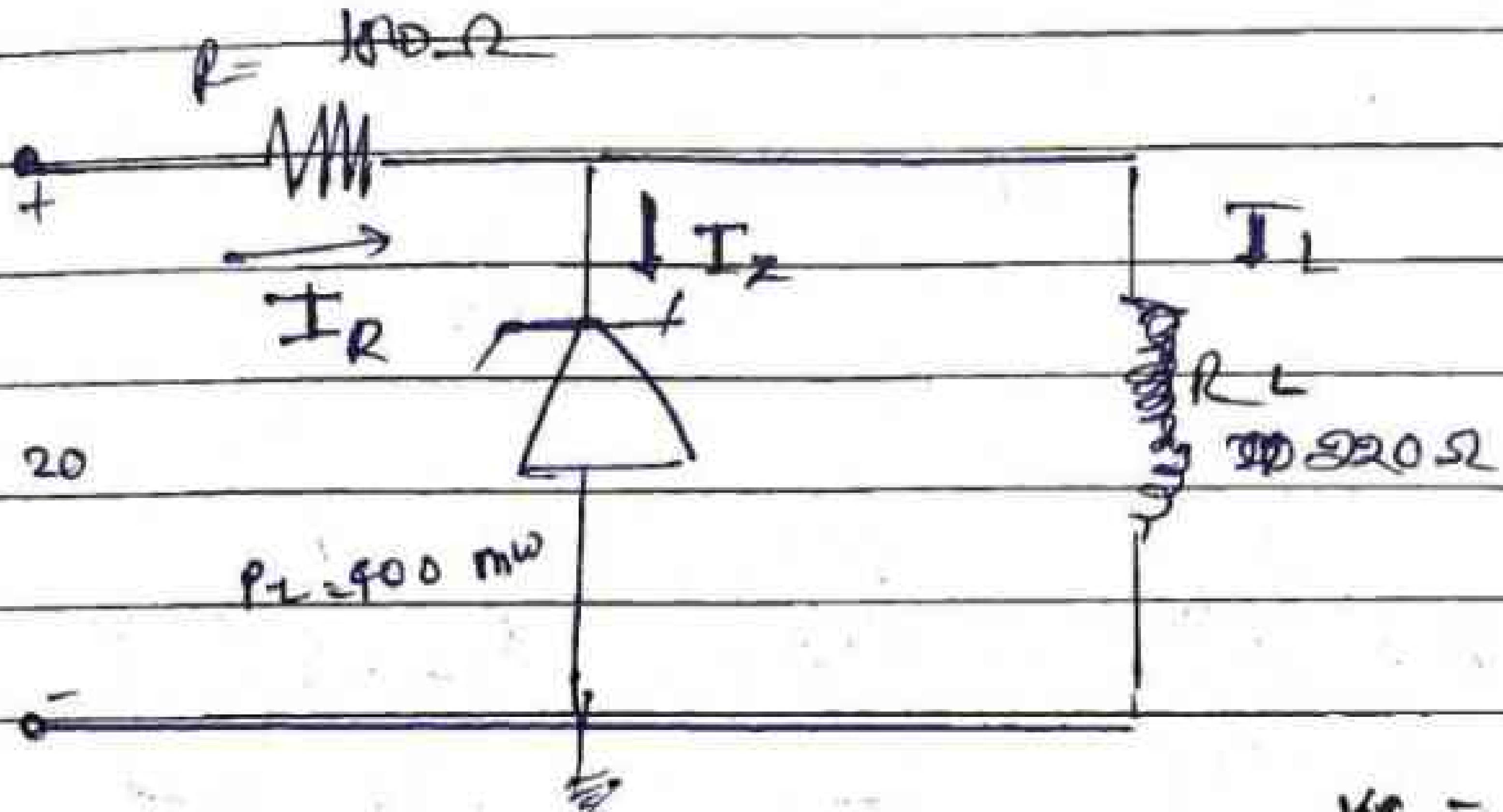
$-0.7 - 20 + V_0 = 0$

~~$V_0 = 20.7$~~

$V_0 = 20.7$

Page ________
Date ________

Determine V_L, I_R, I_Z and I_L of given network

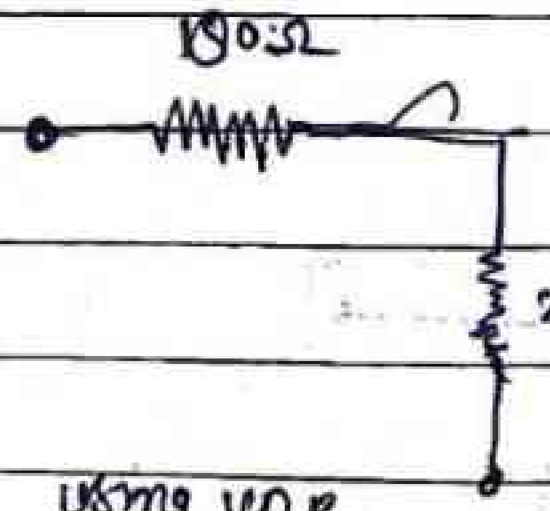


$$V_x = \frac{R_L}{R+R_L} \times V_i$$

$$V_x = \frac{R_L}{R_s+R_L} \times V_i$$

$$\frac{220}{180+220} \times 20$$

=



using VDR

$$V_x = \frac{220}{180+220} \times 20 = 11V$$

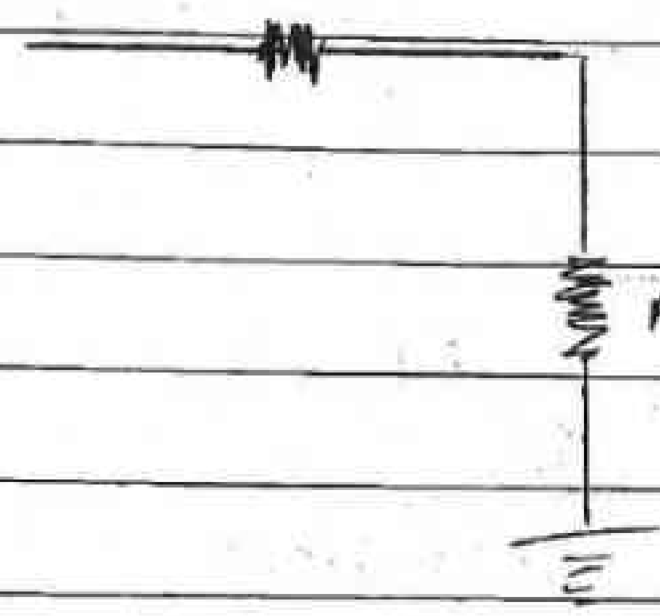
Since :- $V_x > V_Z$, therefore zener diode is on

$\because V_L = V_Z$

$V_Z = V_L$

$$I_R = \frac{V_i - V_Z}{R} = \frac{20-10}{180} = 0.055A$$

using VDR



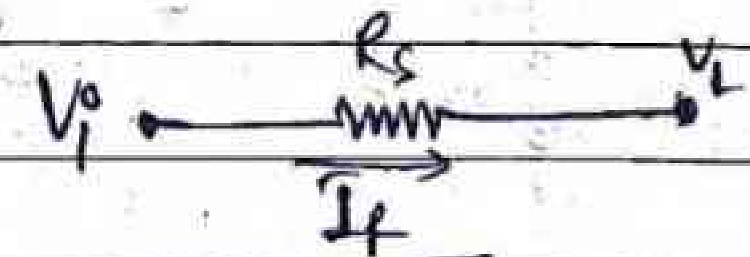
~~$V_x = \frac{R_L}{R_s + R_L}$~~

$$\boxed{V_x = \frac{R_L}{R + R_L} \times V_i}$$

* If $V_x \geq V_z$ then zener diode is ON

$\therefore V_L = V_x$

$\therefore I_L = \frac{V_L}{R_L}$



$$\boxed{I_R = \frac{V_i - V_L}{R_s}}$$

$$I_R = I_Z + I_L$$

$$\therefore \boxed{I_Z = I_R - I_L}$$

$V_{Rs} = \boxed{I_R \times R_s}$ OR $\boxed{V_{Rs} = V_i - V_L}$

$\boxed{P_Z = V_Z \cdot I_Z}$ $P_Z = V_Z \cdot I_Z$

Imp

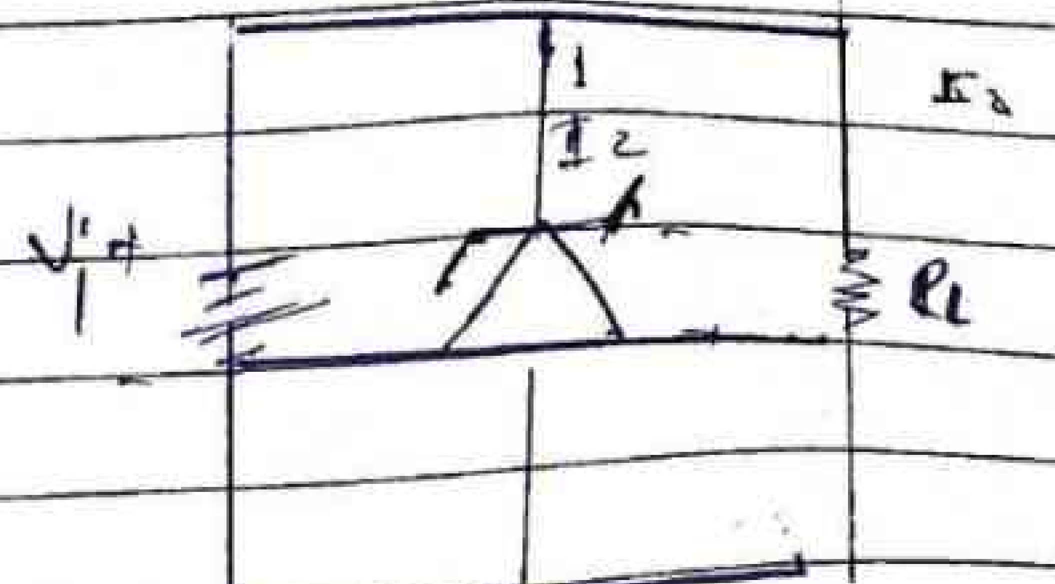
Que Given differences b/w zener breakdown mechanism and avalanche breakdown mechanism.

Ans

Zener breakdown mechanism.	Avalanche breakdown mechanism
① it occurs when V_z is b/w 5V to 8V. $[5V < V_z < 8V]$	① It occurs when V_z is greater than 8V. $[V_z > 8V]$
② The valence electrons are pulled into the conduction band due to very high electric field appearing near the narrow Depletion region.	② The valence electrons are pulled into the conduction band due to the energy imparted by collision of accelerated minority charge carriers.
③ Breakdown Voltage decreases with an increase in temperature.	③ Breakdown voltages increases with an increases in temperature.
④ it's V.I characteristic is very sharp	④ It's V.I characteristic is not so sharp.

Application of Zener diode:-

⇒ Zener Diode as voltage Regulator (Shunt regulator):-



Page ______
Date ______

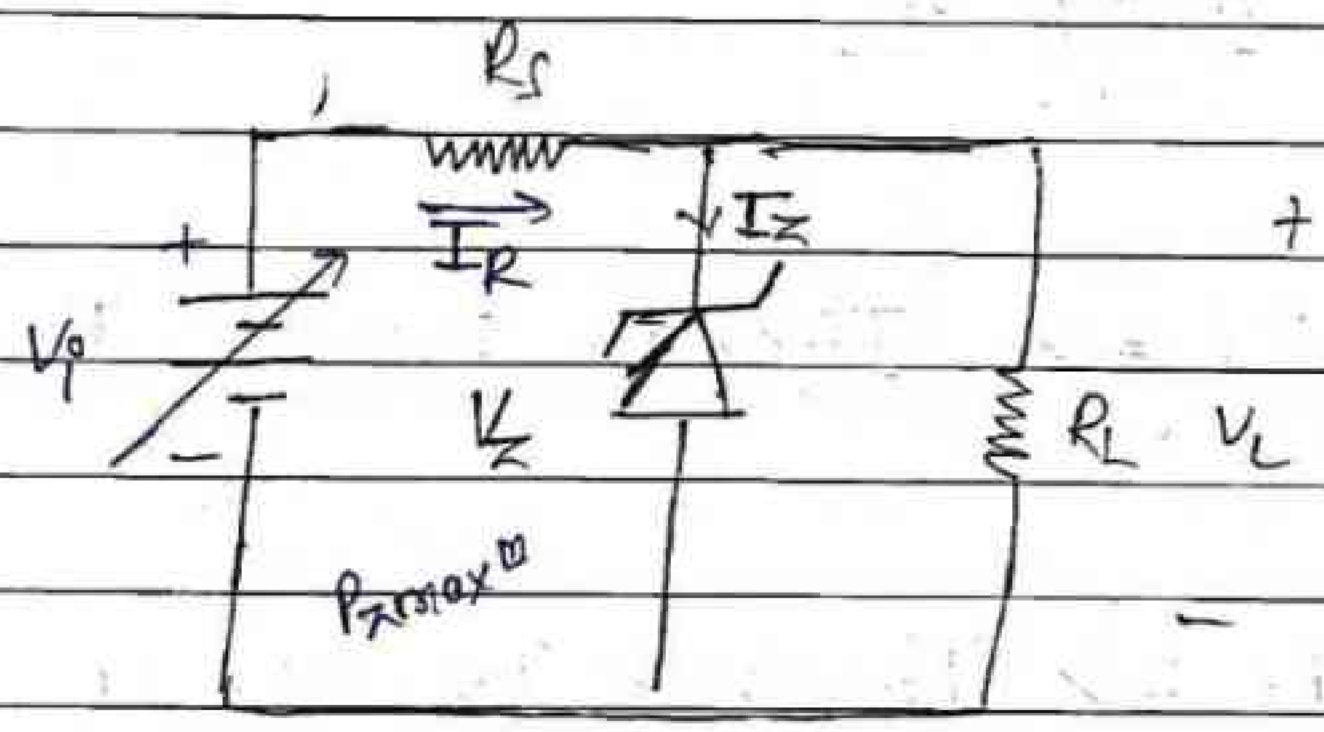
$I_R = \frac{V_i - V_L}{R_S} = \frac{15-8}{1.05} = 6.6\ mA$

$I_L = \frac{V_L}{R_L} = \frac{8}{1.2} = 6.6 mA$

$\therefore I_R = I_Z + I_L$

$\therefore I_Z = I_L - I_R \Rightarrow 6.66 - 6.66 = 0 mA$

Case - II When V_i - ↗ (variable) & $R_L = K$ (constant)



* V_L = Given
$V_L = I_L \cdot R_L$
$K = K \cdot K$

* $V_i = \uparrow (max^m)$
$I_R = I_Z + I_L$
$\uparrow = \uparrow + K$

→ I_Z^{max}

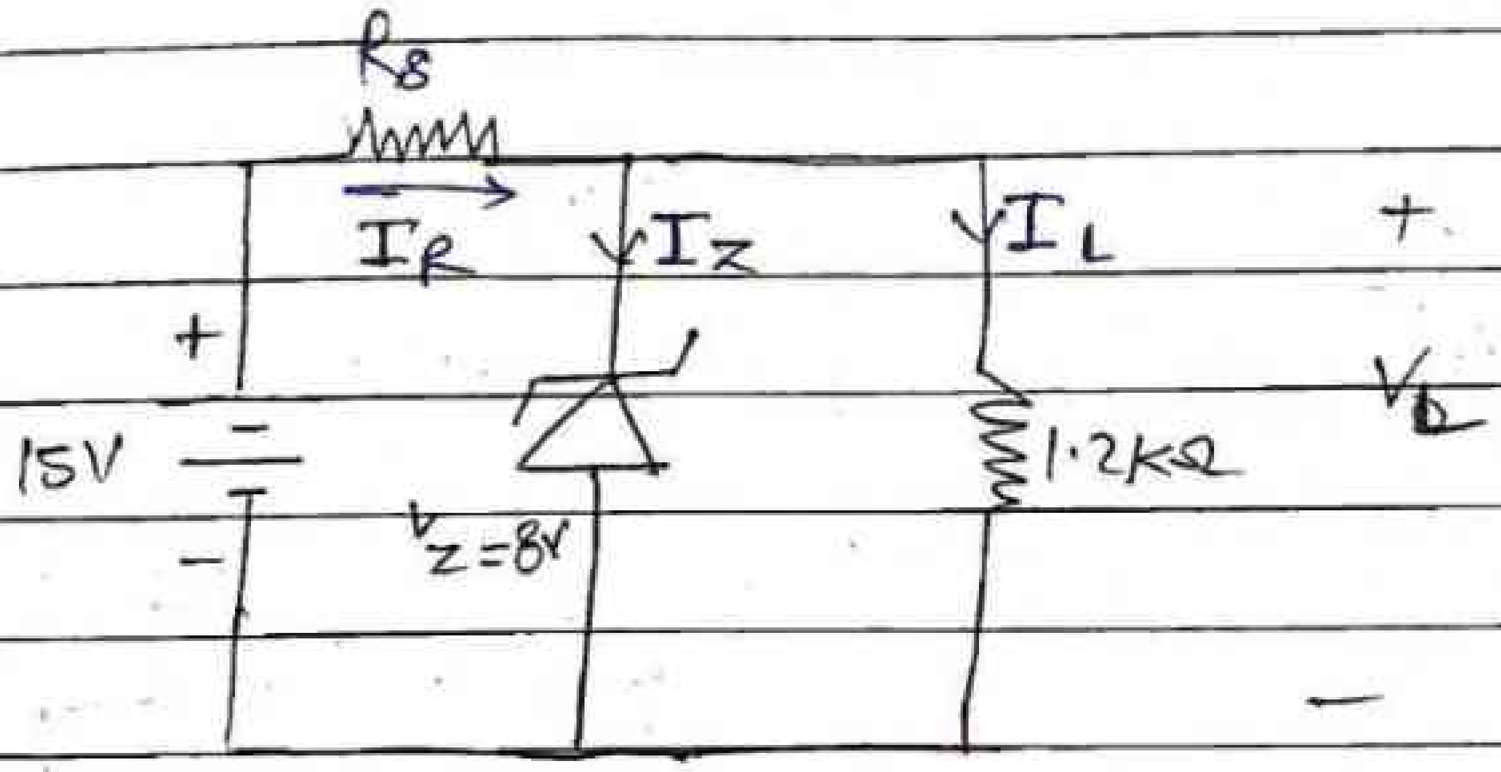
$V_{i\,max^m}$ → $I_{R\,max}$ → $I_{Z\,max}$ → $I_L K$

* $V_i = \downarrow$
$I_R = I_Z + I_L$
$\downarrow = \downarrow + K$

→ I_Z^{min}

$V_{i\,min^m}$ → $I_{R\,min^m}$ → $I_{Z\,min}$ → $I_L K$

Que :- Calculate the value of R_s And I_z for the given network to maintain zener diode in on condition or on escape.



$V_1 = V_z$

$\therefore V_z = 8V$

$\therefore V_L = 8V$

Now by using VDR

$V_L = \frac{R_L}{R_s+R_L} \times V_i$

$8 = \frac{1.2}{R_s+1.2} \times 15$

$(R_s+1.2) V_L = 1.2 \times 15$

$8R_s + 1.2 \times 8 = 1.2 \times 15$

$8R_s + 9.6 = 18$

$8R_s = 18 - 9.6$

$R_s = \frac{8.4}{8}$

$R_s = 1.0125$

$V_L = \frac{R_L}{R_s+R_L} \times V_i$

$V_L(R_s+R_L) = R_L V_i$

$V_L R_s + V_L R_L = R_L V_i$

$V_L R_s = R_L V_i - V_L R_L$

$V_L R_s = R_L (V_i - V_L)$

$V_L R_s = (15-8) 1.2$

$R_s = \frac{1.2(15-8)}{8}$

$= 1.05 K\Omega$

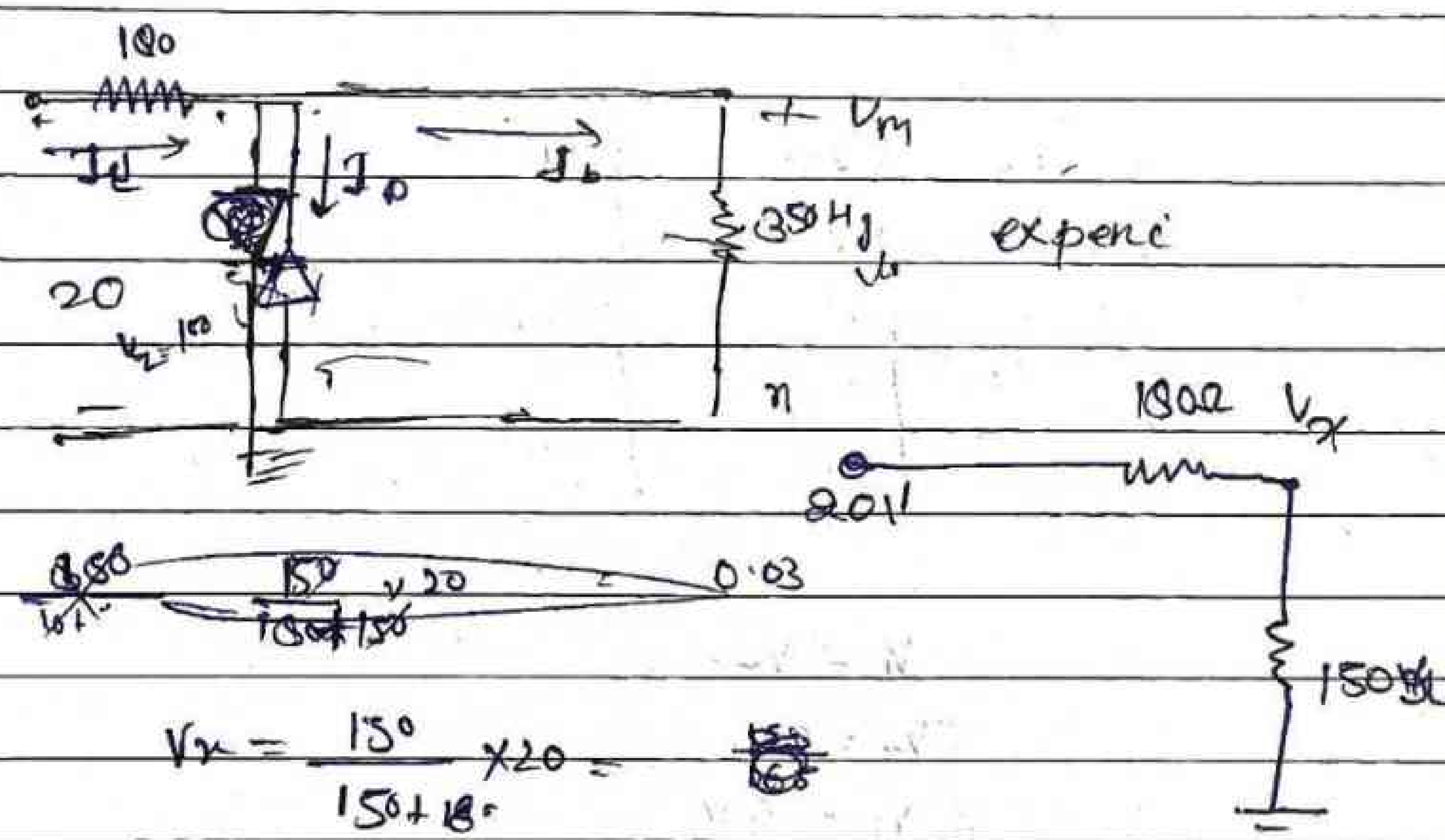
$I_R = I_Z + I_L$

$I_Z = I_R - I_L$

$I_R = I_Z + I_L$ $0.055 - 0.045 = 0.010$

$\therefore I_Z = I_R - I_L = 0.~~05~~ ~~0.045~~ ~~0.0~~10 A$

Que - 02



$V_x = \frac{150}{150+180} \times 20$

$V_x = \frac{150}{330} \times 20$

$V_x = 9.09$

Since $V_0 < V_z$ therefore Zener diode is OFF

$V_L = V_x$

$V_L = 9.09$

$I_R = \frac{V_i - V_L}{R_S} = \frac{20 - 9.09}{180}$

$0.060 A$

$I_L = \frac{9.09}{150} = 0.060 A$

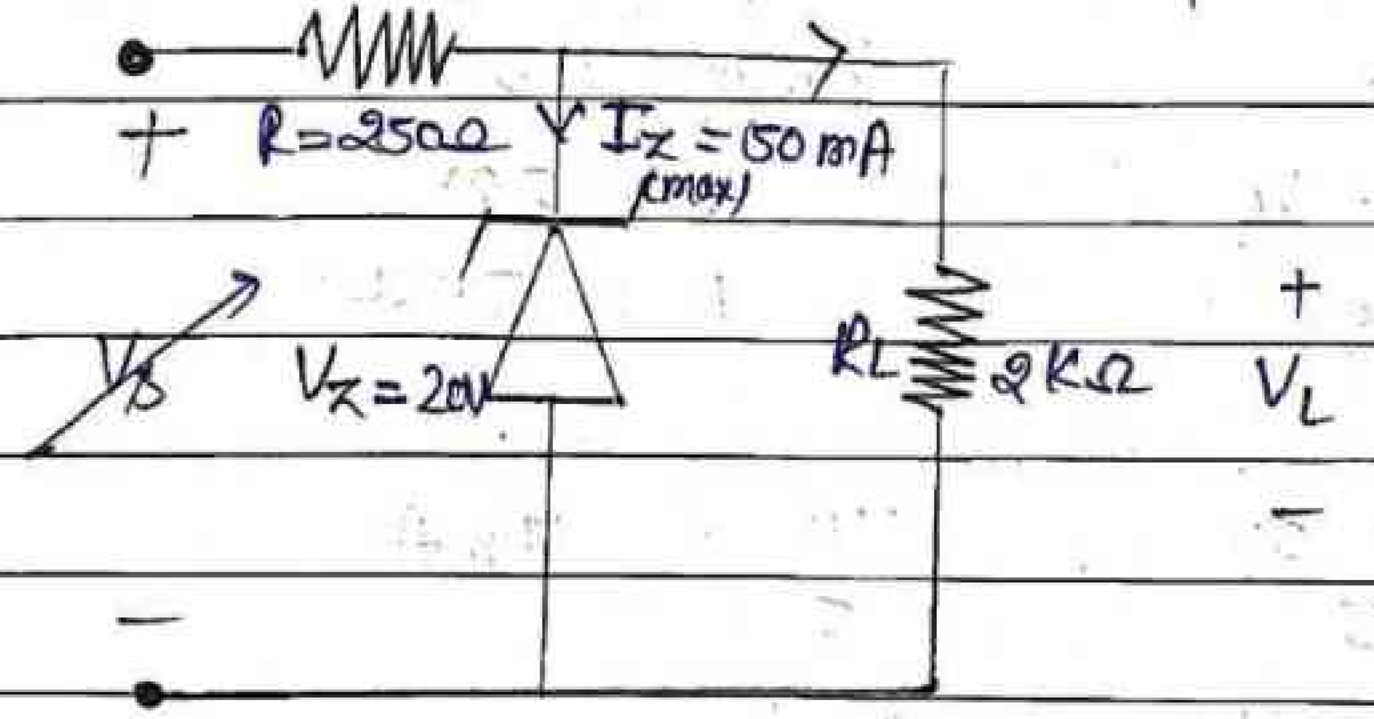
$I_R = I_Z + I_L$

$= 0.060 - 0.060$

$= 0$

Page
Date

Que ⇒ Determine the Range of input Voltage (V_S) for the zener diode to remain on or stay given that $V_Z = 20V$, $I_{Z(max)} = 50mA$, $R_Z = 0\Omega$



Soln ⇒ Since $V_L = V_Z = 20V$
using VDR

$$V_L = \frac{R_L}{R+R_L} \times V_{S_{min}}$$

$$V_{S_{min}} = \frac{V_L(R+R_L)}{R_L}$$

$$= \frac{20(0.25+2)}{2} \Rightarrow 22.5V$$

$$I_{max} = \frac{V_{i\,max} - V_L}{R}$$

$$I_{max} = \frac{V_{S_{max}} - V_L}{R}$$

$$V_{S_{max}} = I_{max} \cdot R + V_L$$

$$V_{S\,max} = (I_{Z\,max} + I_L)R + V_L$$

$$= \left(I_{Z(max)} + \frac{V_L}{R_L}\right)R + V_L$$

Page ______

Date ______

Sol^n → let us assume that zener diode is ON

$\therefore V_L = V_z = 50V$

$I_{max} = ?$

$V_{imax} = 120$

$V_L = 50V$

$R = 5k\Omega$

$I_{(max)} = \frac{V_{i(max)} - V_L}{R}$

$I_{(max)} = \frac{120 - 50}{5} = \frac{70}{5} = 14mA$

$\boxed{I_{(max)} = 14 mA}$

$I_{(min)} = \frac{80 - 50}{5} = \frac{30}{5} = 6mA$

$\boxed{I_{(min)} = 6mA}$

$I_L = \frac{V_L}{R_L} = \frac{50}{10} = 5$

$\boxed{I_L = 5}$

$I_{(max)} = I_{z(max)} + I_L$

$I_{z(max)} = 14 - 5$

$\boxed{I_{z(max)} = 9 mA}$

$I_{z(min)} = I_{min} - I_L$

$6 - 5$

$\boxed{I_{z(min)} = 1 mA}$

$P_{z(max)} = 50 \times 1$

$\boxed{P_{z(max)} = 50V}$

Page
Date

$*$ V_L = Given

$$I_L = \frac{V_L}{R_L}$$

$$I_{R(max)} = \frac{V_{i(max)} - V_L}{R_S}$$

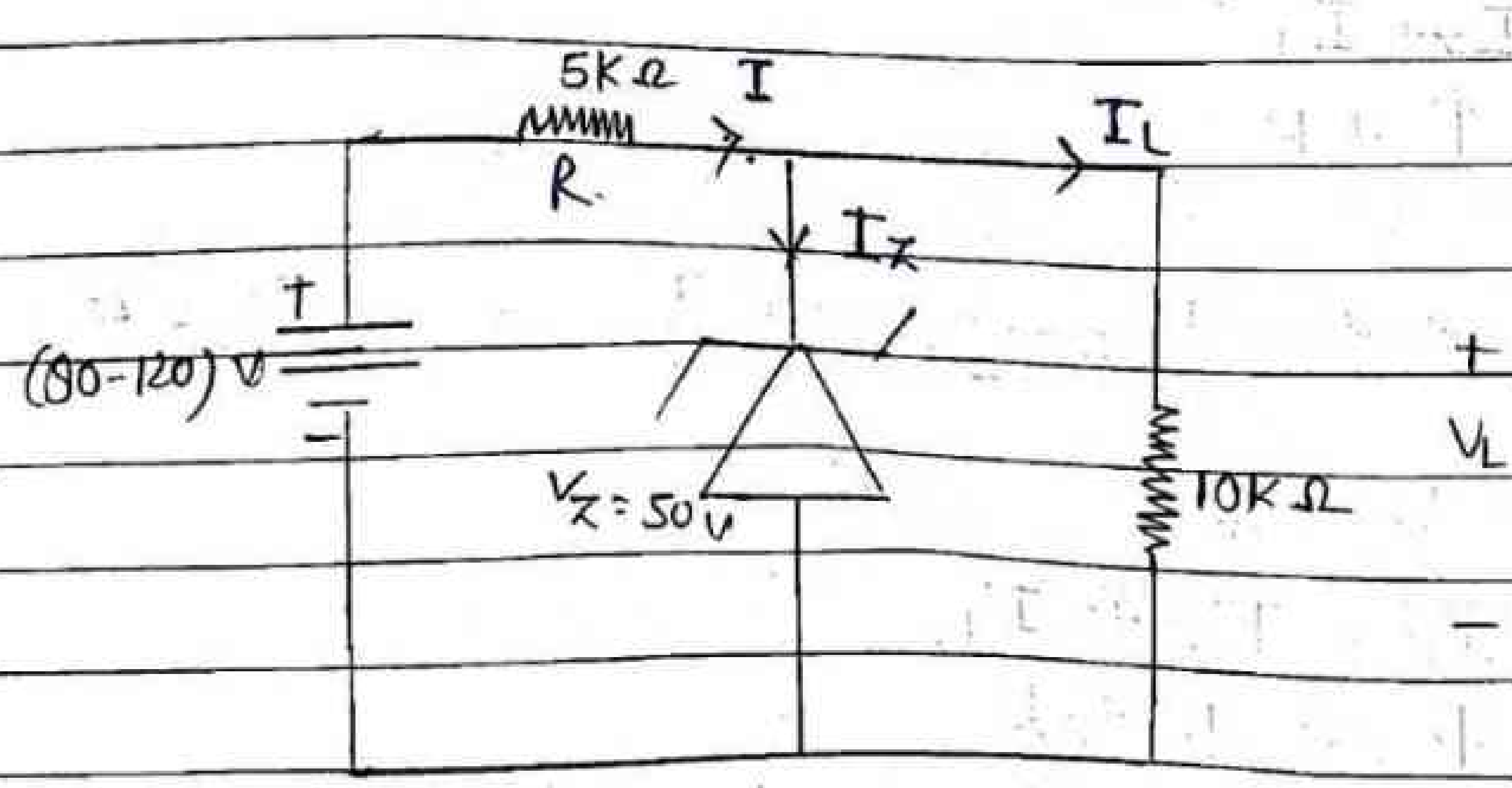
$$I_{R(min)} = \frac{V_{i(min)} - V_L}{R_S}$$

$*$ $I_{R(max)} = I_{Z(max)} + I_L \Rightarrow$ $I_{Z(max)} = I_{R(max)} - I_L$

$*$ $I_{R(min)} = I_{Z(min)} + I_L \Rightarrow$ $I_{Z(min)} = I_{R(min)} - I_L$

$$P_{Z(max)} = V_Z \cdot I_{Z(max)}$$

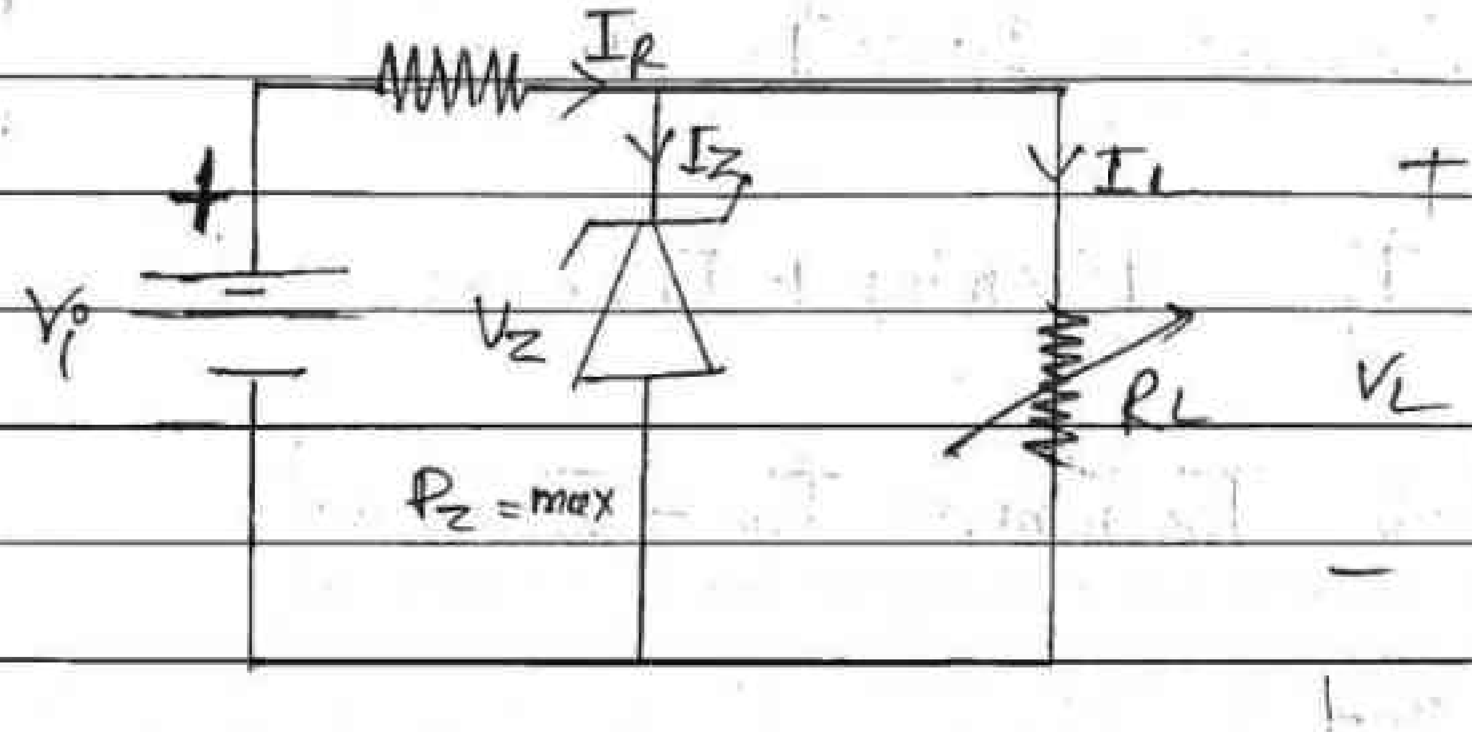
Que :- Detemine the value of maximum and minimum zener diode current for the circuit shown below. ~~current~~.



Page ______

Date ______

Case – III → When V_i = K + R_L = ↑ (x)



* R_L = ↑

$I_R = I_Z + I_L$

K = ↑ + ↓

$R_{L(max)} \longrightarrow I_{Z(max)} \longrightarrow I_{L(min)} \longrightarrow I_{R(K)}$

* R_L = ↓

$I_R = I_Z + I_L$

K = ↓ + ↑

$R_{L(min)} \longrightarrow I_{Z(min)} \longrightarrow I_{L(max)} \longrightarrow I_{R(K)}$

$$I_{L(min)} = \frac{V_L}{R_{L(max)}}$$

$$I_{L(max)} = \frac{V_L}{R_{L(min)}}$$

$$I_R = \frac{V_i - V_L}{R_S}$$

Page ____
Date ____

Since Zener diode is ON, therefore $V_L = V_Z$

$\therefore V_L = 8V$

using VDR

$$V_L = \frac{R_L}{R_S + R_1} V_{in(min)}$$

$$V_{IN(min)} = \frac{V_L(R_S + R_L)}{R_L}$$

$$= \frac{8(0.82 + 0.22)}{0.22} = 10.98V$$

$V_{imax} =$ ~~$V_L(R_S + R_L$~~

$I_{Zmax} \cdot R_S + V_L$

$$= (I_{Zmax} + I_L) R_S + V_L$$

$$= \left(\frac{P_{Zmax}}{V_Z} + \frac{V_L}{R_L}\right) R_S + V_L$$

$$= \left(\frac{400}{8} + \frac{8}{0.22}\right) 0.082 + 8$$

~~(50 + 36.36) .82 + 8~~

$$= (86.36)\,.082 + 8$$

$7.08 + 8$

$V_{in(max)}$ ~~15.08 V~~ $= 15.08V$

Page ______

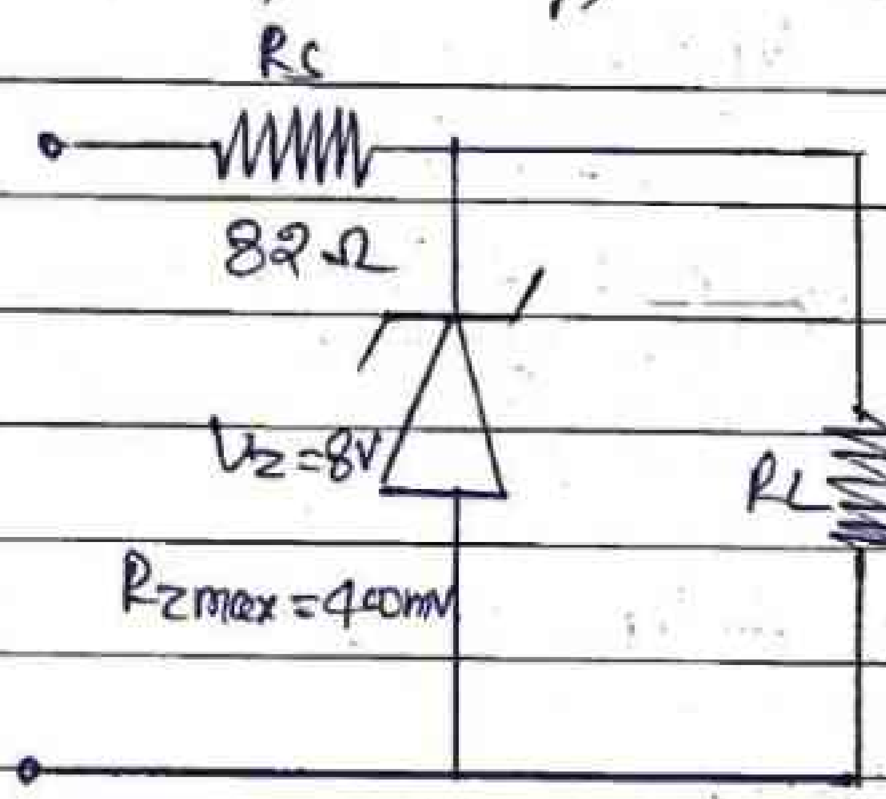
Date ______

$$\left(50 + \frac{20}{2}\right) 0.25 + 20$$

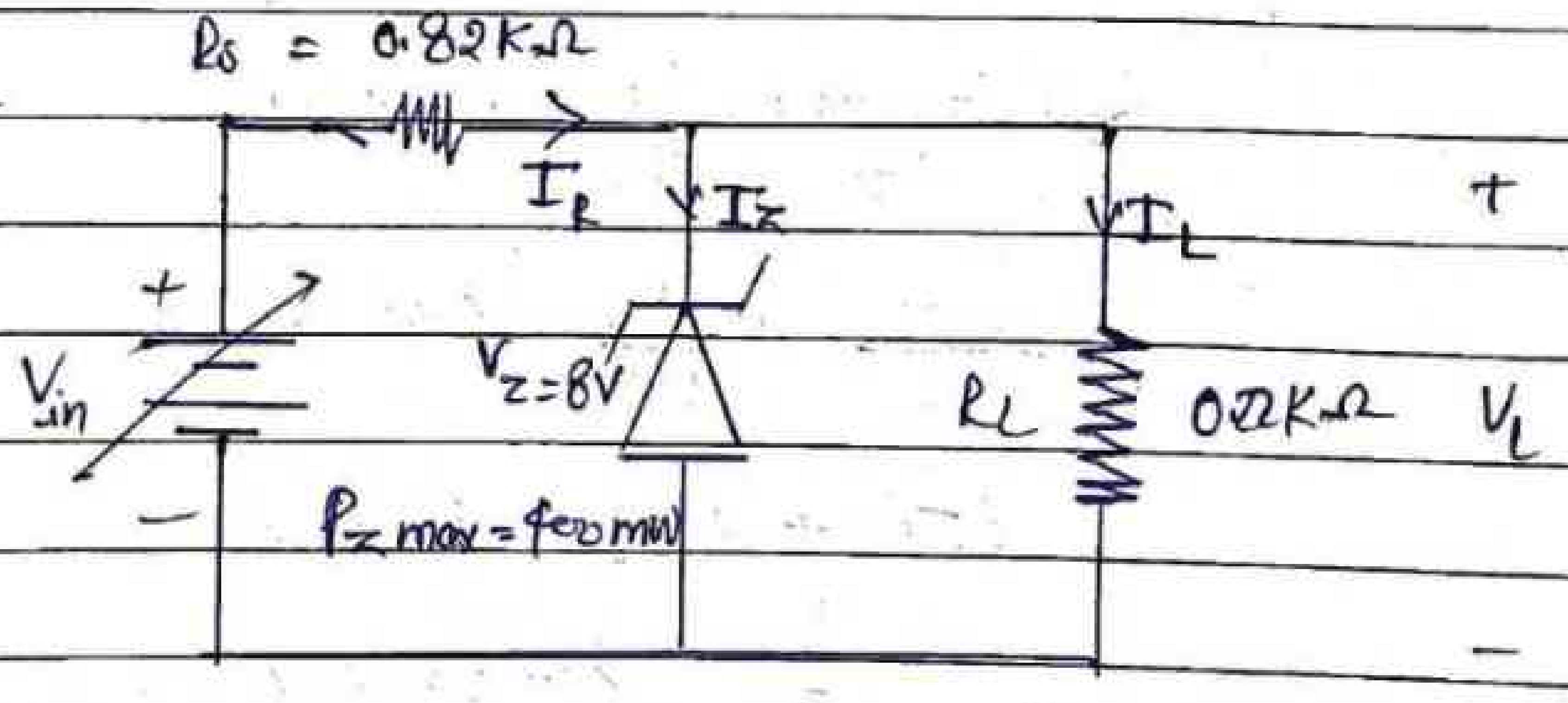
$$V_{s\,max} = 35V$$

Que:- Determine the range of input voltage (V_{in}) to maintain zener diode in ON condition and exceeded the maximum power rating of the zener diode.

V_{in} (input voltage)



Soln



$$V_L = \frac{R_L}{R_S + R_L} \times V_{in}$$

$$= V_L (R_S + R_L) = R_L \cdot V_{in}$$

$$V_L R_S + V_L R_L = R_L \cdot V_{in}$$

$$V_L R_S = R_L \cdot V_{in} - R_L V_L$$

$$V_L R_S = R_L (V_{in} - V_L)$$

$$V R_S =$$

Page

Date

$\therefore R_{L(max)} = \frac{V_L}{I_{L(min)}} = \frac{10}{8} = 1.25\ K\Omega$

Range of R_L = $0.25\ K\Omega$ to $1.25\ K\Omega$

Range of I_L = 8mA to 40mA

ii) $P_{Z(max)} = V_Z \cdot I_{Z(max)} = 10 \times 32 = 320mW$.

Page

Date

Sol^n i) $V_L = 10V$

using VDR

$$V_L = \frac{R_{Lmin}}{R + R_{Lmin}} \times V_i$$

$$V_L R + V_L R_{Lmin} = R_{Lmin} \cdot V_i$$

$$V_L R = R_{Lmin}(V_i - V_L)$$

$$R_{L(min)} = \frac{V_L R}{(V_i - V_L)}$$

$$R_{L(min)} = \frac{10 \times 1}{(50 - 10)} = \frac{10}{40} = 0.25 K\Omega$$

$$V_L = R_{L(min)} \cdot I_{L(max)}$$

$$I_{L(min)} = \frac{V_L}{R_{L(min)}}$$

$$= \frac{10}{0.25} = 40 mA$$

$$\therefore R_{L(max)} = \frac{V_L}{I_{L(min)}}$$

$$\therefore I_R = I_{Z(max)} + I_{L(min)}$$

$$\therefore I_L(min) = I_R - I_{Z(max)}$$

$$= \frac{V_i - V_L}{R} - 32$$

$$= \frac{50 - 10}{1} - 32$$

$$I_{L(min)} = 8 mA$$

$$I_R = I_{Z max} + I_L min$$

$$\therefore \boxed{I_{Z(max)} = I_R - I_{L(min)}}$$

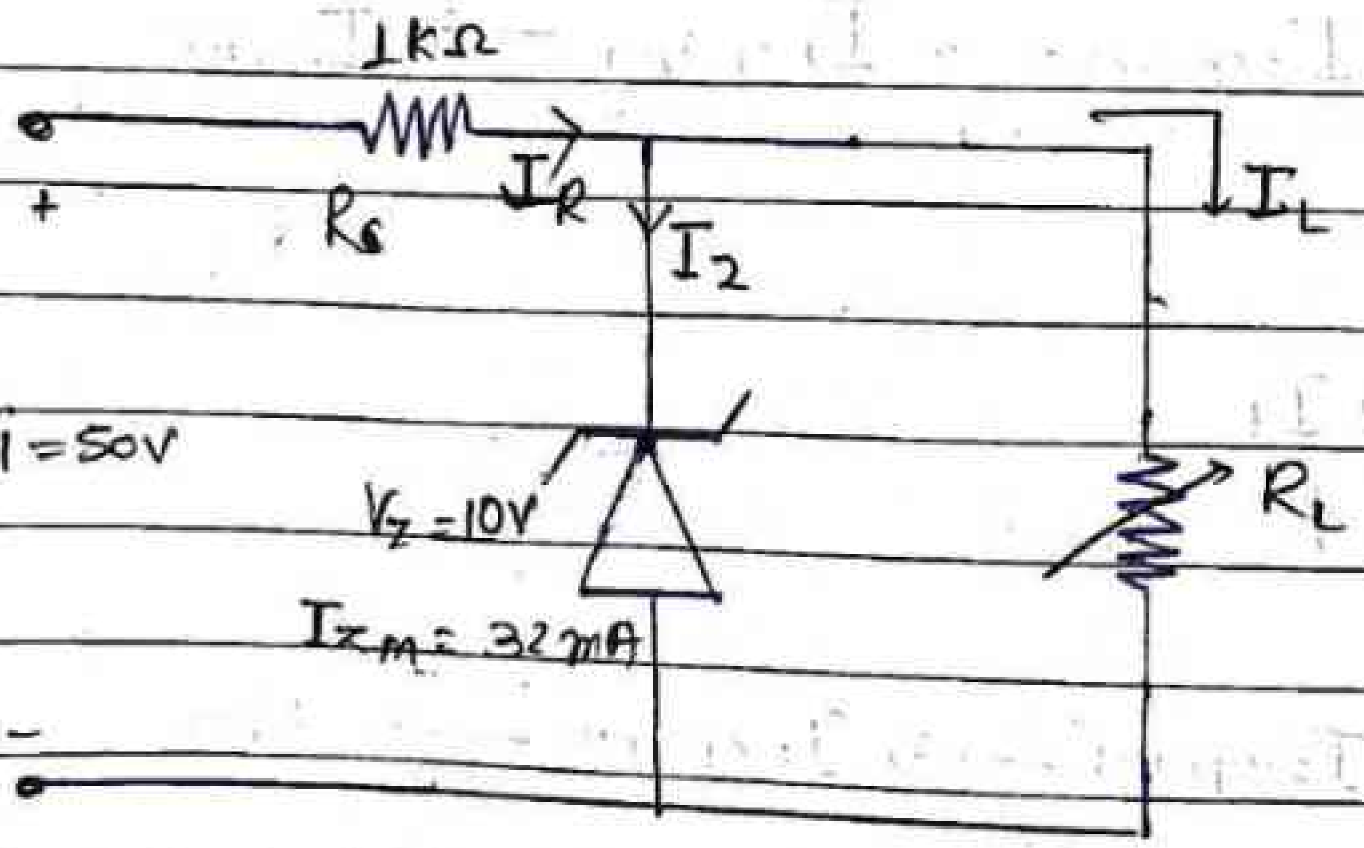
$$I_R = I_{Z(min)} + I_{L(max)}$$

$$\boxed{\therefore I_{Z(min)} = I_R - I_{L(max)}}$$

and

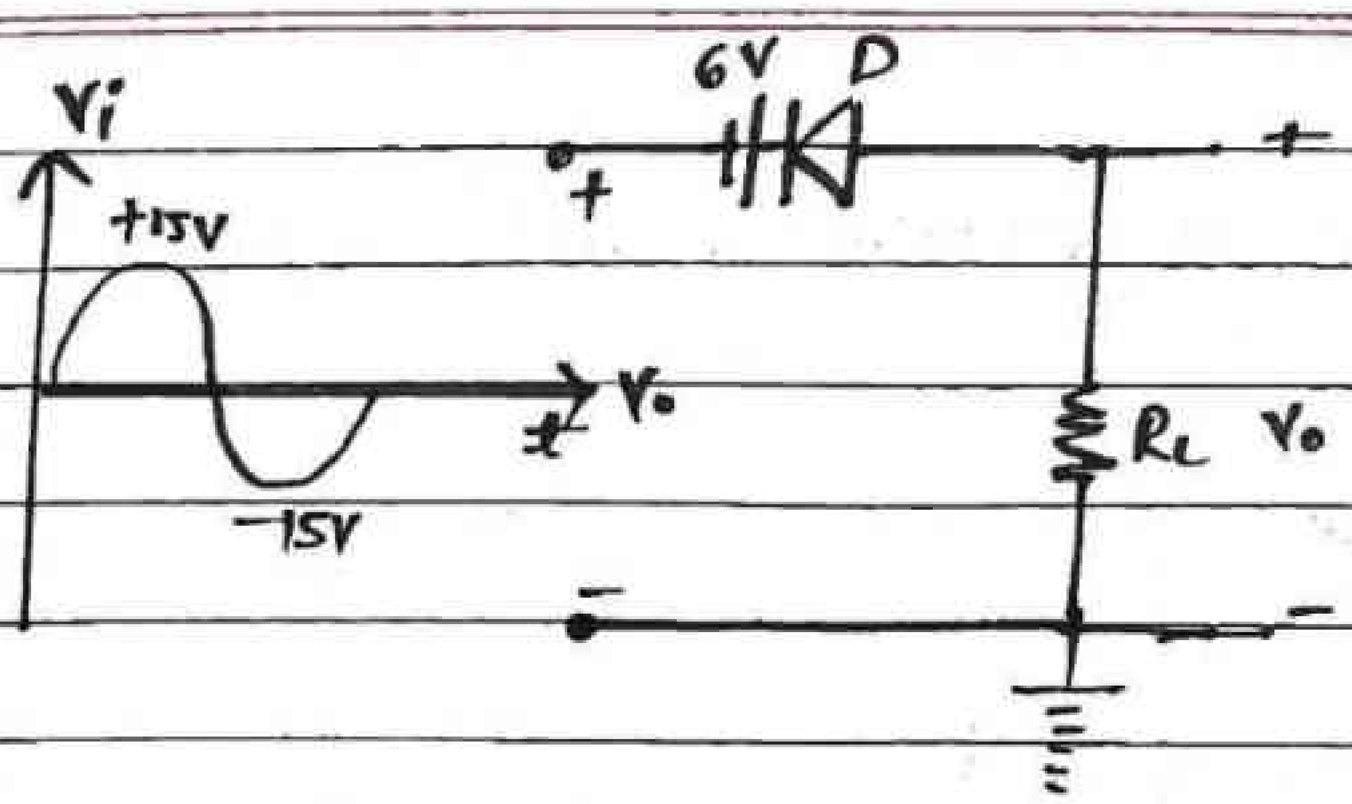
$$\boxed{P_{Z(max)} = V_Z \cdot I_{Z(max)}}$$

Que:- Determine the range of Vi for the figure that will maintain the zenor diode is "on" state?



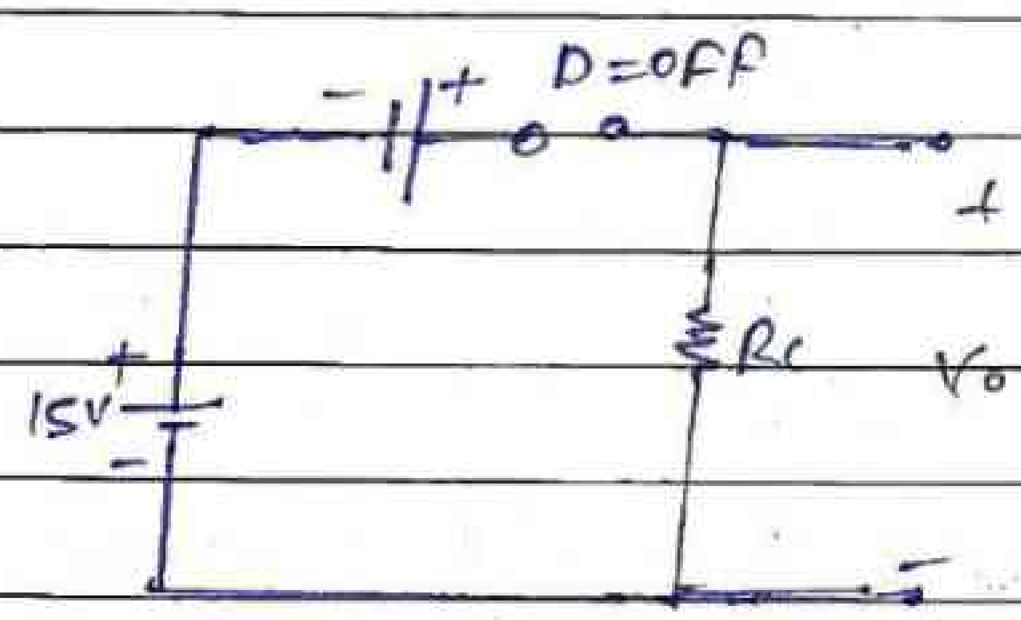
i) Range of R_L and I_L
ii) Maximum wattage rating Given that $P_{Z(max)}$ $V_L = 10V$

Que :-



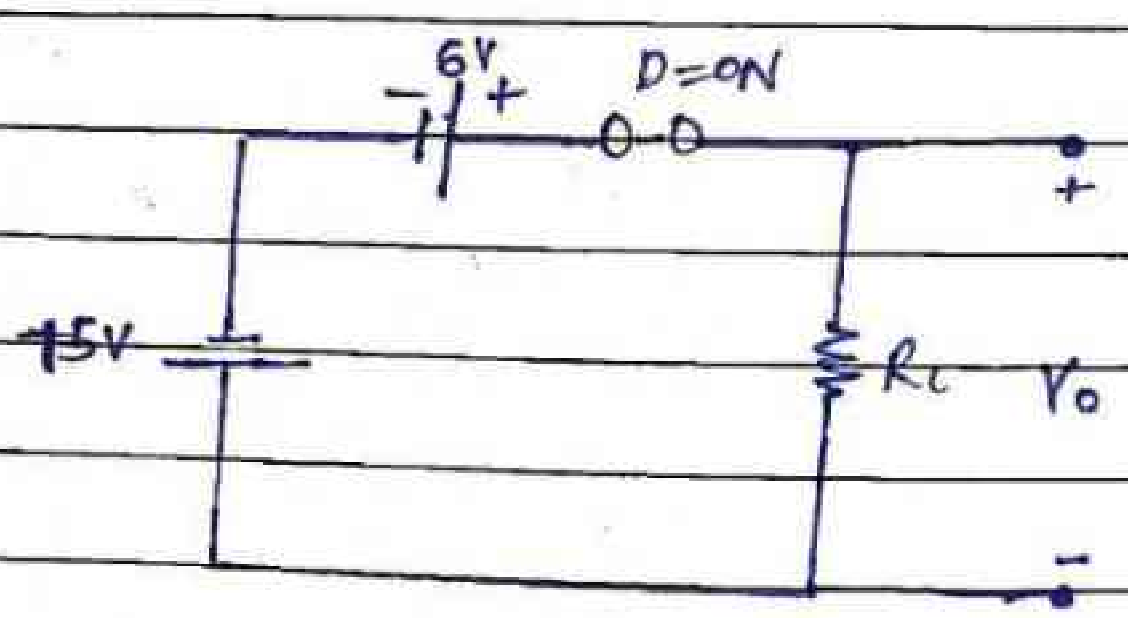
Sol^n

Case I :- During (+ve) Positive Half Cycle



$V_0 = 0V$

Case II :- During -ve Half Cycle



$V_i < -6V$	$V_i > -6$
D = OFF	D = ON
$V_0 = 0V$	$15 + V_0 - 6 = V_0$
	$V_0 = -9V$

Page ______

Date ______

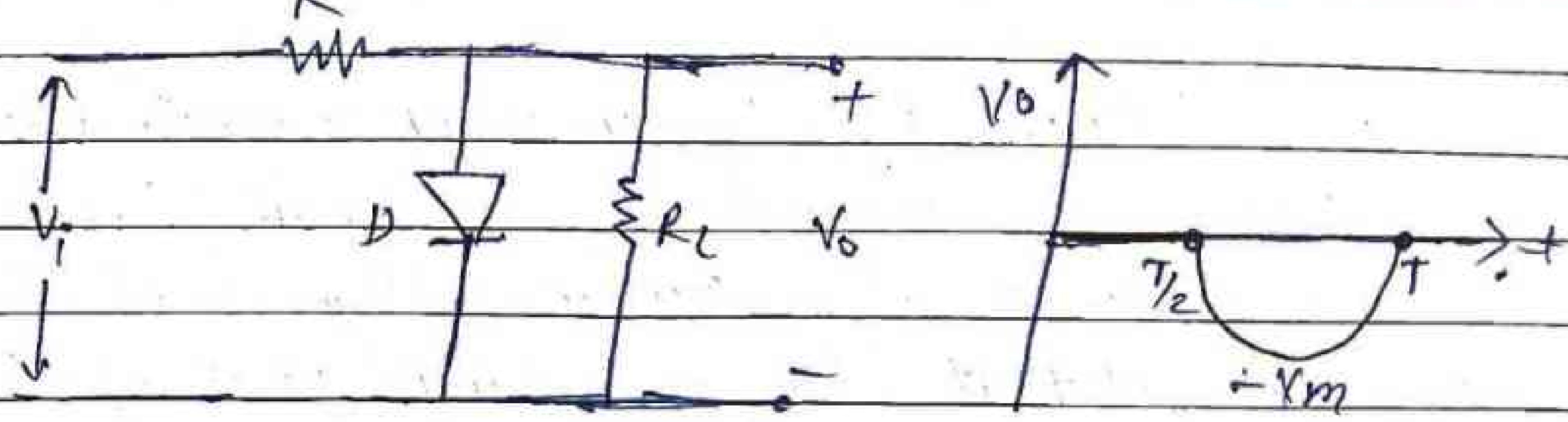


Fig:- Positive Parallel Clipper

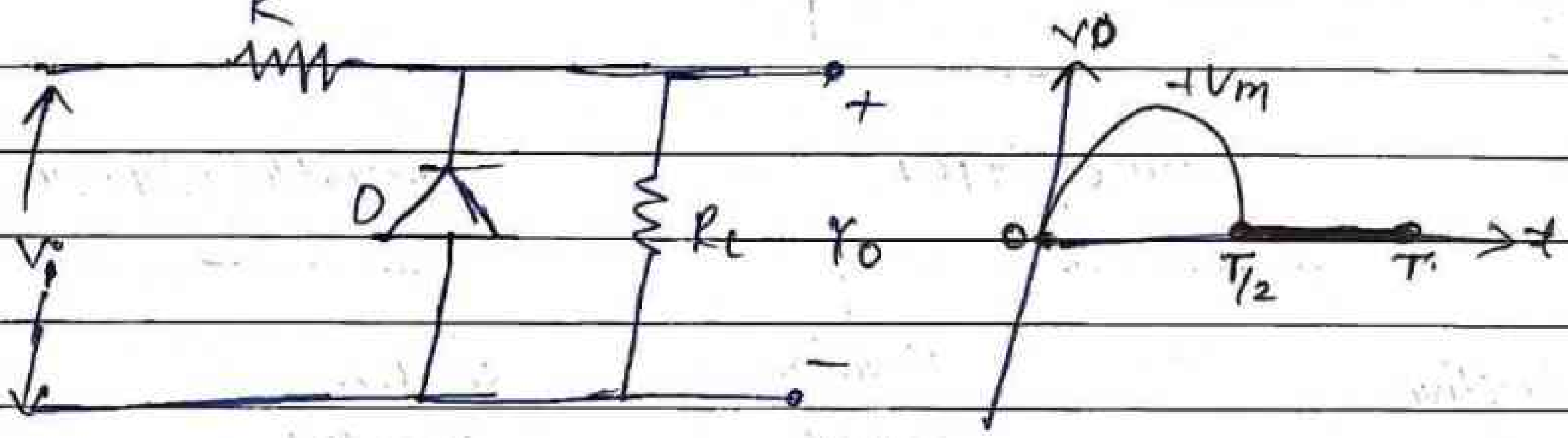


Fig: Negative Parallel Clipper

☆ Note:-

⇒ F.B. Series Clipper ⟶ Case of opposition → D = ON → $V_0 \propto V_i$ → ~~$V_0 \infty$~~

⇒ F.B./R.B. Parallel Clipper ⟶ Case of opposition → D = OFF → $V_0 \propto V_i$

⇒ F.B. Series/Parallel Clipper ⟶ Determine Transition level (T.L.) = ?

Page ______

Date ______

Clipper OR Slicer:- A Clipper is an ~~elextonic~~ electronic designed to prevent of a signal from exceeding a predetermineal reference voltage level. A clipper does not distort the remaining part of the applied input waveform.

Clipper (unbiased / Biased)

- Series clipper
  - Positive Series Clipper
  - Negative Series clipper
- Parallel Clipper
  - Positive Parallel Clipper
  - Negative Parallel Clipper

- Unbiased Clipper:-

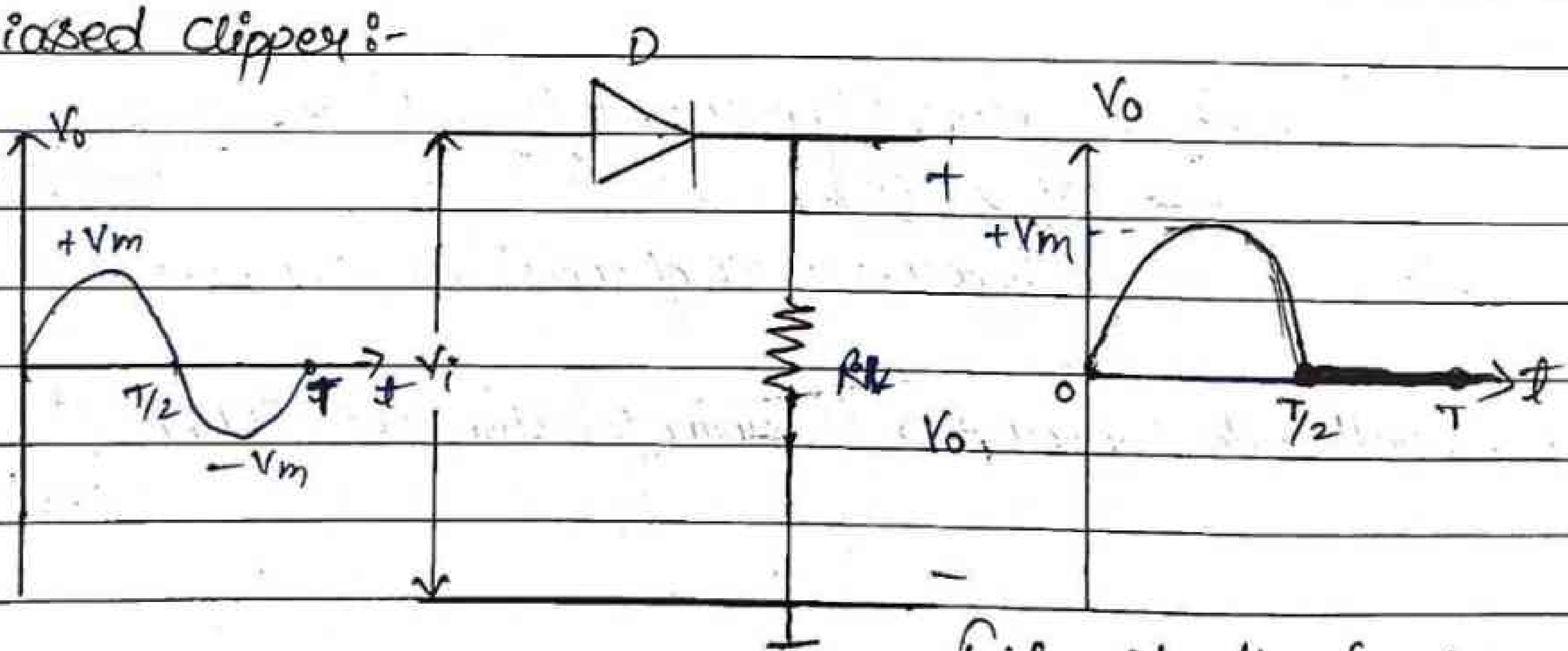


Fig:- Negative Series Clipper

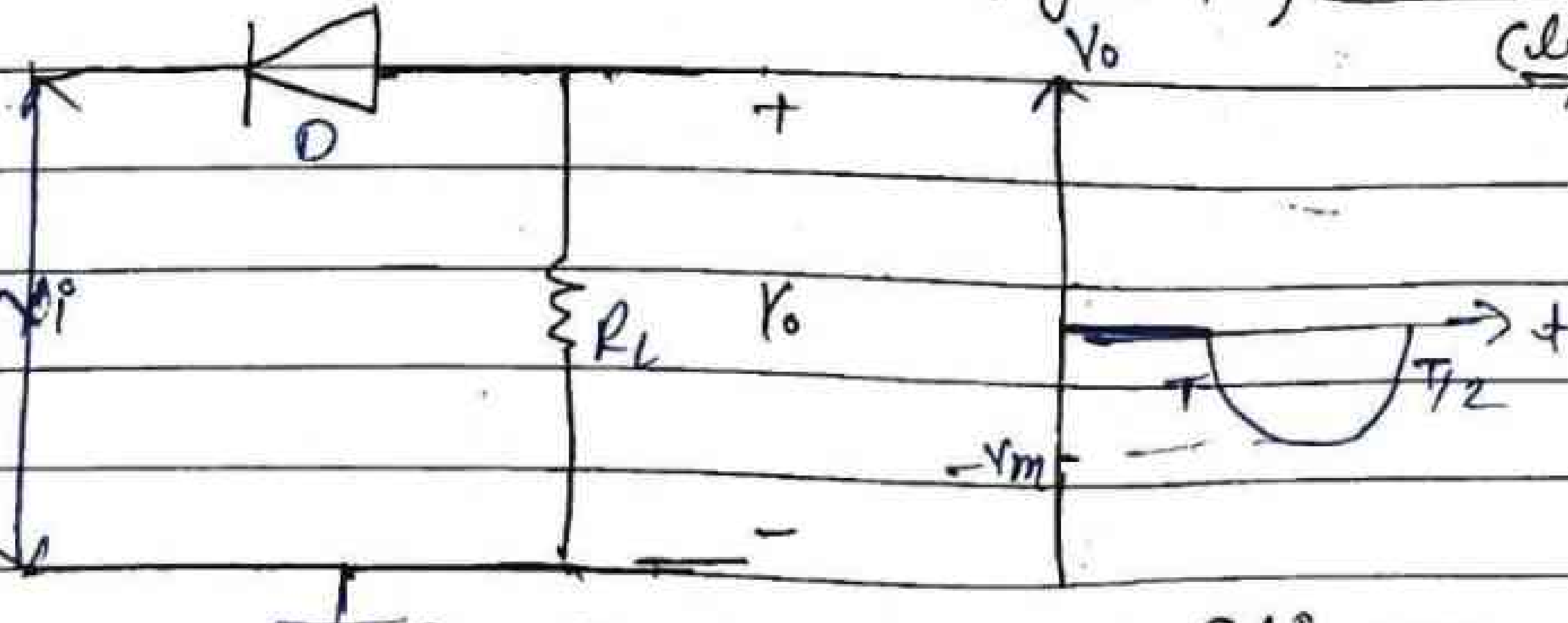
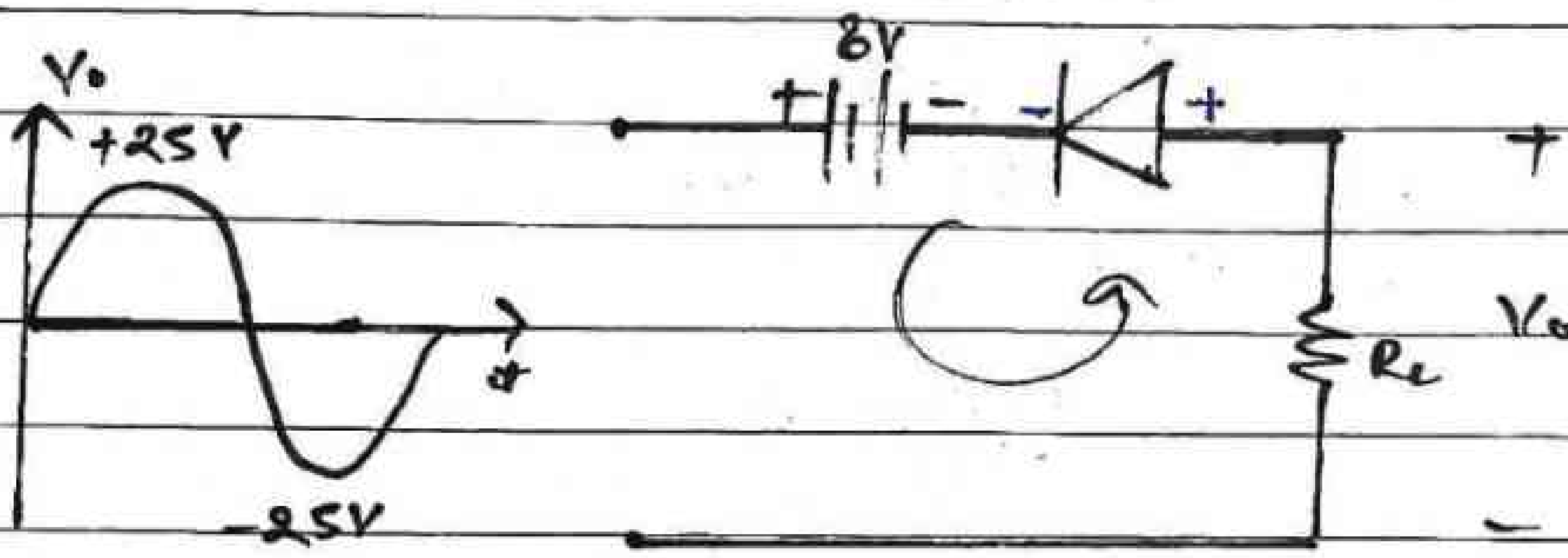


Fig:- Positive Series Clipper

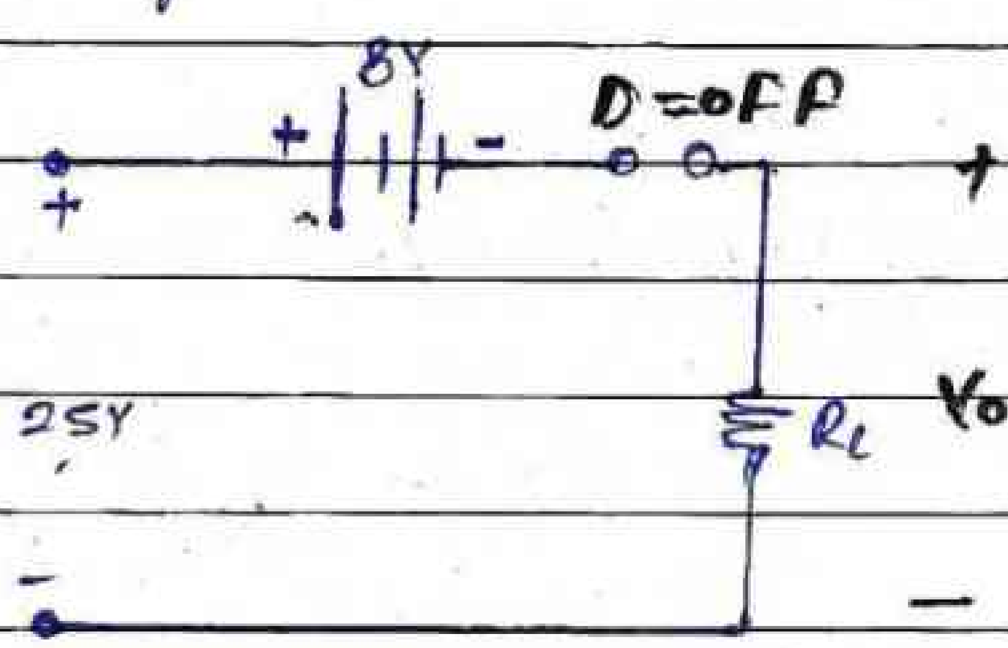
Page ______

Date ______

Que :- Sketch the V_o waveform for the given network.



Case I :- During +ve Half Cycle.



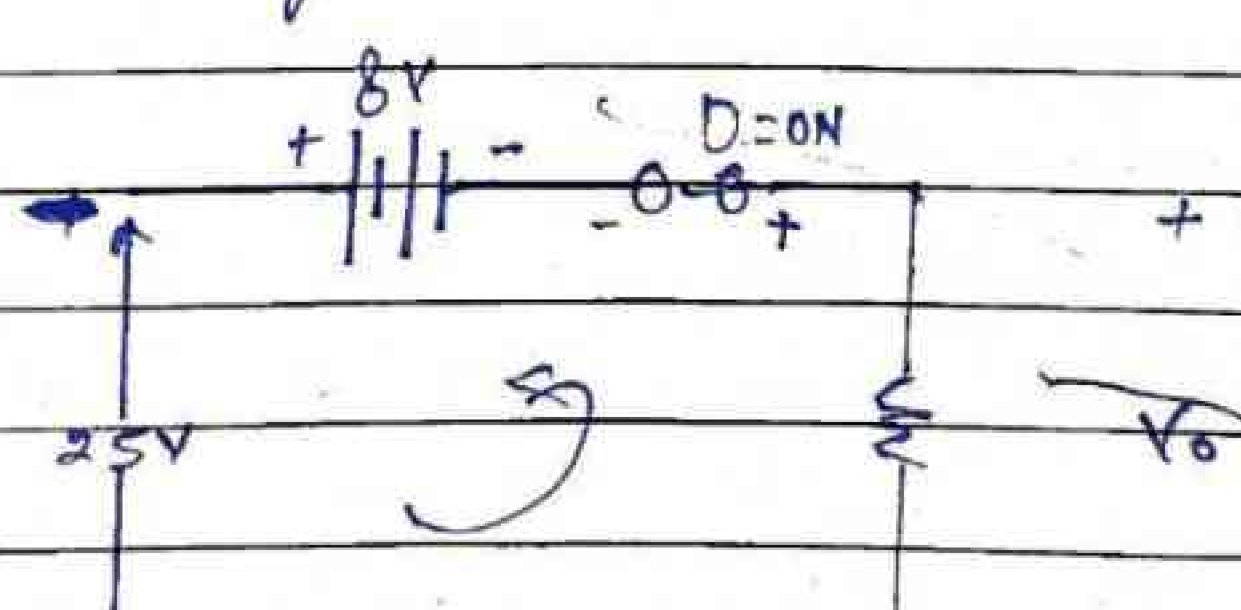
TL=

$V_o + 8V = 0$

$V_o = -8V$

$V_i < 8V$	$V_i > 8V$
D = ON	D = OFF
$V_o \propto V_i$	$V_o = 0$

Case II :- During -ve half cycle.



using KVL

$25 + V_o + 8 = 0$

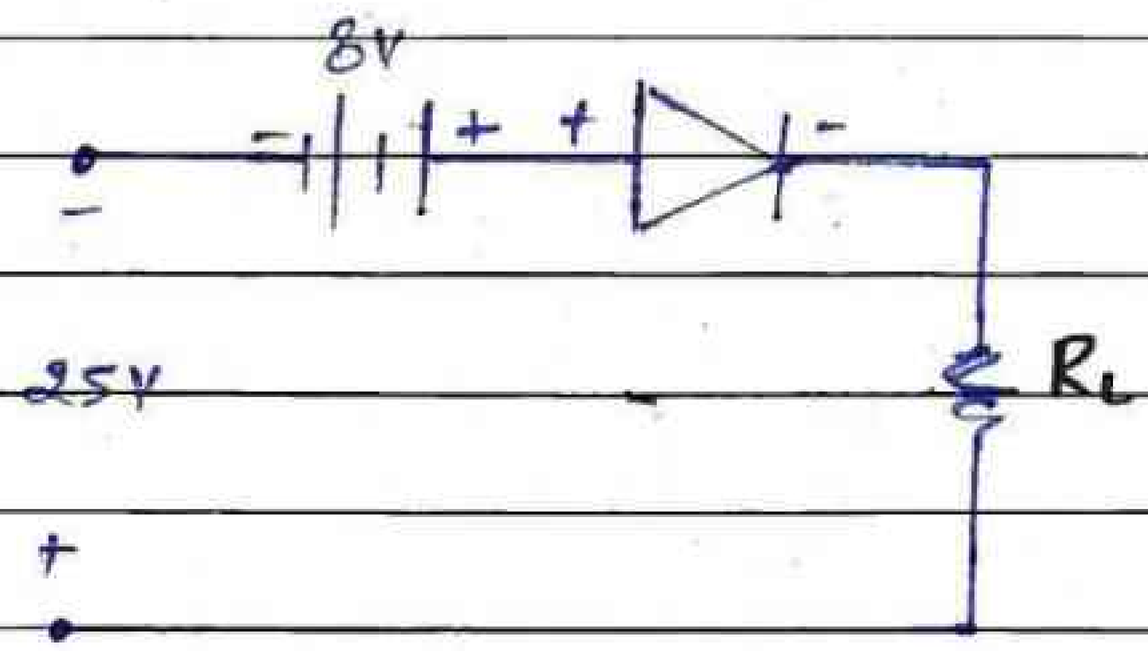
$V_o = -33$

Using KVL:

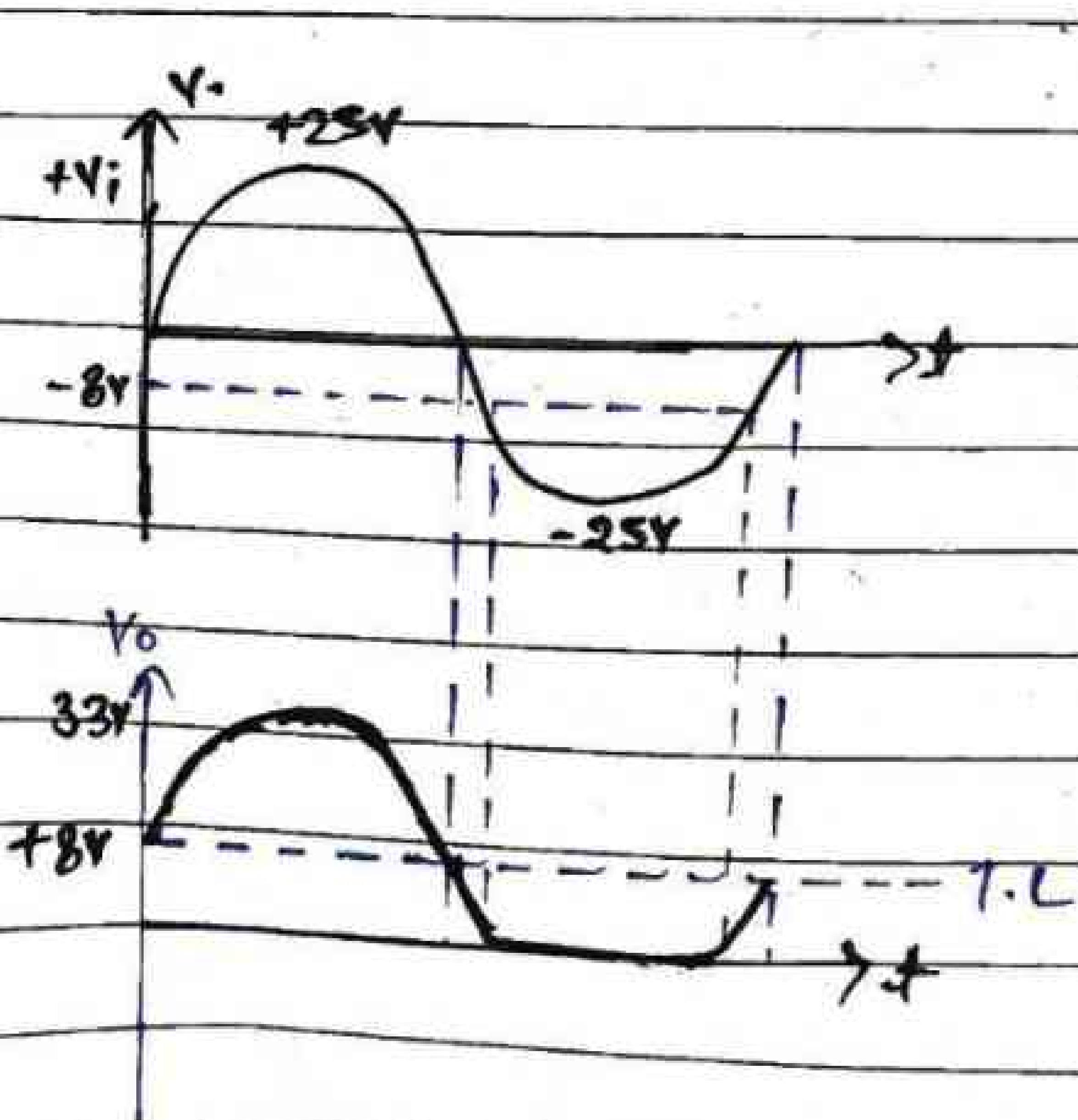
$25 + 8 - V_o = 0$

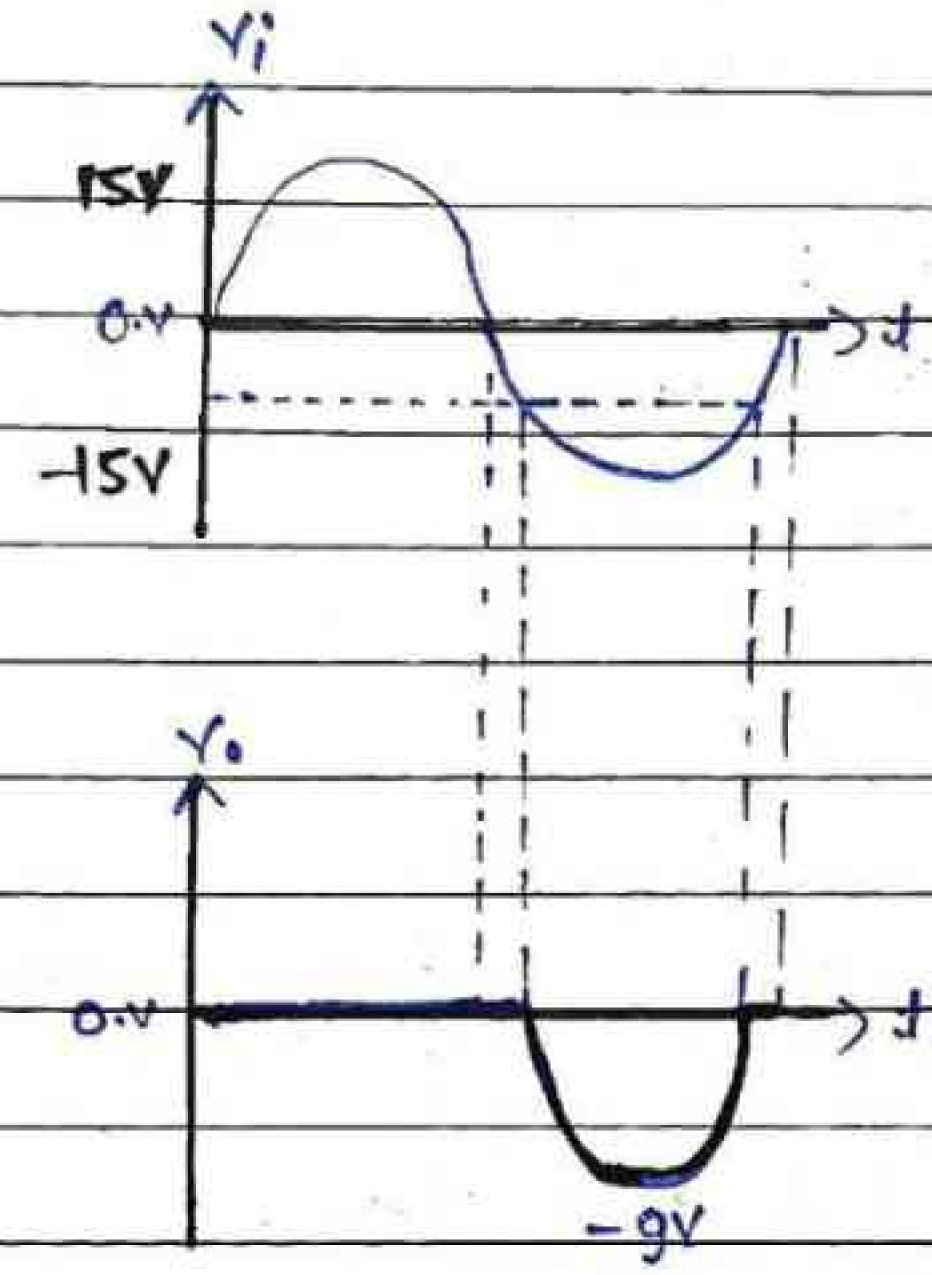
$\boxed{V_o = 33V}$

Case II: During −ve half cycle:-

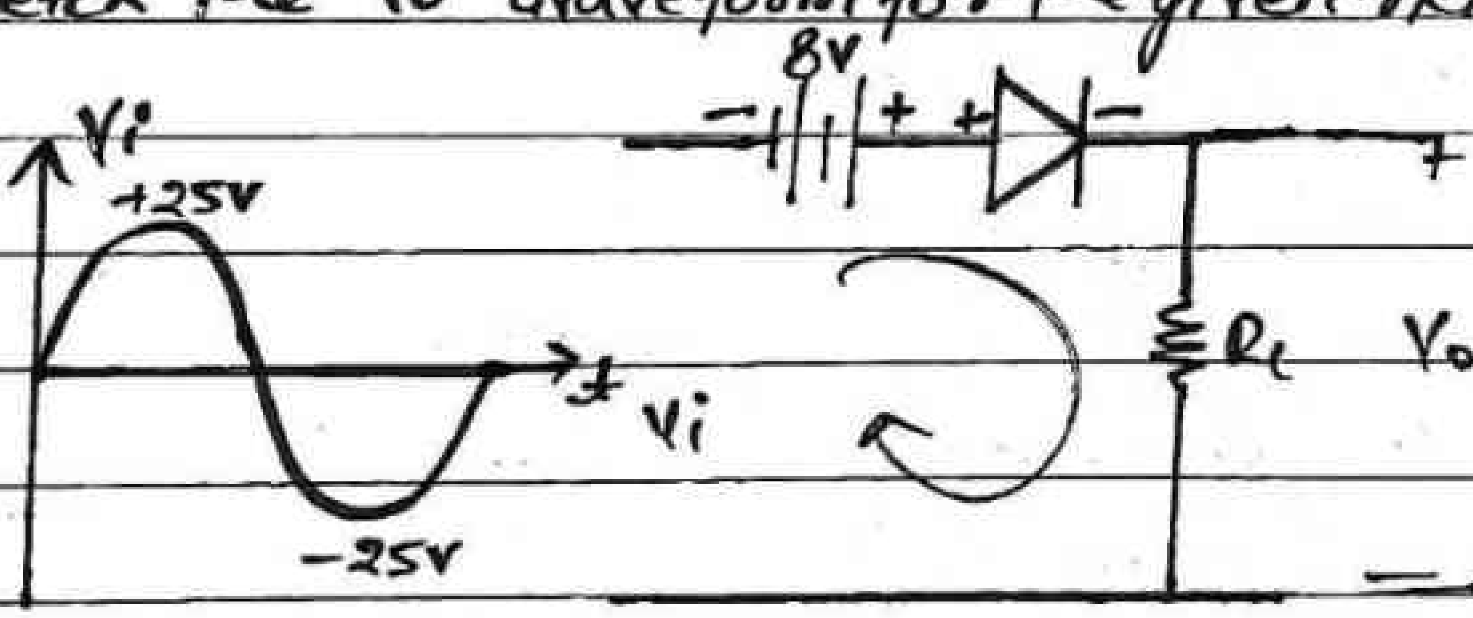


$V_i < -8V$	$V_i > -8V$
D = ON	D = OFF
$V_o \propto V_i$	$V_o = 0V$





Que:- Sketch the Vo waveform for the given network.



Sol^n Transition level (TL):

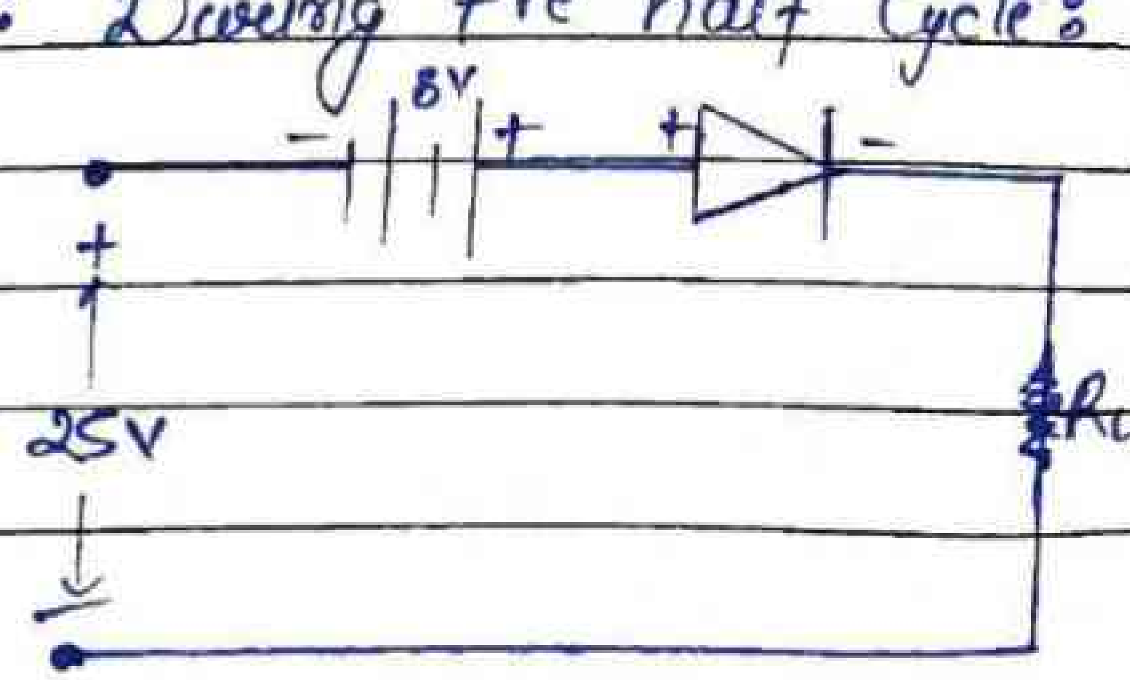
$8 - V_o = 0$

$+V_o = +8$

$V_o = 8$

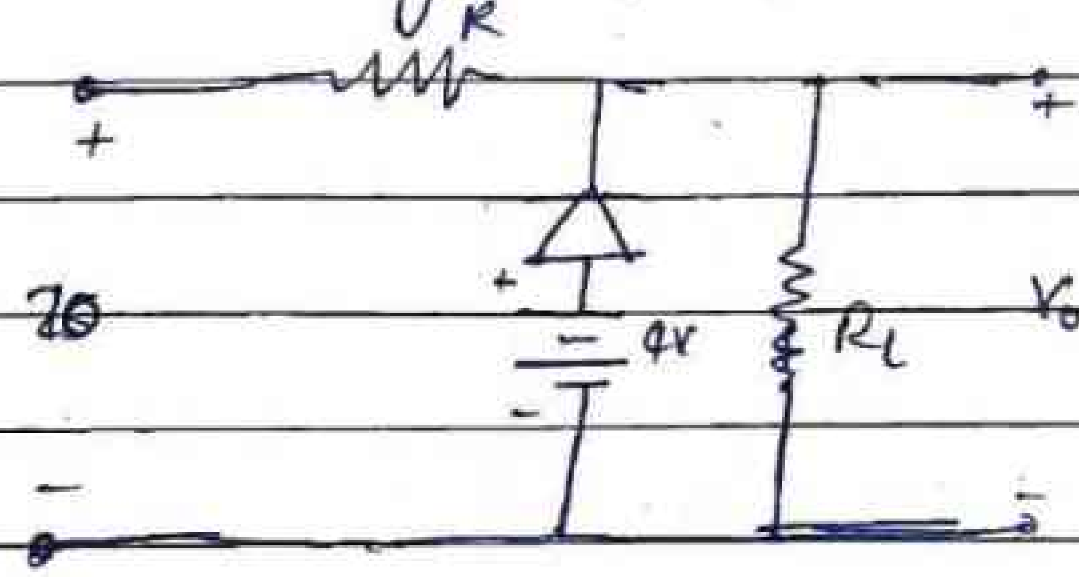
$\therefore$ $\boxed{T.L = 8V}$

Case I: During +ve half Cycle:



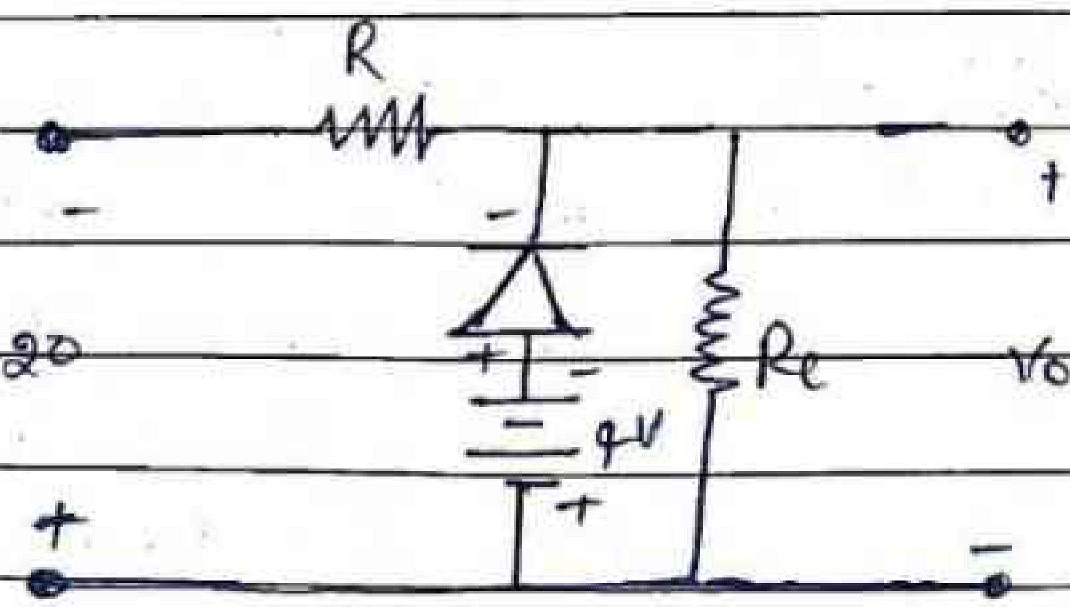
Page
Date

Case I : During (+ve) half Cycle



$V_i < 4V$	$V_i > 4V$
D = ON	D = OFF
$4 - V_0 = 0$	$V_0 \propto V_i$
$V_0 = 4$	

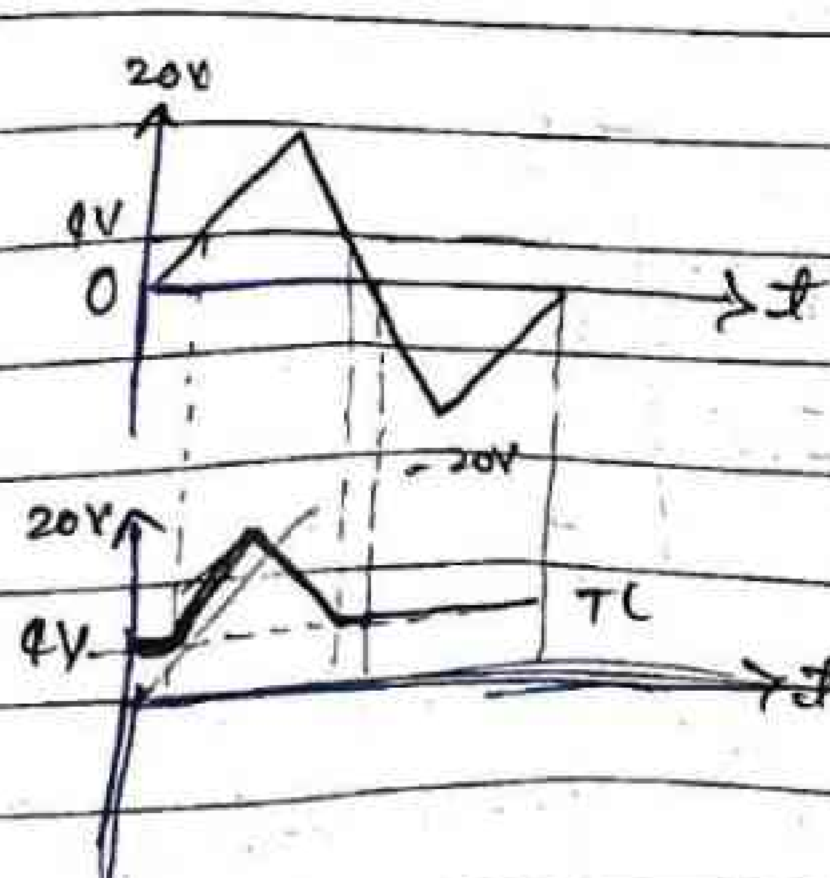
Case II : During (-ve) half Cycle



Using KVL

$4 - V_0 = 0$

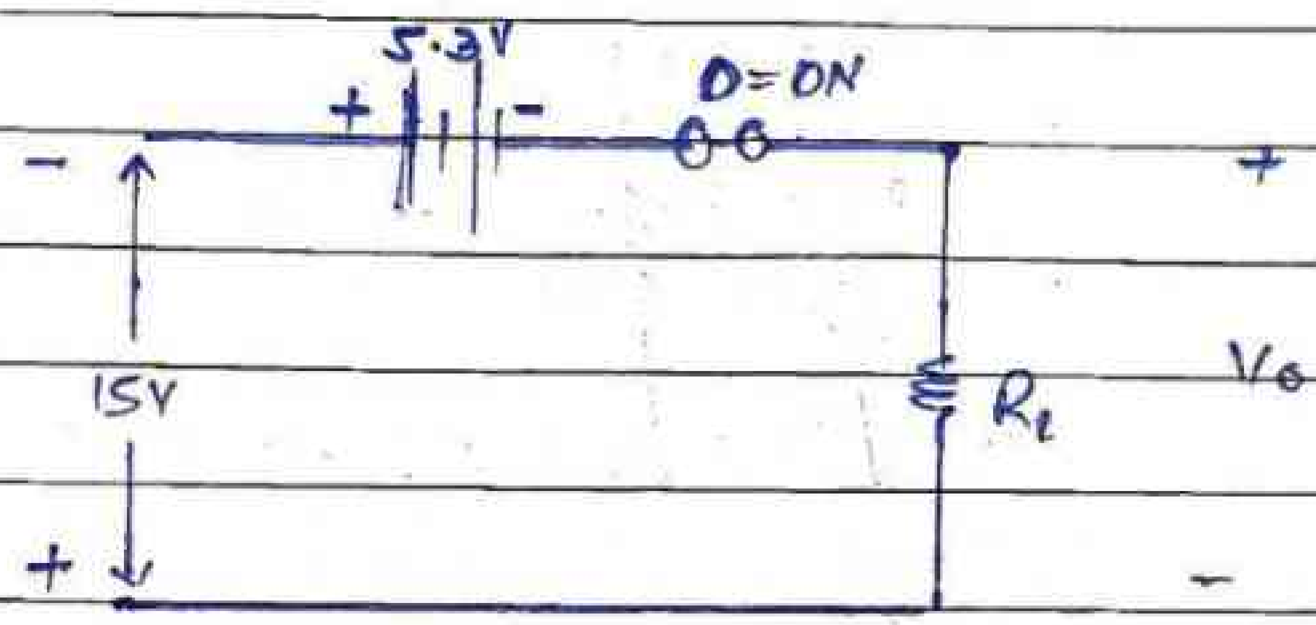
$V_0 = 4$



Page ______

Date ______

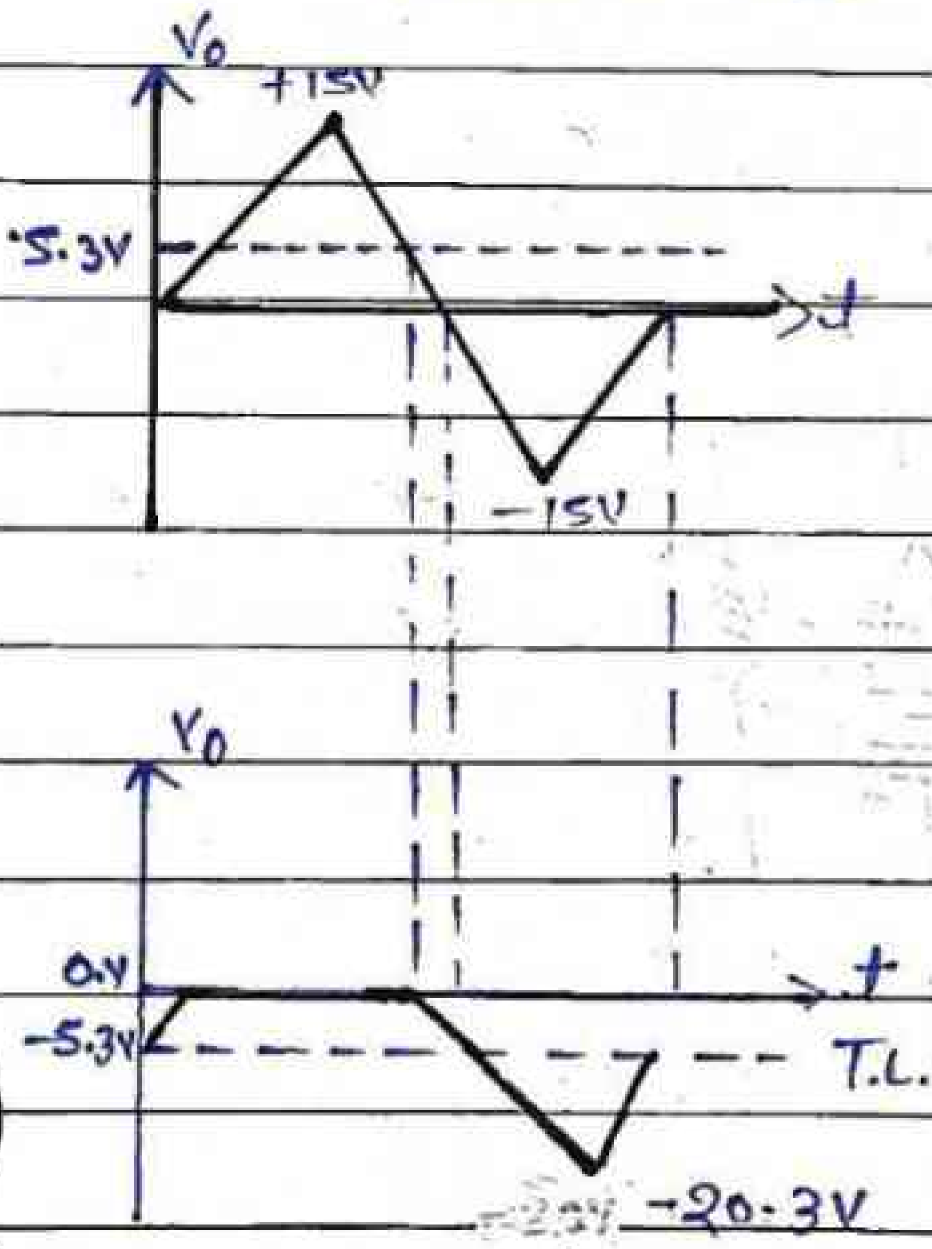
Case II : During -ve Half Cycle



using KVL

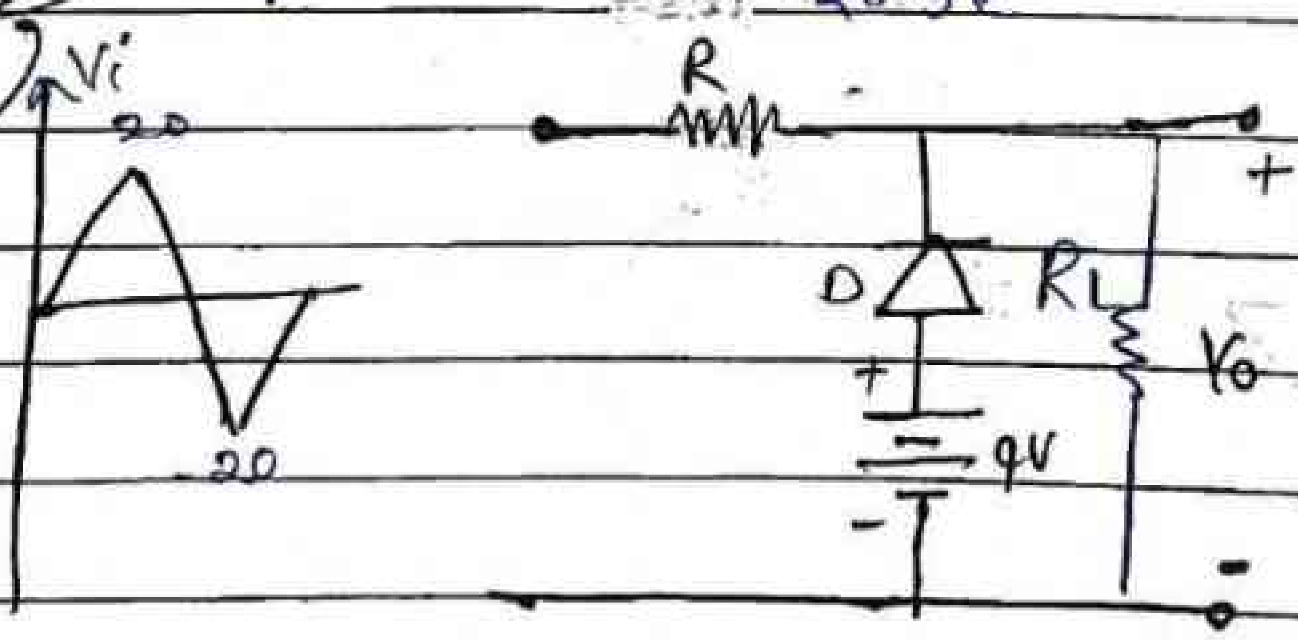
$$15 + V_o + 5.3 = 0$$

$$\boxed{V_o = -20.3}$$



I-Sem 2020-21 Q3-2(d)(ii)

Que



Sol^n

Transition level (T.L)

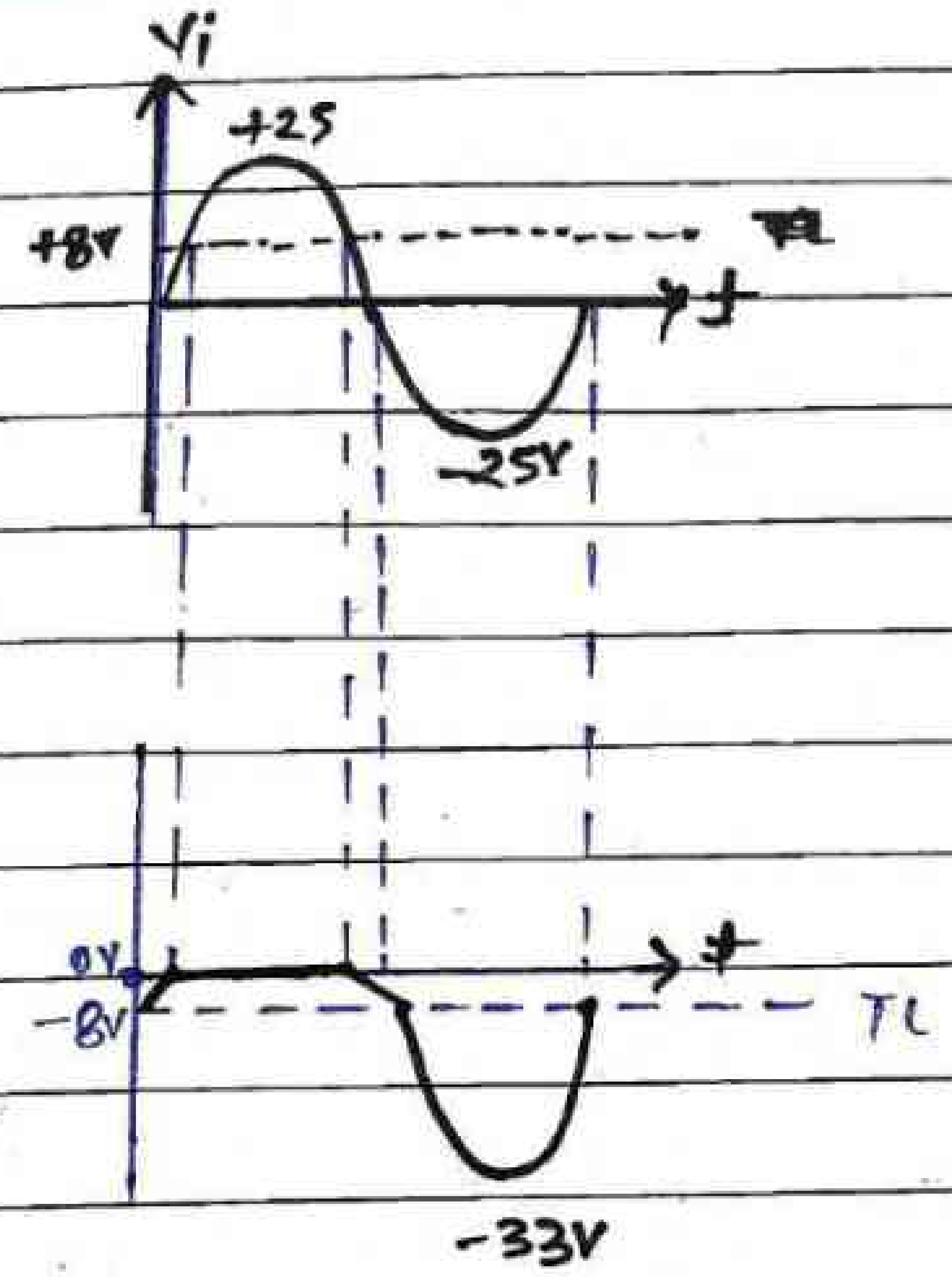
$$9 - V_o = 0$$

$$\boxed{V_o = 9}$$

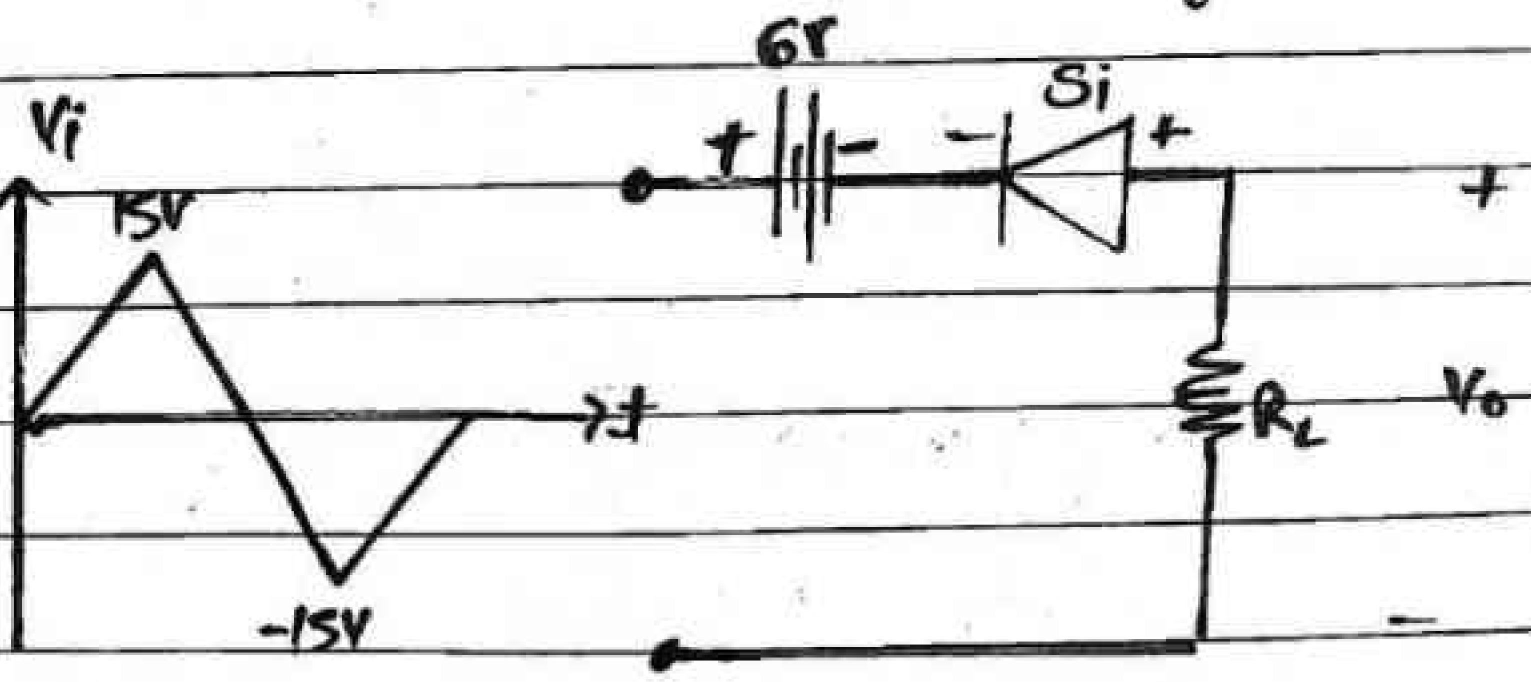
$\therefore \boxed{TL = 9V}$

$\therefore$ T

Page
Date



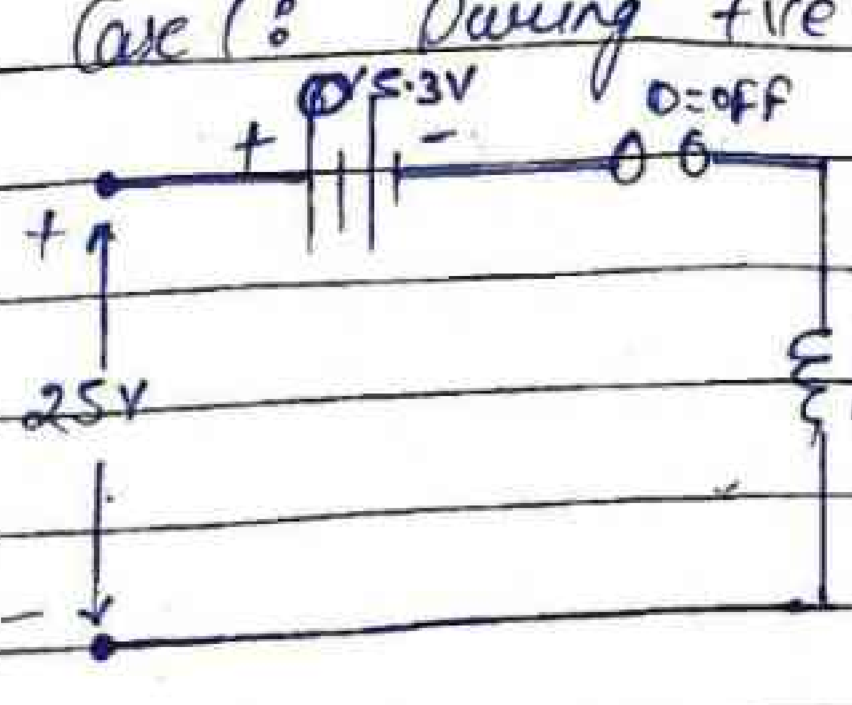
Que :- Sketch the V_o waveform for the given network.



Sol^n

Transition level (T.L.) :-
$V_o = -5.3\ V$
$\therefore TL = -5.3V$

* Case 1 : During +ve Half cycle :-



$V_i < 5.3V$	$V_i > 5.3V$
D = ON	D = OFF
V_o ~~α~~ V_i	$V_o = 0.V$