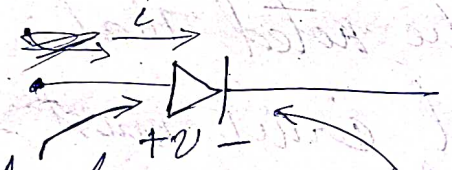
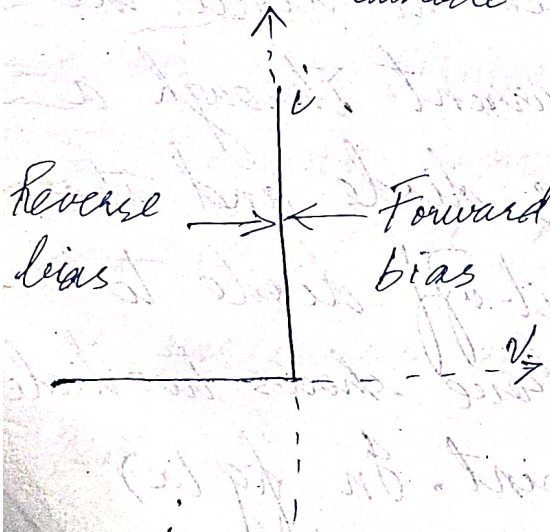
Semiconductor $10^{-8}\ \Omega$-m to $10^{6}\ \Omega$-m

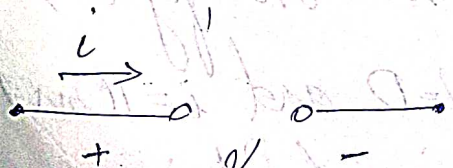
Diodes

The simplest and most fundamental non-linear circuit element is the diode. Just like a resistor, the diode has two terminals; but unlike the resistor which has a straight line relationship between the current flowing through it and the voltage appearing across it, the diode has a non-linear characteristic.

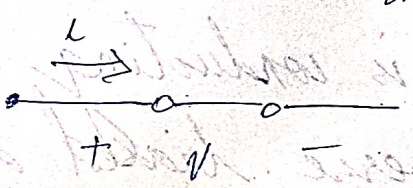
The Ideal Diode: The ideal diode may be considered the most nonlinear circuit element. It is a two terminal device having the circuit symbol as shown in adjacent figure as well as the IV characteristic shown. The terminal characteristic of the ideal diode can be interpreted as follows: If a negative voltage is applied to the diode,







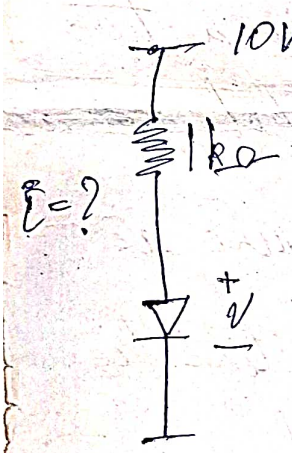
$v < 0 \Rightarrow i = 0$



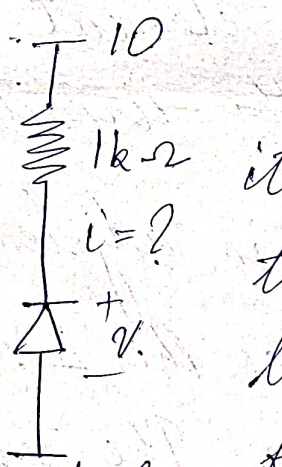
$i > 0 \Rightarrow v = 0$

no current flows and the diode behaves as an open circuit. Diodes operated in this mode are said to be reverse biased, or operated in the reverse direction and is said to be cut-off or simply off.

On the other hand, if a positive current is applied to the ideal diode, zero voltage appears across the diode. In other words the ideal diode behaves as a short circuit in the forward direction, it passes any current with zero voltage drop. A forward biased diode is said to be turned on or simply on.



FB diode ckt (a)



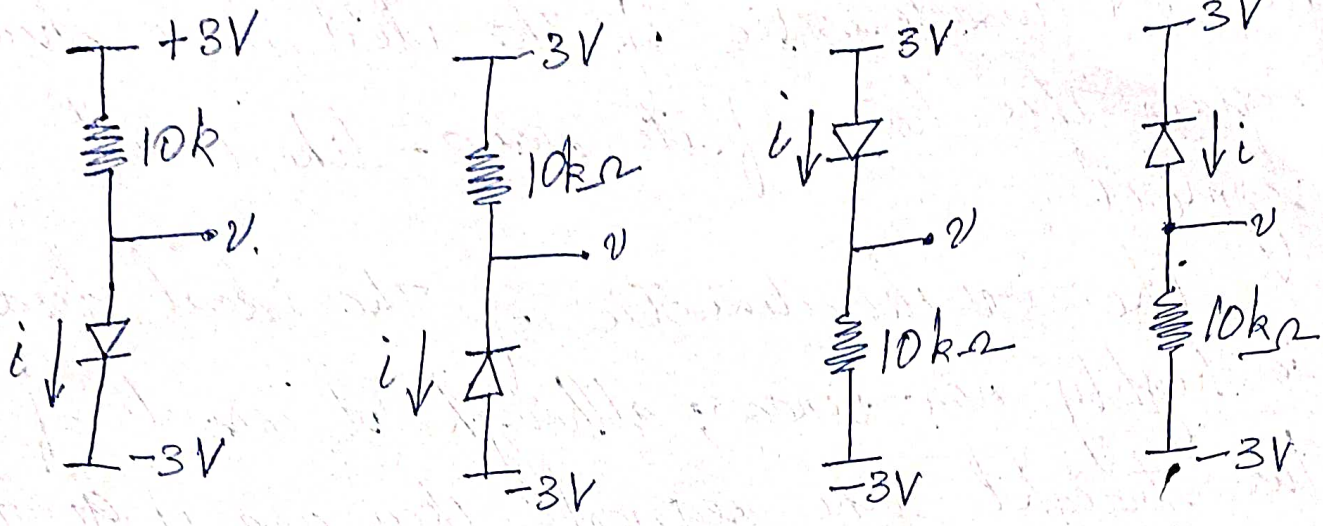
RB diode ckt (b)

From the above description it should be noted that the external circuit must be designed to limit the forward current through a conducting diode and the reverse voltage across a cut-off diode to predetermined values. Figure above shows two diode circuits that illustrate this point. In fig (a) the diode is conducting and $v=0$ and $i=10$ mA. For the reverse biased diode is cut off ie $v=10$ V and $i=0$ A.

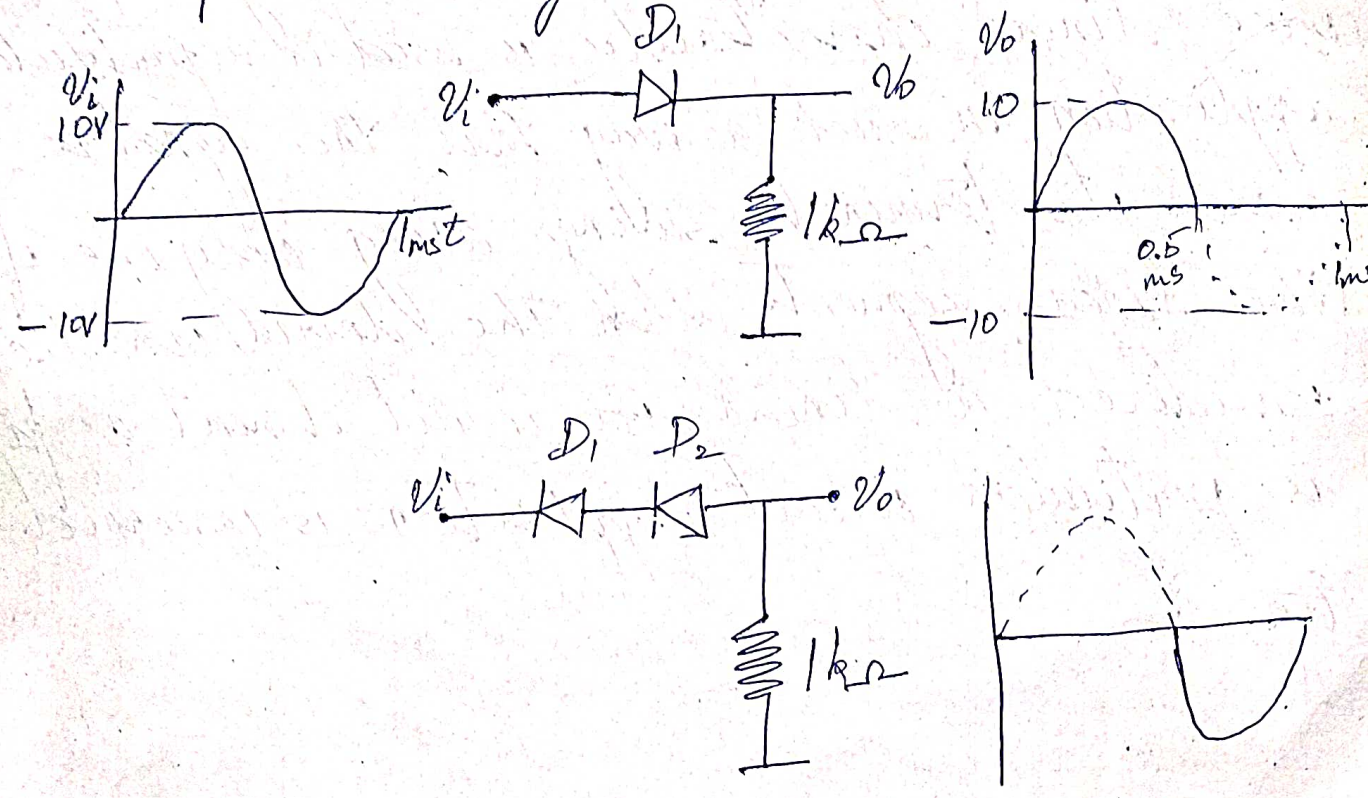
The positive terminal of the diode is called the anode and the negative terminal the cathode. The i-v characteristic of the ideal diode should explain this choice of its arrow-like circuit symbol.

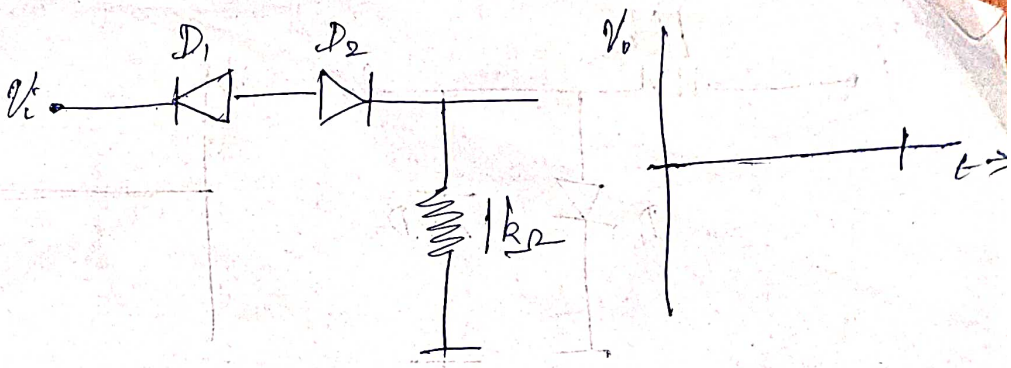
The i-v characteristic of the ideal diode is highly non-linear; although it consists of two straight line segments, they are of 90° to each other. A non linear curve that consists of straight-line segments is said to be piecewise linear. If a device having a peicewise linear characteristic is used in a particular application in such a way that the signal across its terminals swings along only one of the linear segments then the device can be considered a linear circuit element as far as particular circuit application is concerned.

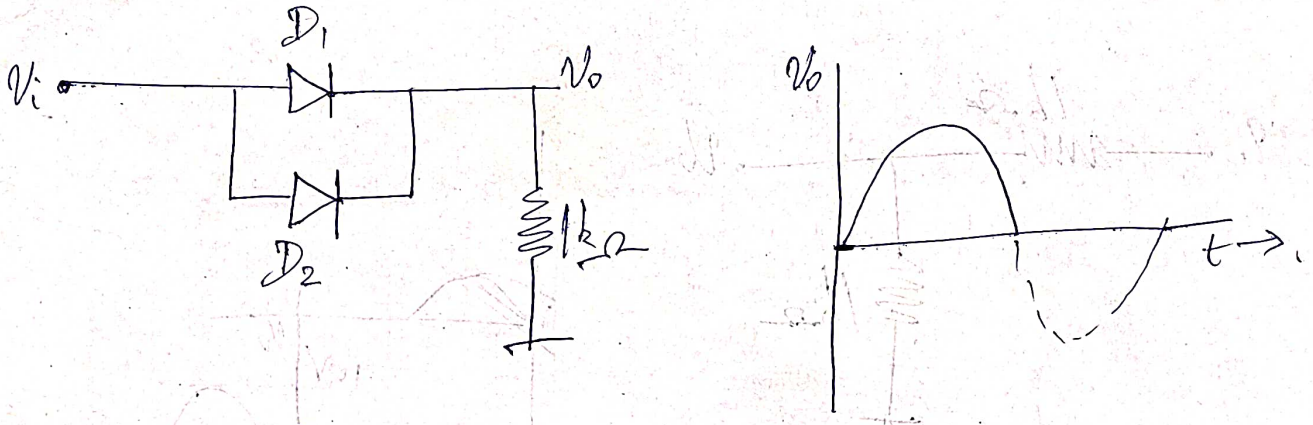
Prob: For the circuits shown in figure ~~below~~ using ideal ~~circuits~~ diodes find the voltages and currents indicated.

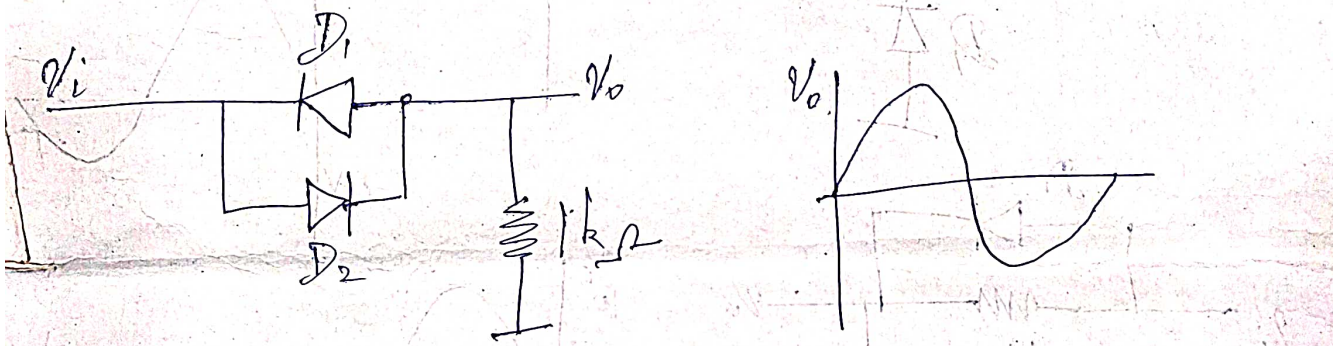


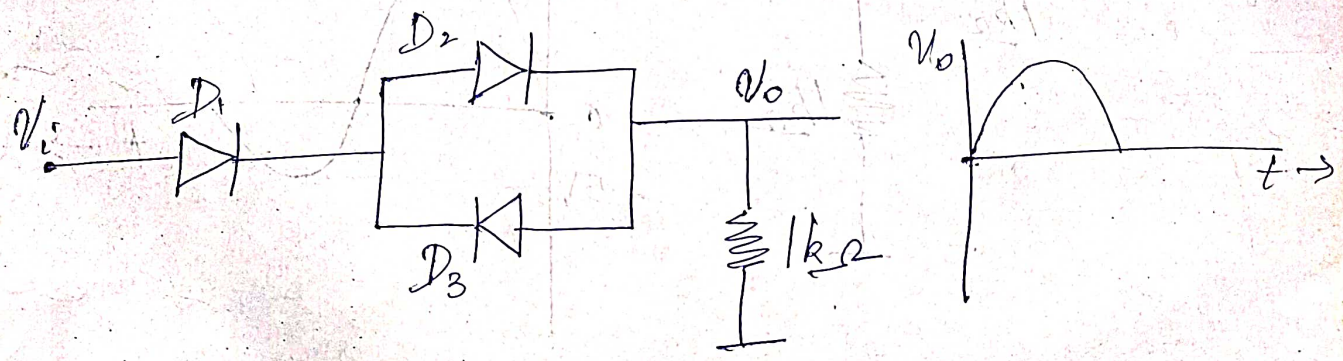
Prob 4 In each of the diode circuits shown in figure v_i is 1kHz, 10V peak sine wave. Sketch the waveform resulting at v_o.

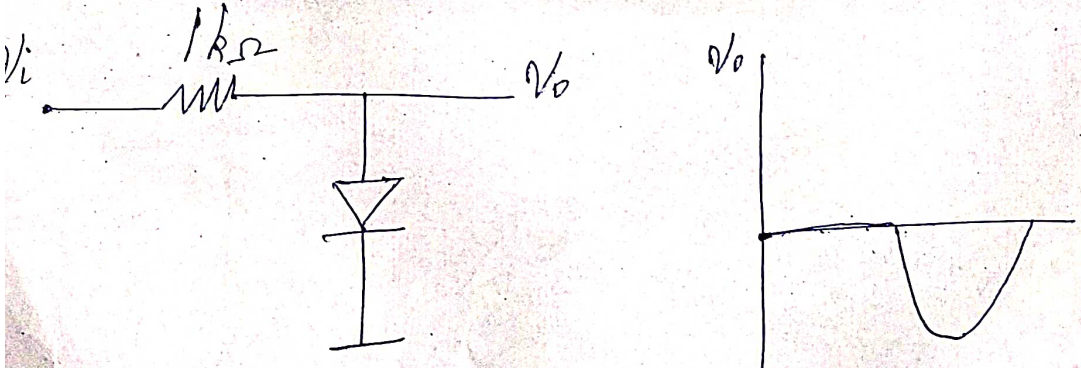


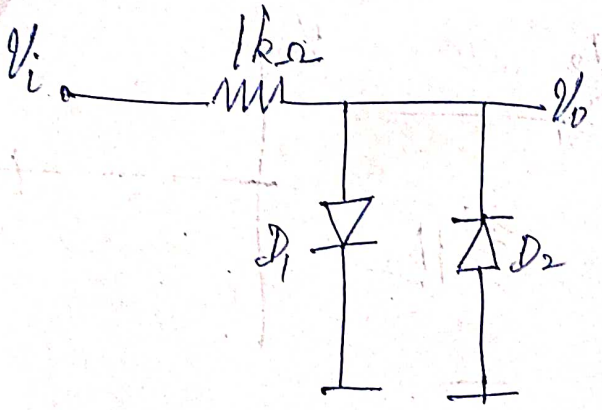

D_1
D_2
V_i
1 kΩ
V_o
t →

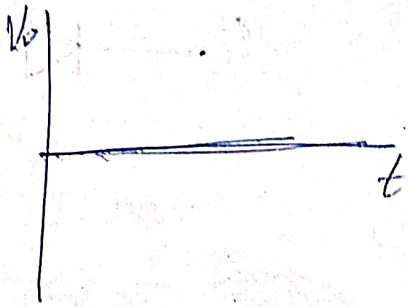

D_1
V_i
V_o
D_2
1 kΩ
V_o
t →

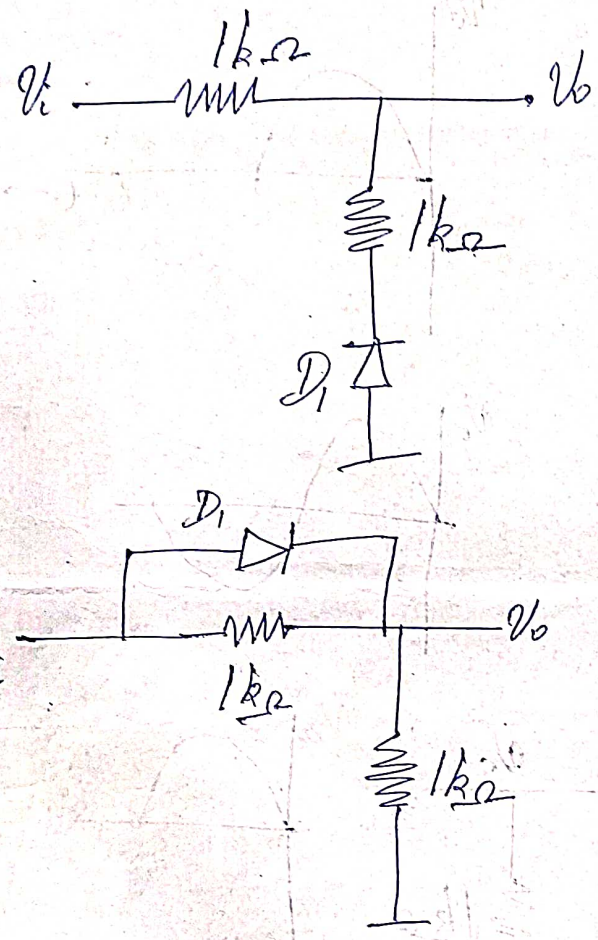

V_i
D_1
V_o
D_2
1 kΩ
V_o
t →

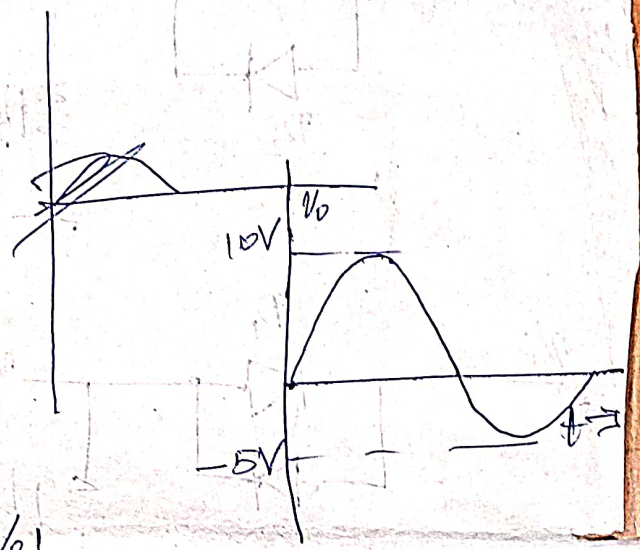

D_2
V_i
D_1
V_o
D_3
1 kΩ
V_o
t →

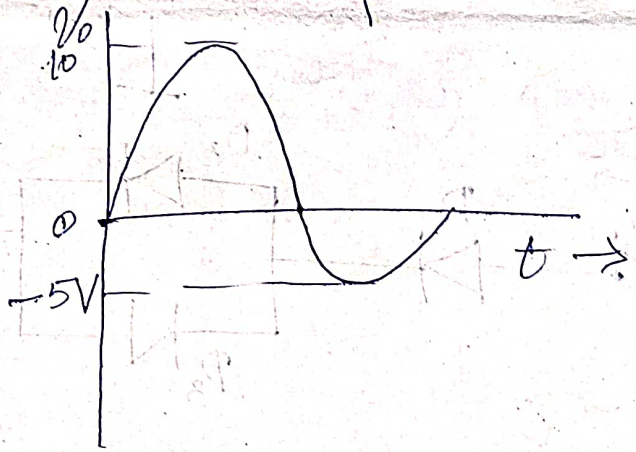

V_i
1 kΩ
V_o
V_o


V_i
1kΩ
V_o
D_1
D_2


V_o
t


V_i
1kΩ
V_o
1kΩ
D_1
D_1
V_i
V_o
1kΩ
1kΩ

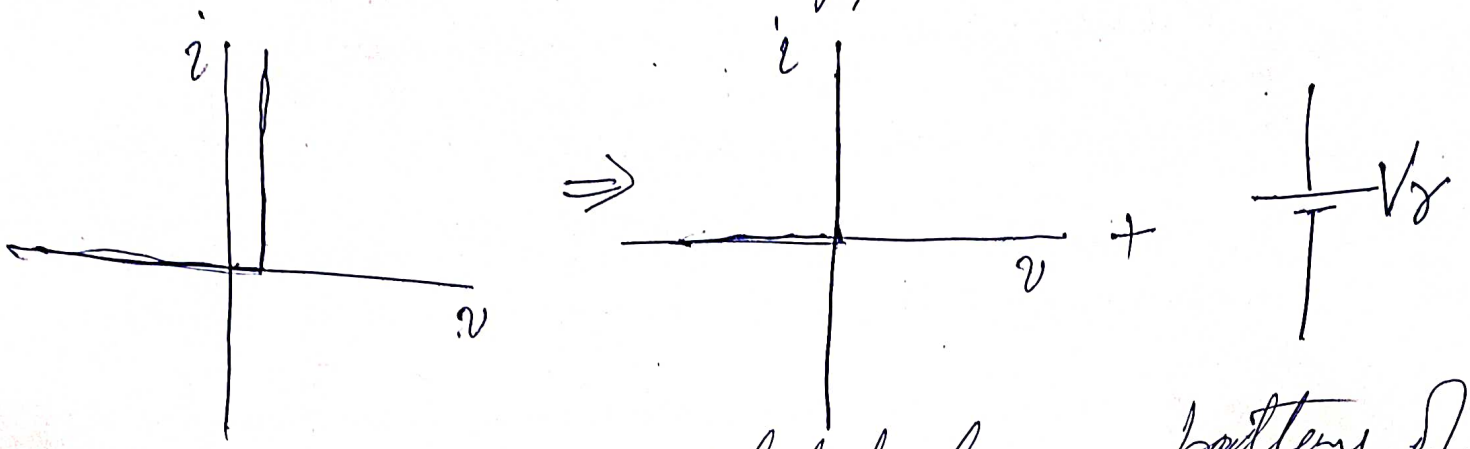

V_o
10V
-5V
t


V_o
10
0
-5V
t

Real diodes (Practical Diodes) as Ideal diodes

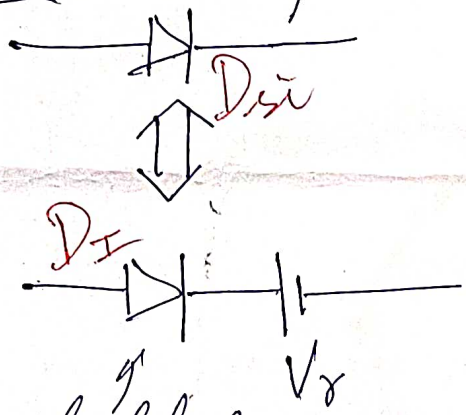
Extension.

If the applied voltages are large the practical diode characteristics can be approximated as



practical diode ideal diode battery of voltage V_γ

Practical diode replacement:



ideal diode.