2/2/2020

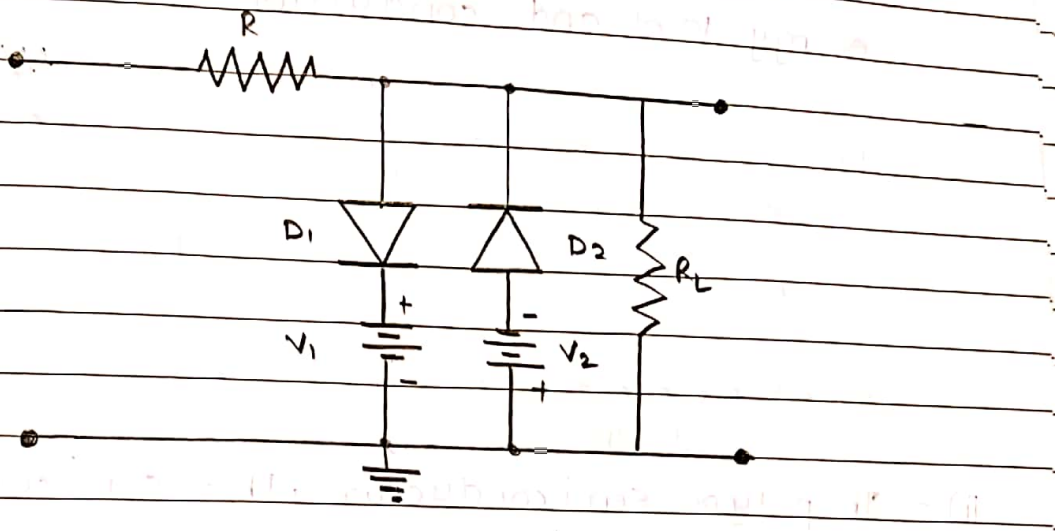
PEE : Graded Assignment 1

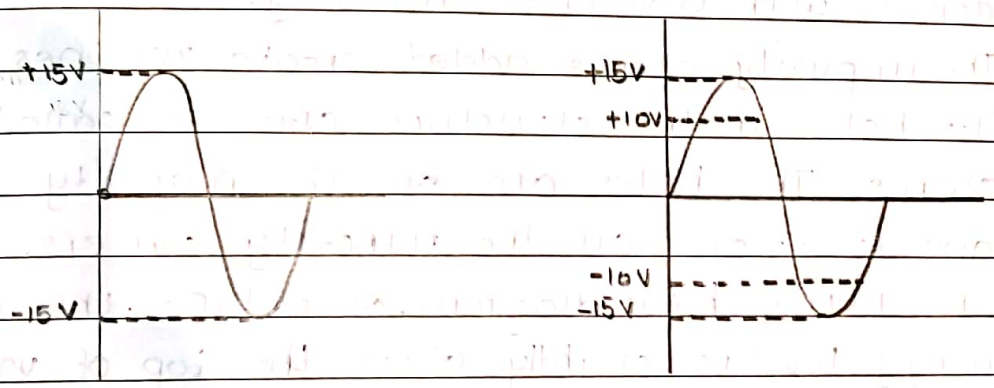
Q1:) Double ended clipper:-

A circuit that can be used to limit the peaks of both half cycles of an A.C input signal is called double ended clipper.

Ideal Diode:-

$V_\gamma = 0$ (The diode has zero volts is considered as ideal diode)





INPUT WAVEFORM

OUTPUT WAVEFORM

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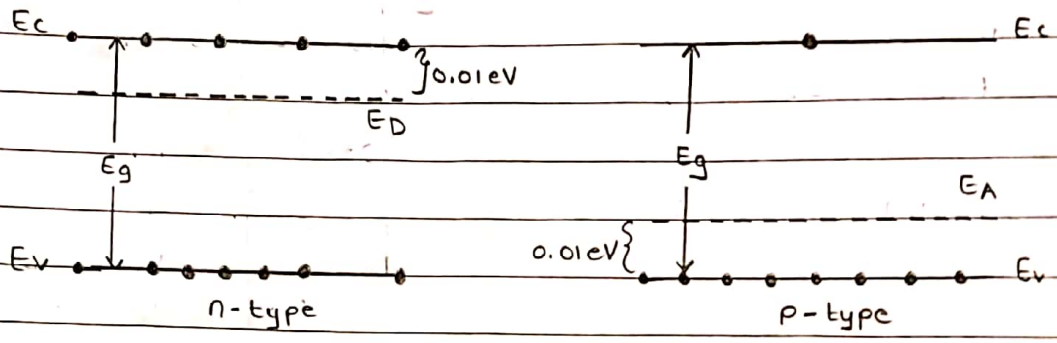
Q2.) i) - In n-type semiconductor, the semiconductor is doped with pentavalent impurity.
- The electrons are majority carriers and holes are minority carriers. In energy band diagram of n-type semiconductor, the donor energy level is slightly below the bottom of conduction band and thus, the electron can move to conduction band; even with small supply of energy.
- The fermi-energy level lies in between the donor energy level and conduction band



ii.) - In p-type semiconductor, the semiconductor is doped with trivalent impurity.
- The impurity atoms added, create vaccines of electron (i.e holes) in the structure and are called acceptor atoms. The holes are ~~are~~ the majority carriers and electrons are the minority carriers.
- In energy band diagram of p-type, the acceptor energy level is slightly above the top of valence band
- Thus, even with small supply of energy, electron from valence band can jump to level and ionise the acceptor, negatively.
- The Fermi-energy level lies in between the acceptor energy level and valence band.

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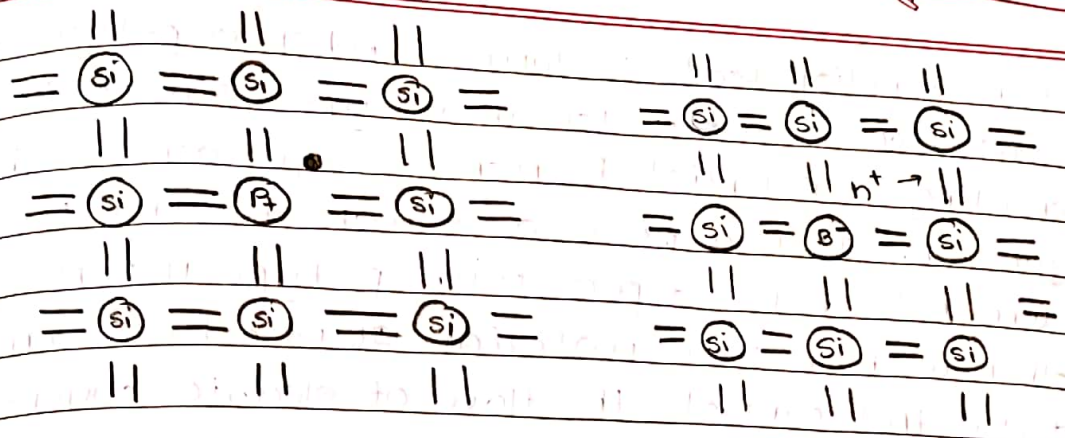
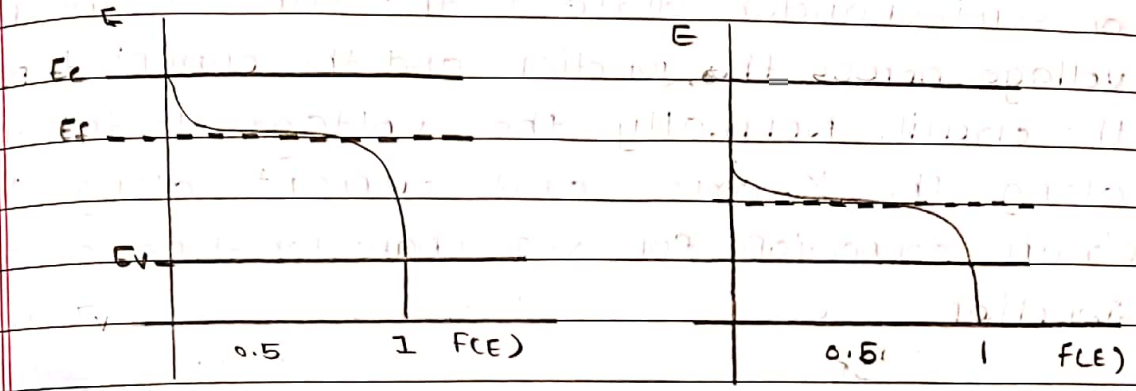


n-type

→ Effect of doping on fermi level.



n- type

p- type

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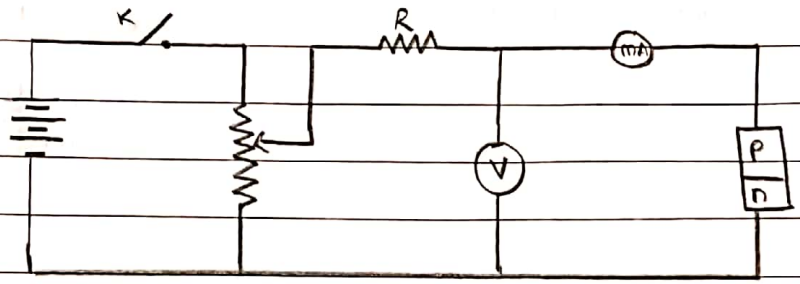
Q3) P-N Junction Diode is formed when a p-type semiconductor is fused to an n-type semiconductor creating a potential barrier voltage across the diode junction. It is a piece of silicon having two terminals, one doped with p-type material and other with n-type material. It is a basic semiconductor device that controls the flow of electric current in the circuit

- V-I characteristics of PN Junction Diode:-

Volt-ampere (V-I) characteristics of a pn junction or semiconductor diode is the curve between voltage across the junction and the current through the circuit. Normally the voltage is taken along the X-axis and current along Y-axis.

- Circuit connection for V-I characteristics of a p-n Junction.



The characteristics can be explained under three cases

1) Zero bias
2) Forword bias
3) Reverse bias

- Case 1: Zero Bias

In zero bias condition, no external voltage is applied to the pn junction i.e the circuit is open at K. Hence, the potential barrier at the junction does not permit current flow. Therefore, the circuit current is zero at V = 0V.

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- **Case 2 : Forward Bias**

In forward biased condition, p-type of the pn junction is connected to the positive terminal and n-type is connected to the negative terminal of the external voltage. This results in reduced potential barrier.

→ From forward characteristics, it can be noted that at first i.e region OA, the current increases very slowly and the curve is non-linear. It is because in this region the external voltage applied to the pn junction is used in overcoming the potential barrier. However, once the external voltage exceeds the potential barrier voltage, the potential barrier is eliminated and the pn junction behaves as an ordinary conductor. Hence, the curve AB rises very sharply with the increase in external voltage and the curve is ~~at~~ almost linear.

- **Case 3 : Reverse Bias**

In reverse bias condition, the p-type of the pn junction is connected to the negative terminal and n-type is connected to the positive terminal of the external voltage. This results in increased potential barrier at junction. Hence, the junction resistance becomes very high and as a result paractically no current flows through the circuit. However, a very small current of the order uA flows in the circuit which is known as saturation current (I_S) and is due to the minority carriers in the junction. A break down voltage also occurs which is charaterised by a sudden increase of reverse current and a sudden fall of the resistance of barrier region.

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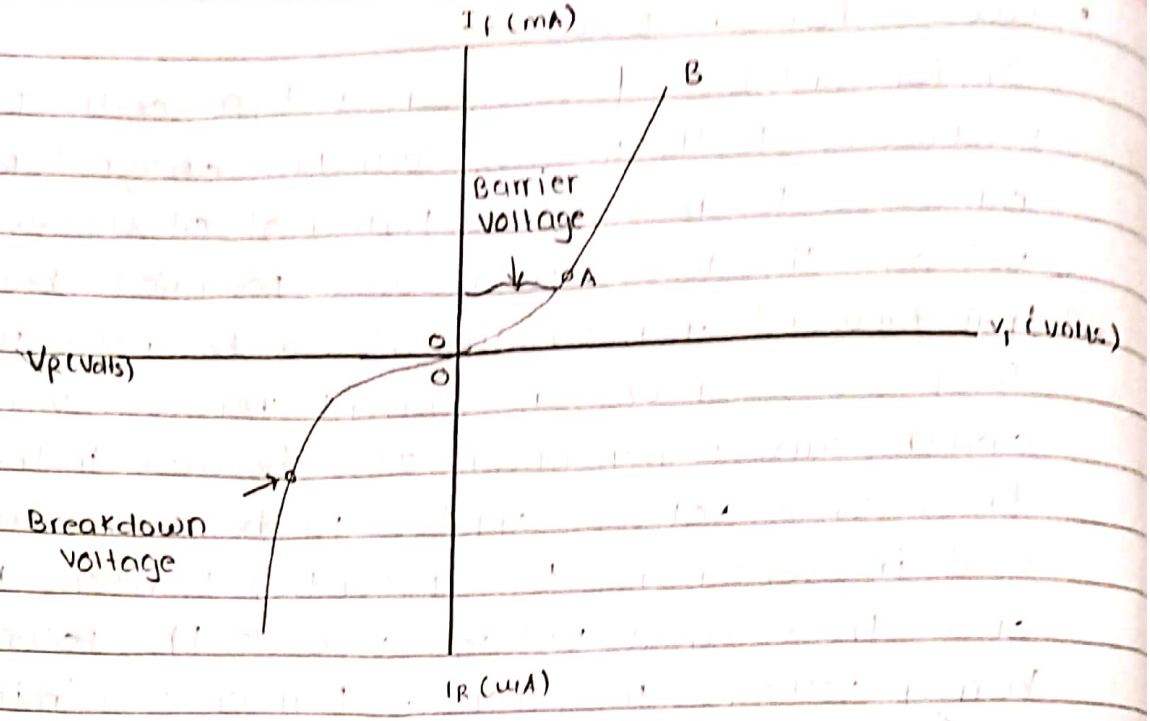
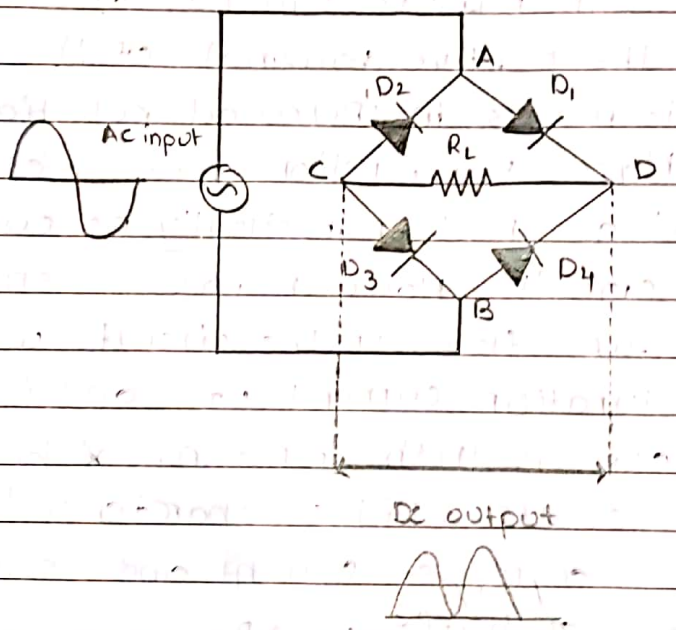


Q4) A Bridge rectifier :-

A bridge rectifier is a type of full wave rectifier which uses four or more diodes in a bridge circuit configuration to efficiently convert the Alternating current (AC) into Direct current (DC)

Construction:-



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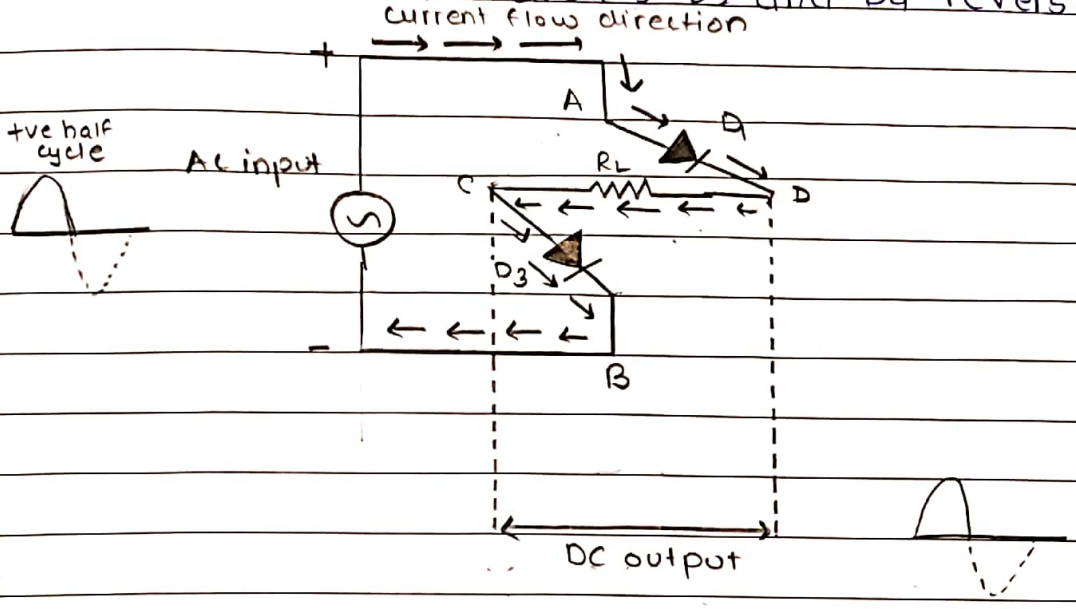
The input AC signal is applied across two terminals A and B and the output DC signal is obtained across the load resistor R_L which is connected between terminals C & D. The four diodes D_1, D_2, D_3, D_4 are arranged in series with only two diodes allowing electric current during each half cycle.

→ ~~During~~ Bridge rectifier during positive half cycle.
During +ve half cycle, the terminal A becomes positive while B becomes negative. This causes the diodes D_1 and D_3 forward biased and at the same time, it causes the diodes D_2 and D_4 reverse biased.



→ Bridge rectifier during negative half cycle:-
During negative half cycle, terminal B becomes +ve and terminal A becomes −ve. This causes the diodes D_2 and D_4 forward biased and at the same time, it causes the diodes D_1 and D_3 reverse biased. ~~The current~~

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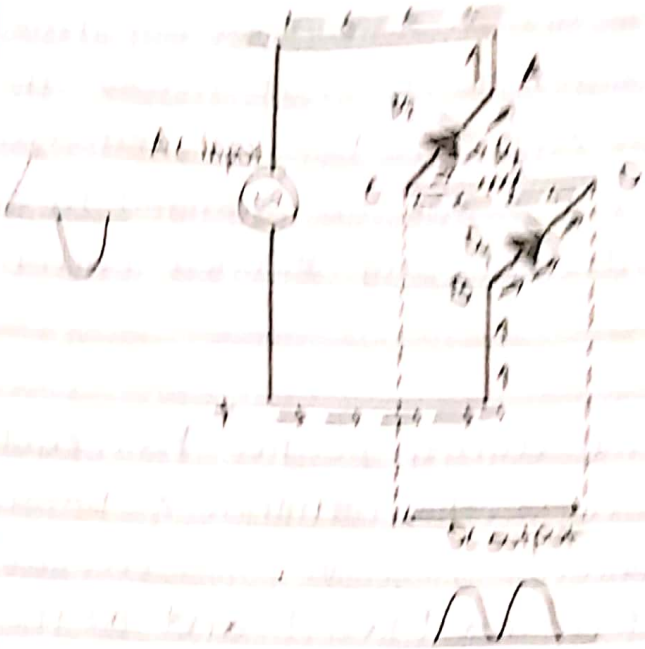

PEE : Research Assignment 1 (voluntary)

Q1.) Diode capacitance consists of 2 components Junction capacitance and diffusion capacitance. Junction capacitance is also known as transition capacitance. We know the capacitors store electric charge in the form of electric field. This charge storage is done by using two electrically conducting plates seperated by an insulating material dielectric.

→ Junction capacitance comes from the depletion region. There is junction capacitance in both forward and reverse bias.

→ Diffusion capacitance only exists in forward bias. This is a non linear capacitor; and it is difficult to model. The capacitance comes from stored charge due to minority carriers diffusion current.

Q2.) In depletion region, the electric charges do not move from one place to another place. However, they exert electric field or electric force. Therefore, charge is stored at the depletion region in the form of electric field. The capacitance at the depletion region changes with the change in applied voltage. When reverse bias voltage applied to the p-n junction diode is increased a large number of holes (majority carriers) from p-side and electrons (majority carriers) from n-side are moved away from the p-n junction. As a result, the width of depletion region increases whereas the size of p-type and n-type regions (plates) decreases.

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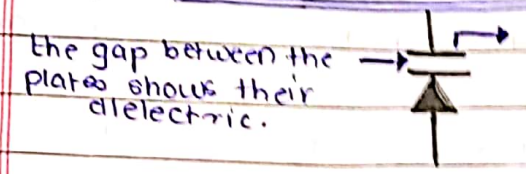
Q3) Varactor Diode:

The diode whose internal capacitance varies with the variation of the reverse voltage such type of diode is known as the varactor diode. It is used for storing the charge. The varactor diode always works in reverse bias, and it is a voltage dependent semiconductor device. Varactor diode is known by several names as varicap, voltcap voltage variable capacitance or tunning diode.

→ Rep symbol of Varactor Diode.



The diode has two terminals: anode and cathode.

→ Varactor Diode Formulae:

- Capacitance of Varactor Diode $C_j = \frac{CK}{(V_b - V)^m}$
- Quality factor of the Varactor Diode $Q = \frac{F}{f}$

C_j → Diode capacitance
C → Diode capacitance when device is unbiased
V → applied voltage
V_b → barrier voltage at the junction
m → constant depending upon the material
k → constant equal to 1
F → Maximum operating frequency
f → Operating frequency

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