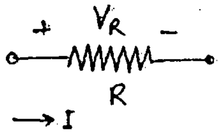
DIODE.

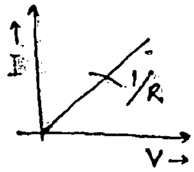
* It is a non linear Resistor.

LINEAR RESISTOR :-

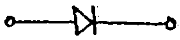


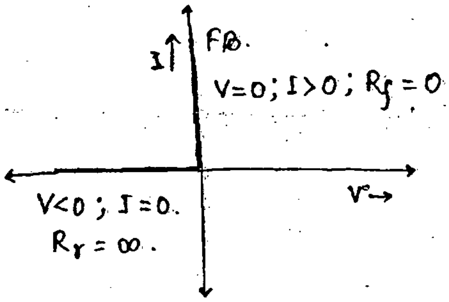
$V \propto I$; ↓ R

$\boxed{V = RI}$

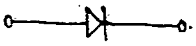


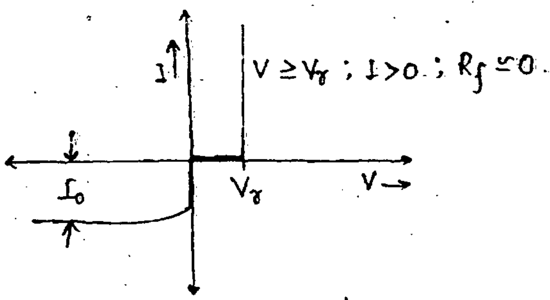
IDEAL DIODE :-





PRACTICAL DIODE.





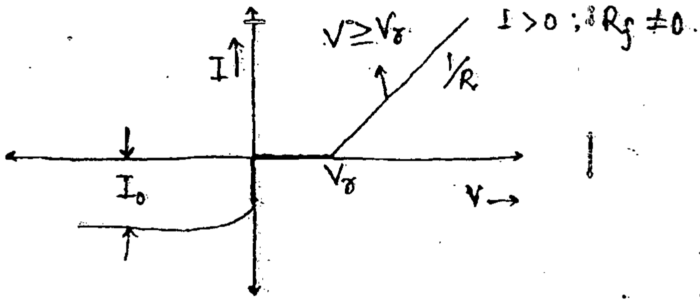
V_γ = 0.1V to 0.3V (Ge)

V_γ = 0.5V to 0.7V (Si)

I_0 = Reverse Saturated current

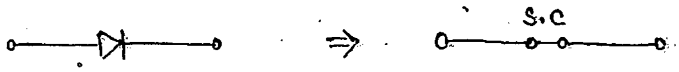
I_0 = μA or nA.
↓ (Ge) ↓ (Si)

PIECE WISE LINEAR MODEL.

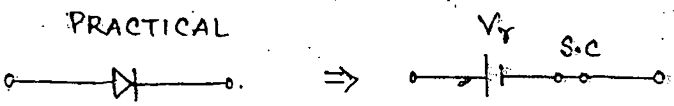


EQUIVALENT MODELS IN ON STATE.

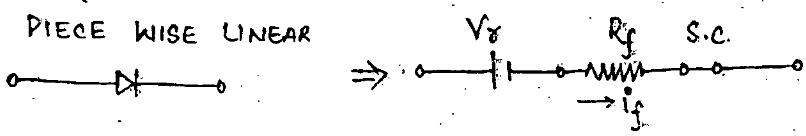
IDEAL.



PRACTICAL

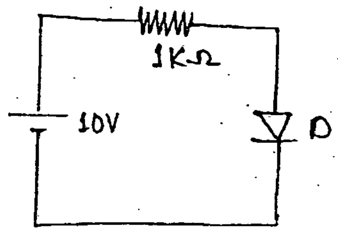


PIECE WISE LINEAR

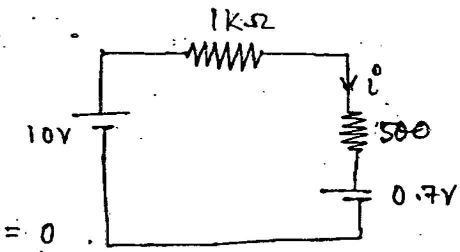


QUESTION :→ The VI characteristics of a diode is defined as

$$i = \begin{cases} \dfrac{V-0.7}{\underbrace{500}_{R_f}} & V \geq 0.7 \\ 0 & V < 0.7 \end{cases}$$



Solution :→ $\dfrac{V - \overbrace{0.7}^{V_\gamma}}{\underbrace{500}_{R_f}}$

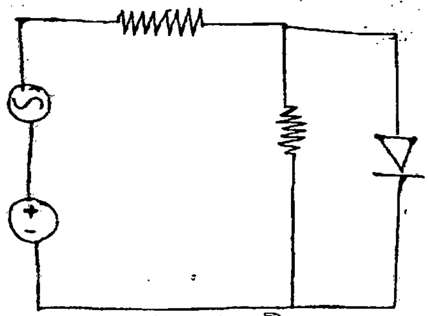


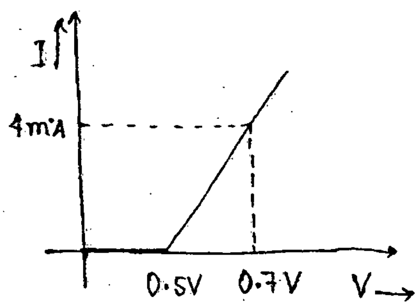
∵ R_f is present equivalent ckt is an piece wise linear diode.

$\Rightarrow 10 - i(1000+500) - 0.7 = 0$

$\Rightarrow i = \dfrac{10-0.7}{1500} = 6.2mA.$

QUESTION :→



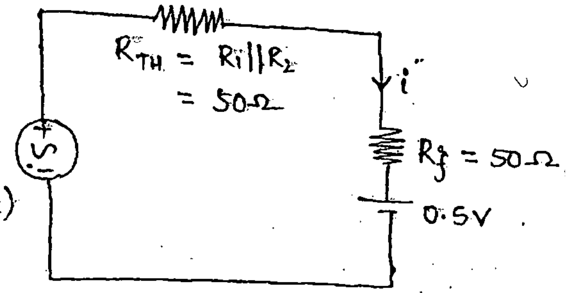


$V_\gamma = 0.5V$, $R_f = \frac{\Delta V}{\Delta I} = \frac{0.7 - 0.5}{4mA - 0} = 50\Omega$.

$2+\cos$ 

$V_{TH} = \frac{(2+\cos\omega t)\times 100}{200}$

$\Rightarrow V_{TH} = (1+0.5\cos\omega t)$



$i = \frac{1 + 0.5\cos\omega t - 0.5}{100} = \frac{0.5(1+\cos\omega t)}{1000} \times 10$.

$\Rightarrow i = 5(1+\cos\omega t)\, mA = \underbrace{5}_{DC} + 5\cos\omega t$

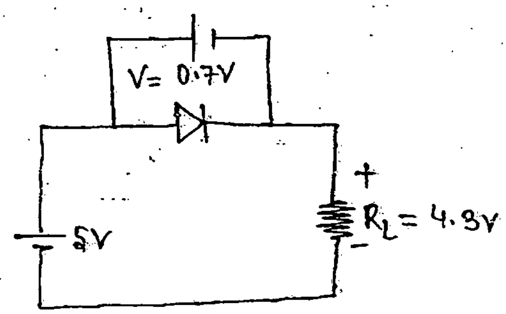
□ V-I CHARACTERISTICS EQUATION OF DIODE.

$$\boxed{I = I_0\left(e^{V/\eta V_T} - 1\right)}$$

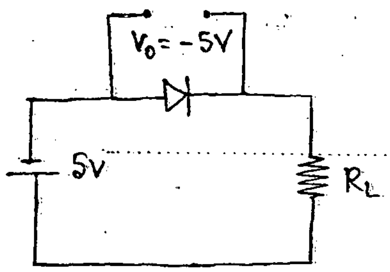
Where ; I = Total current through diode.

I_0 = Reverse saturated current.

V = Applied voltage drop across diode.



Forward Biased



Reversed Biased

η = Idealized Factor.

$\eta = 1$ (Ge) | $\eta = 1$ (Si) → Integrated electronics

$\eta = 2$ (Si) | $\eta = 2$ (Si) → Discrete electronics.

$$\boxed{V_T = \frac{KT}{q} = \frac{T}{11,600}}$$ Volt eq. Temp (or) Thermal Voltage

Where K = Boltzmann constant
$= 1.38 \times 10^{-23}$ J/K.
T = Temperature in Kelvin.
q = charge.

AT $T = 27°C$ (Room Temp) $= 300\,K$
$q = 1.6 \times 10^{-19}\,C$

$$V_T = \frac{300}{\frac{1.6 \times 10^{-19}}{1.38 \times 10^{-23}}} \text{ or } \frac{T}{11,600} = \frac{300}{11,600} = 25\,mV \text{ (or) } 0.025\,V$$

or $26\,mV$ (or) $0.026\,V$

FORWARD BIASED.

$$I = I_0\left(e^{V/V_T} - 1\right) \qquad \eta = 1.$$

$\Rightarrow V \geq V_\gamma \quad \Rightarrow V = V_\gamma = 0.7V$
$= 700\,mV$

$$I = I_0\left(e^{\frac{700\,mV}{25\,mV}} - 1\right)$$

$$\boxed{I = \underbrace{I_0}_{nA} \cdot \underbrace{e^{V_D/V_T}}_{A}}$$ mA. I_0 is neglected.

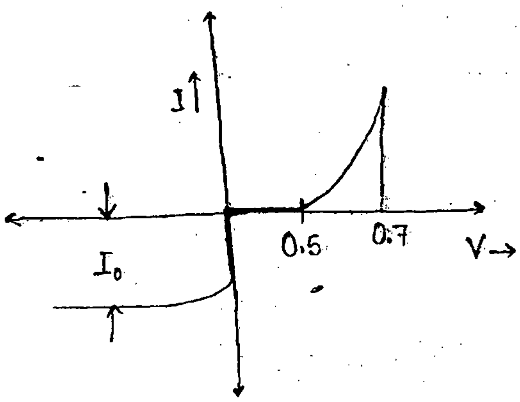
REVERSED BIASED.

$$I = I_0\left(e^{V/V_T} - 1\right)$$

$V < 0$; $V = -V$; Assume $-5V$.

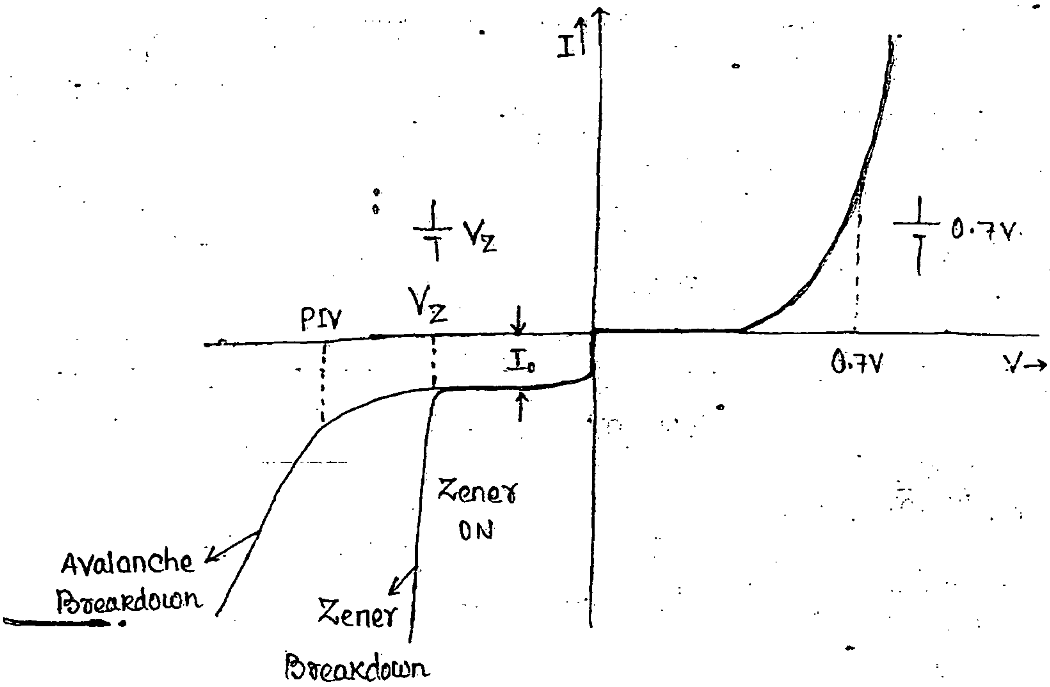
$$I = I_0\left[e^{-5/25\,mV} - 1\right]$$

$$= I_0\left[\underbrace{\frac{1}{e^{5/25\,mV}}}_{=0} - 1\right] \Rightarrow \boxed{I = -I_0}$$



$V_{D\,cut\,in} = 0.5V.$

$V_{D\,active} = 0.7V.$



Reversed Biased :→ "I_0" increases by 7% / °c rise in temperature.

'OR'

"I_0" doubles for every 10°c rise in temperature

$1 + 0.07 = (1.07)^{10} = 1.96 \simeq 2.$

Forward Biased :→ $I = I_0 \cdot e^{V_D/V_T}$

$\downarrow V_D = V_T \ln \left(\frac{I}{I_0\uparrow}\right)$ I → Fixed by Battery; I_0 → depend on temperature.

$$\frac{dV_D}{dT} = -2.5\ mV/^{\circ}c.$$

Ch-2

Q6, Q9 40 PA, every $10^{\circ}c$ → double

$30^{\circ}c$ = 10 PA × 2 = 20 PA.
$40^{\circ}c$ = 20 × 2 = 40 PA.

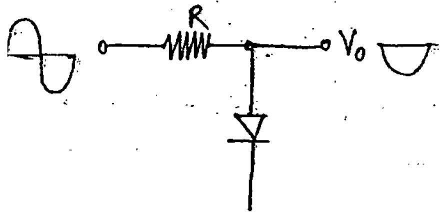
$$\boxed{I_{02} = I_{01}\ 2^{(T_2 - T_1)/10}}$$ → Shortcut.

Q9. $4^{\circ}c$ → −10 mV.
$20^{\circ}c$ → −50 mV.

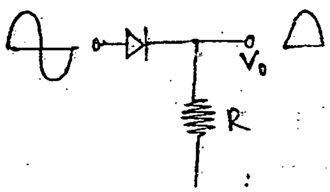
☐ CLIPPERS.

Clippers

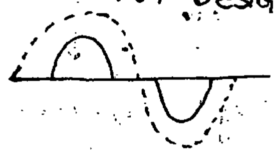
1. SHUNT CLIPPER.



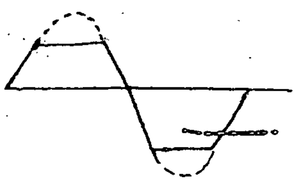
2. SERIES CLIPPER



3. OUTPUT FOLLOWING INPUT DESIGN.

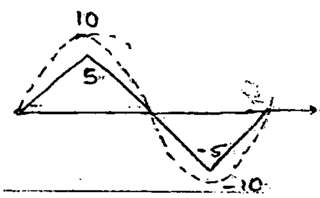


4. Two Independent Level Clipping.



5. Attenuation

$$V_0 = \frac{V_i}{A}$$

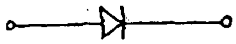


6. Single Branch Design.

7. Multi branch Design.

14/10/14

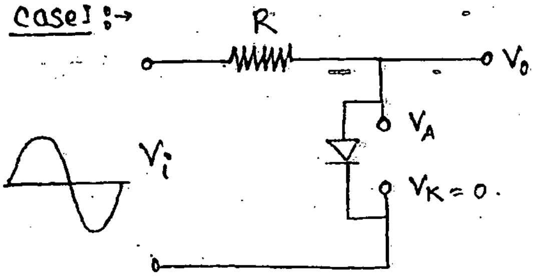
1. SHUNT CLIPPERS.



$V_A > V_K$ Diode will be ON S.C. → Forward Biased

$V_A \leq V_K$ Diode will be OFF O.C. → Reversed Biased.

Case I :→



Condition :→

$V_i < 0$ Diode OFF → $V_0 = V_i$

$V_i > 0$ Diode ON → $V_0 = 0$

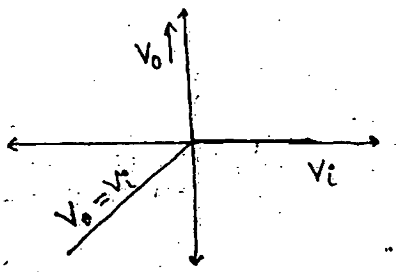


Fig : TRANSFER STUDY

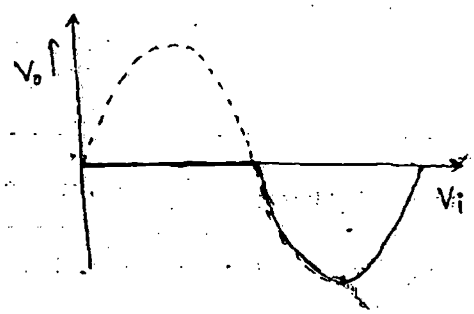
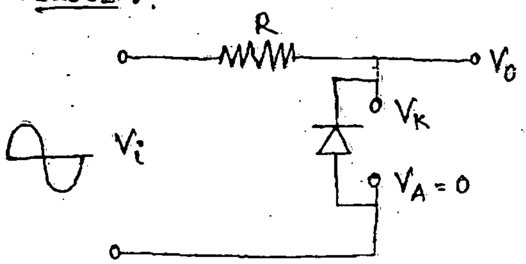


Fig :- O/P CHARACTERISTICS.

Case II :→



Condition :→

$V_i < 0$ Diode ON → $V_0 = 0$

$V_i > 0$ Diode OFF → $V_0 = V_i$

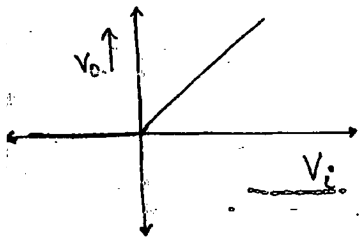


Fig :- TRANSFER STUDY

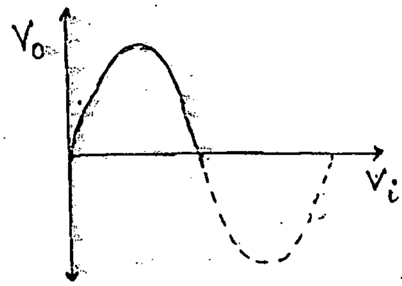
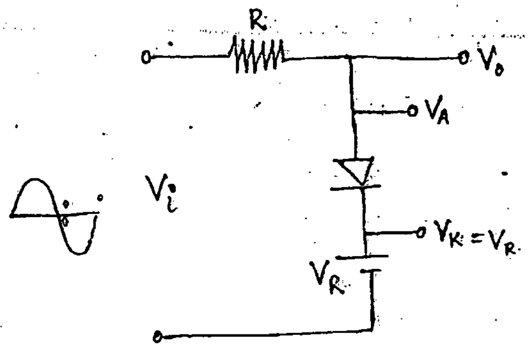


Fig :- O/P CHARACTERISTICS.

NOTE :- Limiting of ~~op~~ output comes by battery.

caseIII :-



CONDITIONS :-

$V_i < V_R$ Diode OFF $V_o = V_i$

$V_i > V_R$ Diode ON $V_o = V_R$.

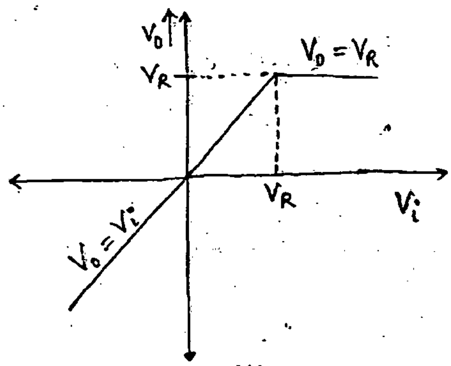


Fig :- TRANSFER STUDY

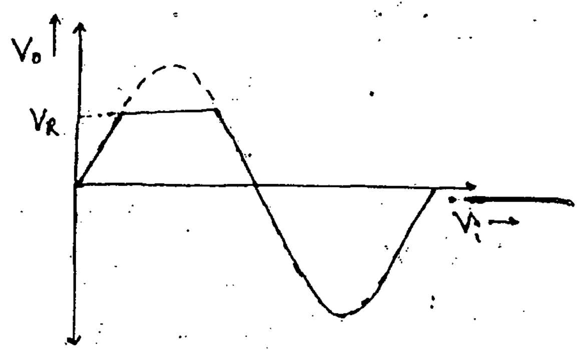
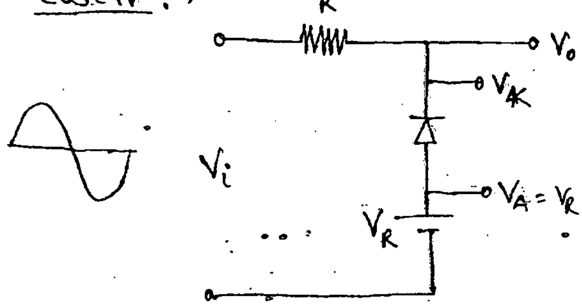


Fig :- O/P CHARACTERISTICS

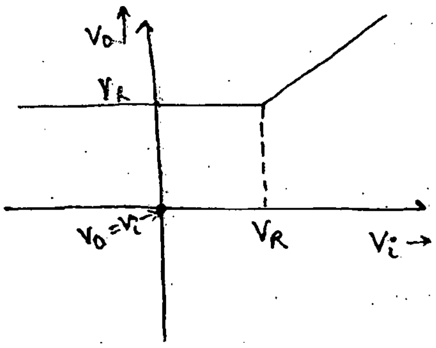
case IV :-

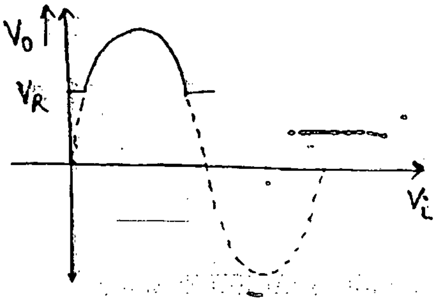


condition :-

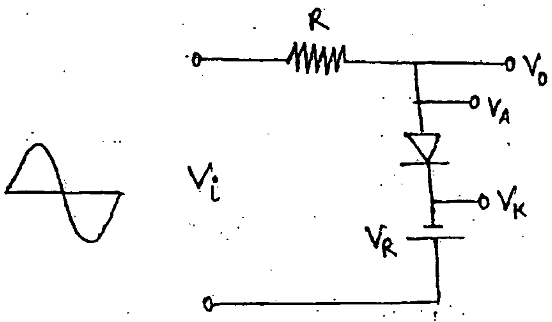
$V_i < V_R$ Diode ~~OFF~~ ON $V_o = V_R$

$V_i > V_R$ Diode ~~ON~~ OFF $V_o = V_i$



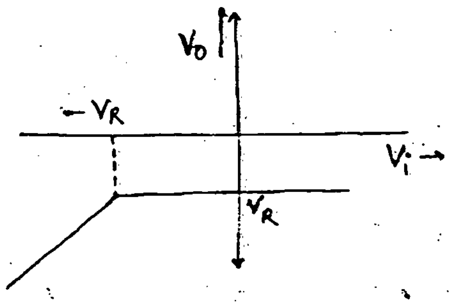


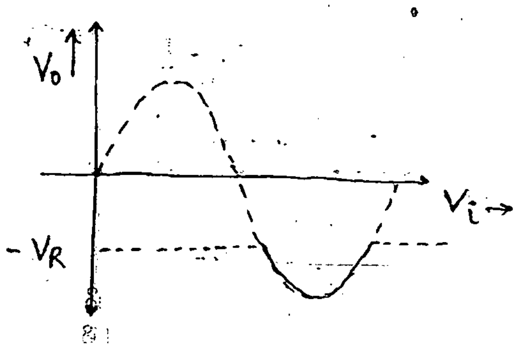
<u>Case - V</u> :→



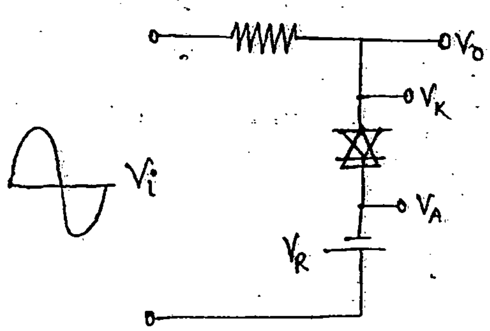
$V_i < -V_R$ Diode OFF $V_0 = V_i$

$V_i > -V_R$ Diode ON $V_0 = -V_R$



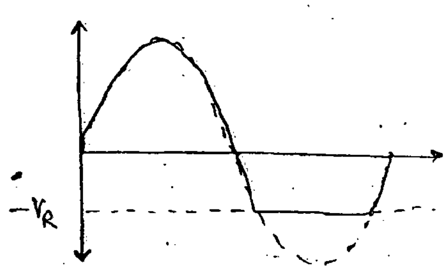


<u>Case - VI</u> :→



$V_i < -V_R$ Diode ON $V_0 = -V_R$

$V_i > -V_R$ Diode OFF $V_0 = V_i$



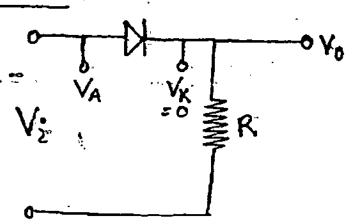
→ TECHNIQUES IN SHUNT CLIPPERS.

When the diode is in downward direction the signal will be transmitted below the reference voltage.

When the diode is in upward direction the signal will be transmitted above the reference voltage.

2 SERIES CLIPPER.

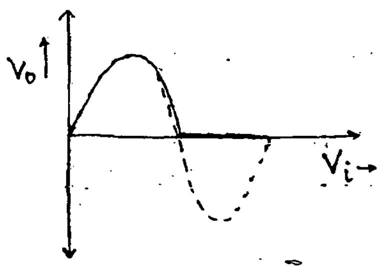
Case I :→



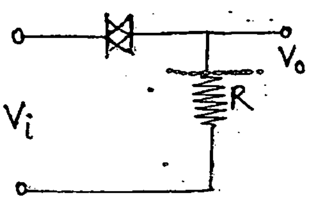
Conditions :-

$V_i < 0$ Diode OFF $V_o = 0$

$V_i > 0$ Diode ON $V_o = V_i$.



Case II :→



Conditions :-

$V_i < 0$ Diode ON $V_o = V_i$

$V_i > 0$ Diode OFF $V_o = 0$

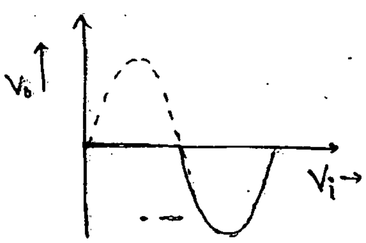
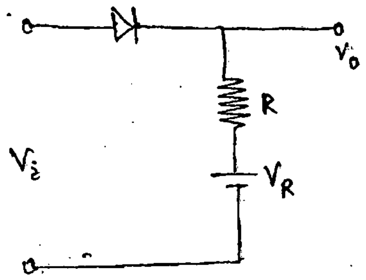


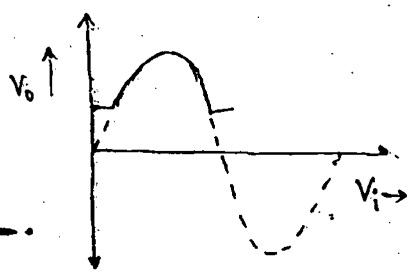
Fig :- O/p CHARACTERISTICS.

Case III :-

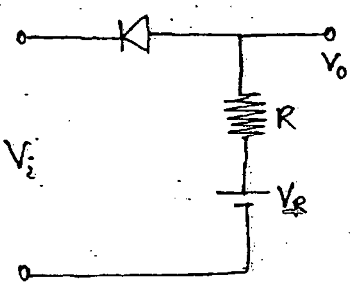


$V_i < V_R$ Diode OFF $V_o = V_R$

$V_i > V_R$ Diode ON $V_o = V_i$

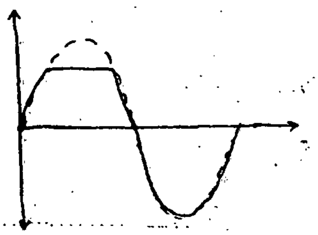


Case IV :-

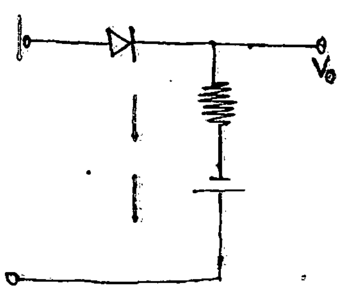


$V_i < V_R$ Diode ON $V_o = V_i$

$V_i > V_R$ Diode OFF $V_o = V_R$

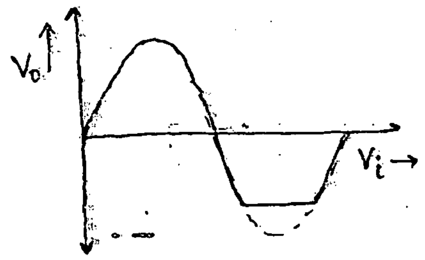


Case V :-

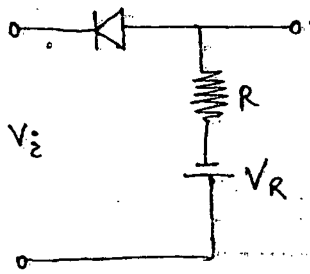


$V_i < -V_R$ Diode OFF $\cancel{V_o} = V_R$

$V_i > -V_R$ Diode ON $V_o = V_i$



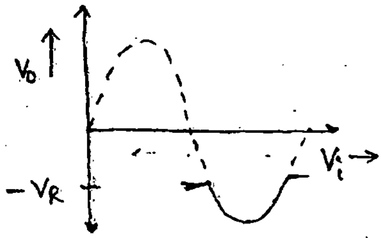
Case VI :→



conditions :→

$V_i < -V_R$ Diode ON $V_o = V_i$

$V_i > -V_R$ Diode OFF $V_o = -V_R$



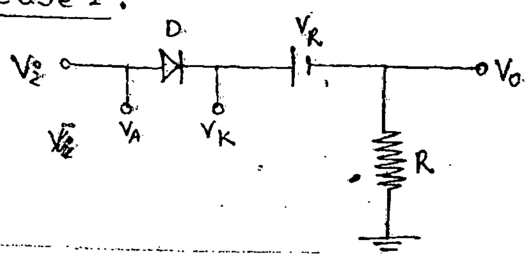
→ TECHNIQUES IN SERIES CLIPPERS.

When the diode is in forward direction to i/p s/g the s/g will be transmitted above the reference voltag

When the diode in reverse direction to the i/p s/g the s/g will be transmitted below the reference voltage

⊡ OUTPUT FOLLOWING INPUT DESIGN.

Case I :-



$V_i < V_R$ Diode OFF $V_o = 0$

$V_i > V_R$ Diode ON $V_o = V_i - V_R$

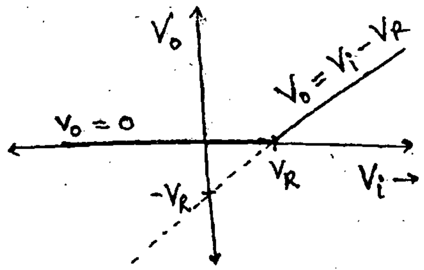


Fig :- TRANSFER STATE.

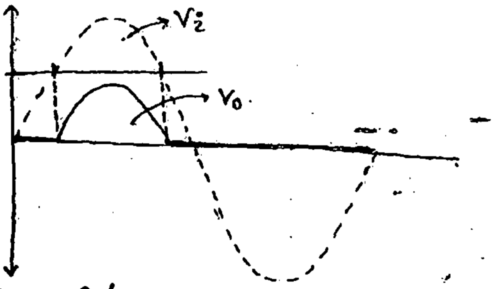
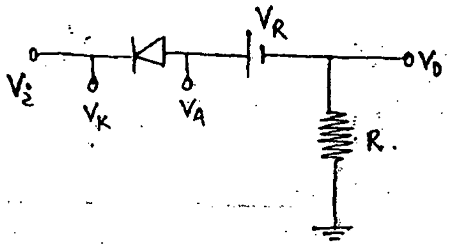


Fig :- O/P CHARACTERISTICS

Case II :→



condition :-

$V_i < V_R$ Diode ON $V_o = V_i - V_R$

$V_i > V_R$ Diode OFF $V_o = 0$

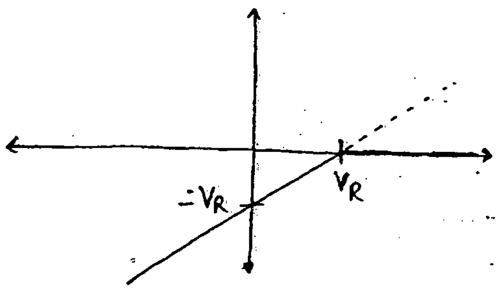


Fig :- TRANSFER STATE

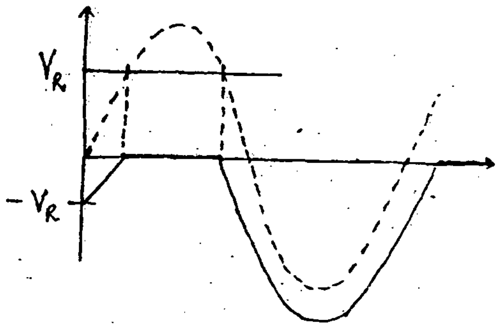
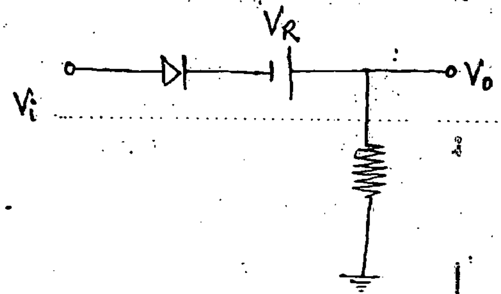


Fig :- O/P CHARACTERISTICS

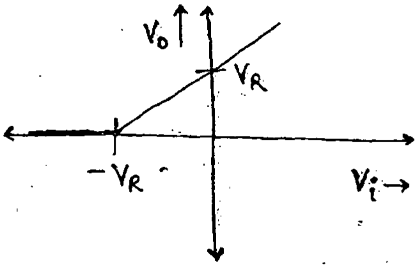
Case III :→

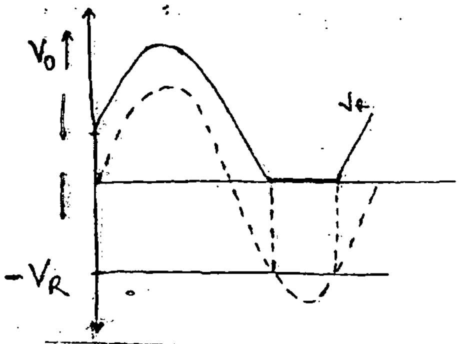


condition :-

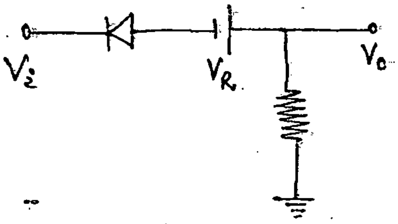
$V_i < -V_R$ Diode OFF $V_o = 0$

$V_i > -V_R$ Diode ON $V_o = V_i + V_R$.





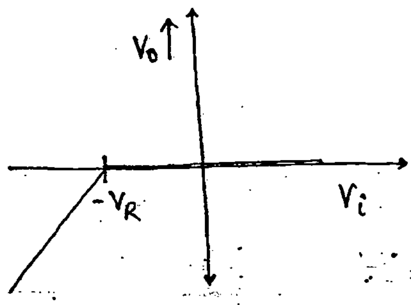
Case-IV :→

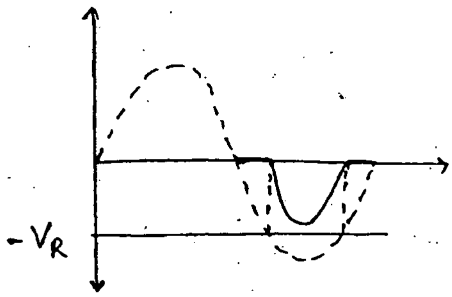


Conditions :→

$V_i < -V_R$ Diode ON $V_o = V_i + V_R$

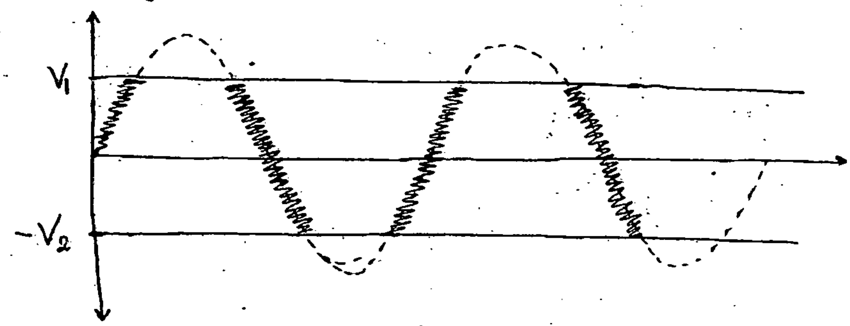
$V_i > -V_R$ Diode OFF $V_o = 0$



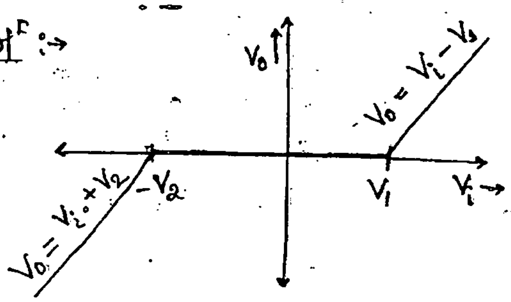


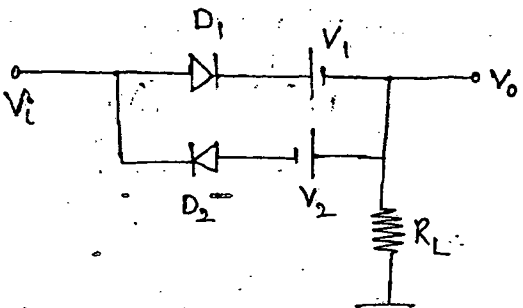
⊡ APPLICATIONS

Q:→ Design a noise eliminator ckt with the given i/p.



Sol^n :→





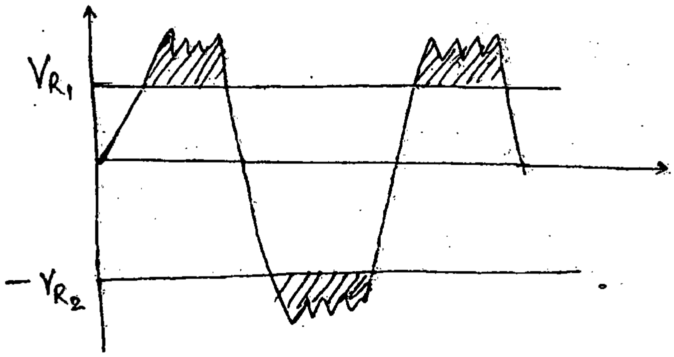
$V_i < -V_2$; D_1 OFF , D_2 ON ; $V_o = V_i + V_2$

$-V_2 < V_i < V_1$; D_1 OFF , D_2 OFF ; $V_o = 0$

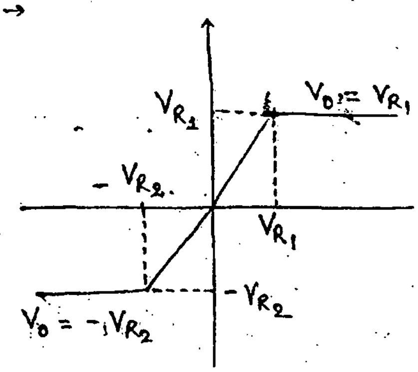
$V_i > V_1$; D_1 ON ; D_2 OFF , $V_o = V_i - V_1$

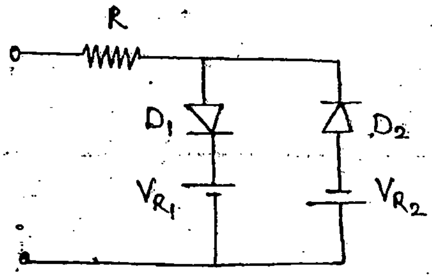
Two independent level clipping :- $V_{R_1}(D_1) > V_{R_2}(D_2)$

Question :- Design a noise eliminator crt with the given i/p.



Sol^n :-



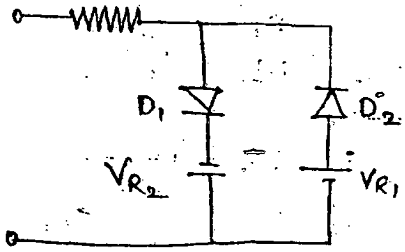


$V_i < -V_2$; D_1 OFF, D_2 ON ; $V_0 = -V_{R_2}$

$-V_2 < V_i < V_1$; D_1 OFF, D_2 OFF ; $V_0 = V_i$

$V_i > V_1$; D_1 ON, D_2 OFF ; $V_0 = V_{R_1}$

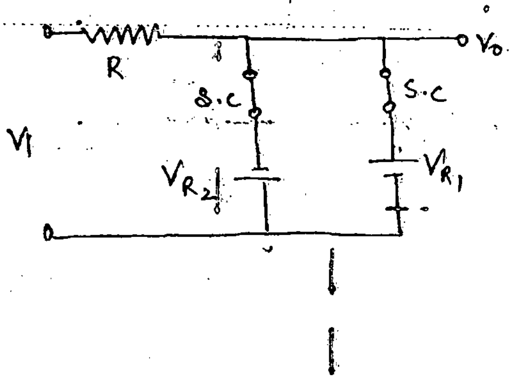
NOTE :-

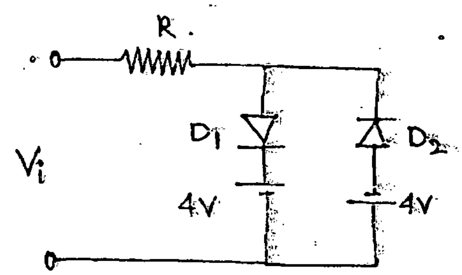
* 

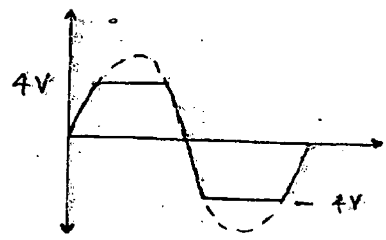
$V_{R_2}(D_1) < V_{R_1}(D_1)$

NOT VALID X

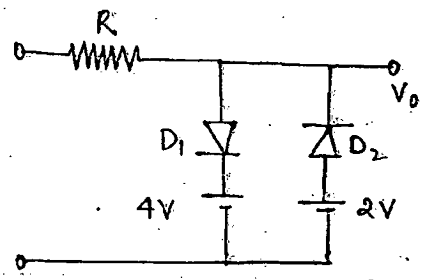
$-V_{R_2} < V_i < V_{R_1}$ D_1 ON D_2 ON



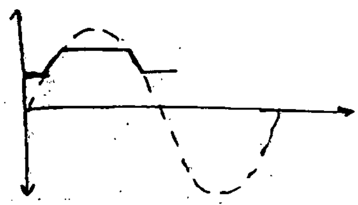




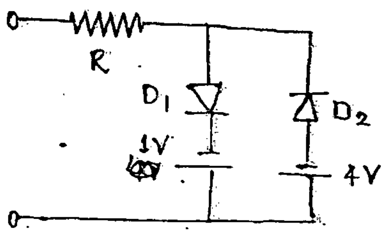
$V_{R_1} > V_{R_2}$

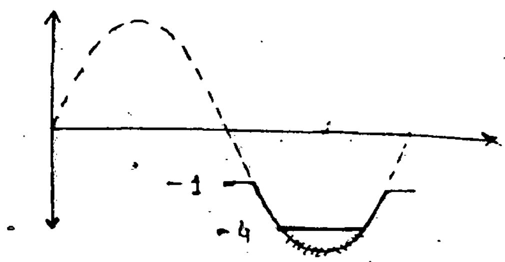


4V > 2V.



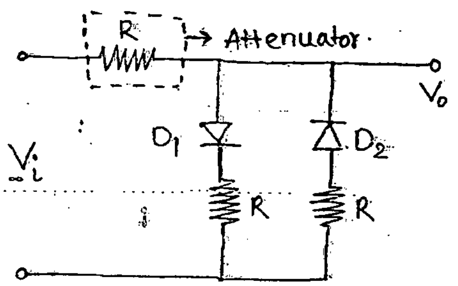
$V_{R_1} > V_{R_2}$





$V_{R_1} > V_{R_2}$.

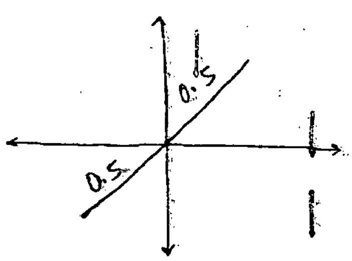
ATTENUATOR.

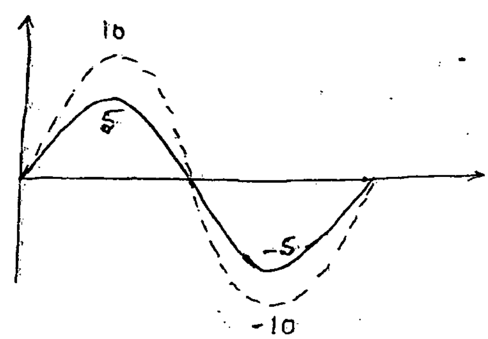


Conditions :-

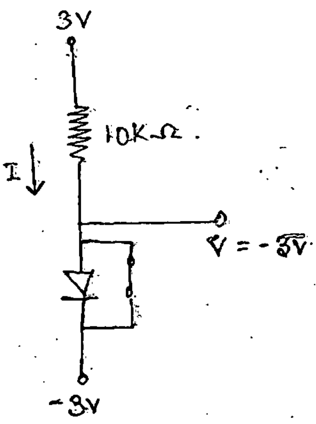
$V_i < 0$; D_1 OFF , D_2 ON ; $V_0 = \frac{V_i}{2}$

$V_i > 0$; D_1 ON , D_2 OFF ; $V_0 = \frac{V_i}{2}$



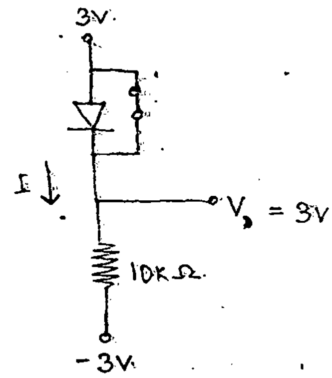


SINGLE BRANCH DESIGN.



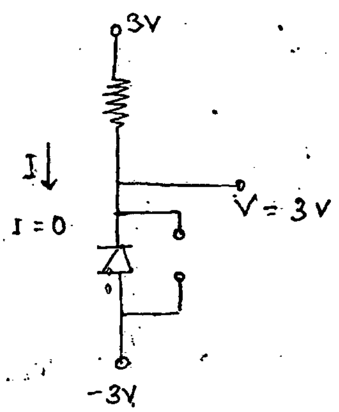
$I = \frac{3-(-3)}{10K}$

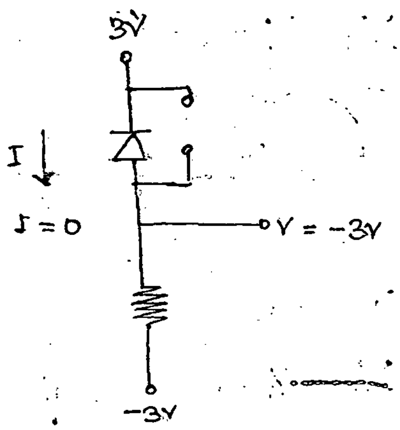
$I = 0.6mA$



$I = \frac{3-(-3)}{10K}$

$I = 0.6mA$.

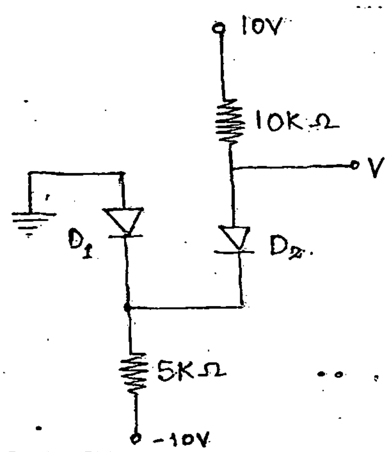




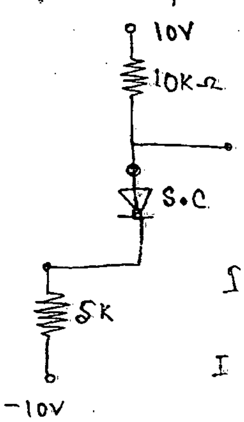
CONCLUSION :-

In any single branch ckt current will be same but voltage may be different.

MULTI BRANCH DESIGN.



STEP-I :- Assume D_1 OFF, D_2 ON.

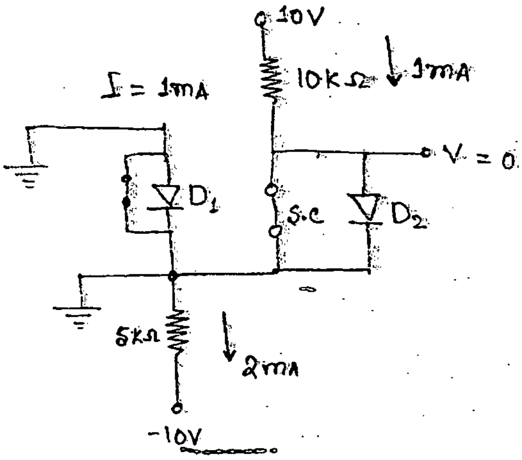


$V_o = 10 - 10K \times 1.33$
$= -3.3V$

$I = \frac{10-(-10)}{15K}$

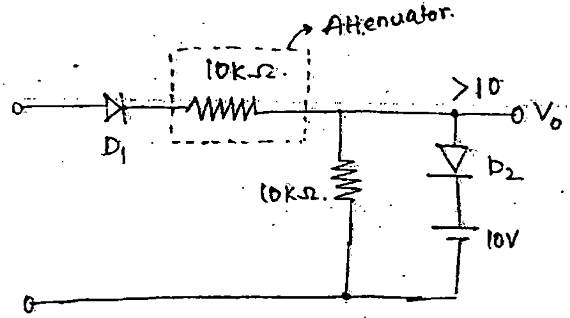
$I = 1.33mA$.

Step 2 :- Connect D_1.



Ch-3

Q1 :-



* Identify the Reference

Here → 2 two Reference

* Identify Slope is present or not.

Here → yes.

1^{st} Reference = 0 → For D_1

2^{nd} " = 10V → For D

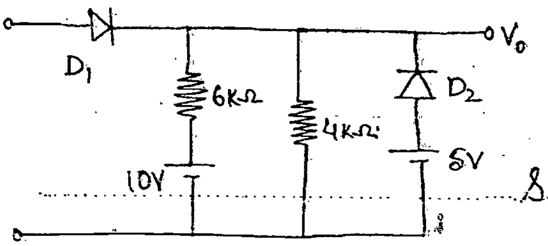
$V_i < 0$; D_1 OFF , D_2 OFF ; $V_o = 0$.

$0 < V_i < 20$; D_1 ON , D_2 OFF ; $V_o = \frac{V_i}{2}$

$V_i > 20$; D_1 ON , D_2 ON ; $V_o = 10$

∴ (C) Ans

Q7.

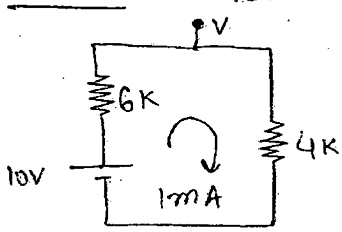


Reference for D_1 = 10 & 0.

Reference for D_2 = 5V

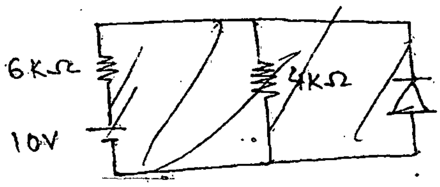
Solve by multiple Branch.

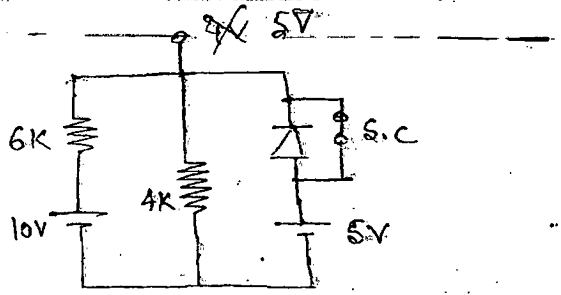
Case-I :- Assume D_1 and D_2 OFF



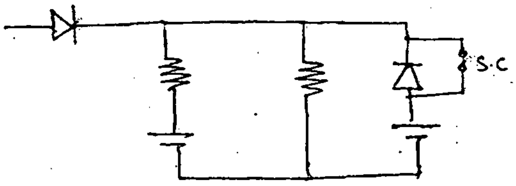
V = 4K.

Case 2 :-



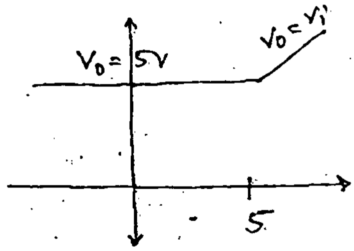


Case 3 :-

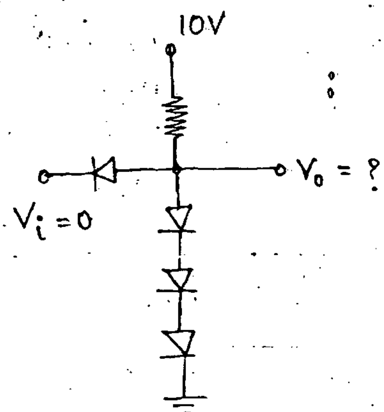


$V_i < 5V$ D_1 OFF D_2 ON $V_o = 5V$

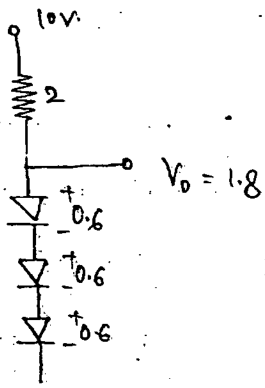
$V_i > 5V$ D_1 ON , D_2 OFF $V_o = V_i$

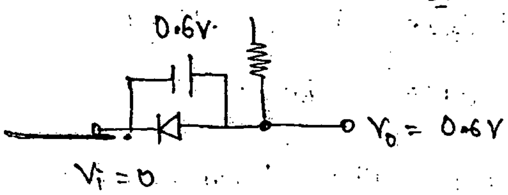


Q11.



⇒





∴ (a)

Q 13, 14, 15, 8, 12.