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1. State the difference between
a) Avalanche and Zener breakdown
b) Drift and diffusion current

a) Avalanche and Zener breakdown

S.No	Avalanche breakdown	Zener breakdown
1.	The process of applying high voltage and increasing the free electrons or electric current in semiconductors and insulating materials is called an avalanche breakdown.	The process in which the electron move across the barrier from the valence band of p-type material to the conduction band of n-type material is known as zener breakdown.
2.	The increase in temperature increases the breakdown voltage.	The increase in temperature decreases the breakdown voltage.
3.	The VI Characteristics curve of the avalanche breakdown is not as sharp as the zener breakdown.	The VI characteristics of a zener breakdown has a sharp curve.
4	It occurs in diodes that are highly doped.	It occurs in diodes that are lightly doped.
5	The potential barrier is destroyed in this case.	The potential barrier is not destroyed in this case.

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b) Drift and diffusion Current

S.N.	Drift current	Diffusion Current
1.	It is due to the movement of carriers in response to an implemented electric field.	The motion of charge carriers from higher concentration to lower concentration produces diffusion current.
2.	Positive carriers or holes flow in the same direction as the electric field, while negative carriers or electrons flow in the reverse direction.	When a semiconductor is doped non-uniformly, there is a non-uniform concentration of carriers or a concentration gradient.
3.	The drift velocity rises with an increasing electric field and raises the mobility of the transmitters.	The repulsive forces will drive carriers diffusion, leading to a variation in concentrations and eventually a uniform arrangement.
4.	It requires electrical energy for the process of drift current.	Some amount of external energy is enough for the process of diffusion current.
5.	The direction of this current mainly depends on the polarity of the applied electric field.	The direction of this current mainly depends on the charge within the concentrations of carrier.

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2. The reverse saturation current at 300K of a Ge diode is 5 microamp. Find the voltage to be applied across the junction to obtain a forward current of 50mA.

=> Soln:-

The current I for an applied voltage V is given for a Ge p-n diode by

$$I = I_s\left[\exp\left(\frac{eV}{k_BT}\right) - 1\right]$$

Here,

$I = 50mA = 50 \times 10^{-3} A$

$I_s = 5\mu A = 5 \times 10^{-6} A$ and $T = 300K$ so,

$$\exp\left(\frac{eV}{k_BT}\right) = \frac{I}{I_s} + 1 = \frac{50 \times 10^{-3}}{5 \times 10^{-6}} + 1 = 10^4$$

$$V = \frac{k_BT}{e} \ln 10^4 = \frac{1.38 \times 10^{-23} \times 300}{1.6 \times 10^{-19}} \times 2.303 \times 4$$

$$= 0.238V$$

So, the required voltage is 0.238 V.

3) A centre tap full wave rectifier uses two diodes with an equivalent forward resistance 50Ω. If the input a.c voltage is 10 sin(200πt) and the load resistance of 950Ω calculate.

i) Peak, average and r.m.s value of current

ii) Efficiency

iii) Ripple factor.

=> Soln:-

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$V = V_m \sin\omega t$ — (i)

$V = 10 \sin(200\pi t)$ — (ii)

V = voltage at time 't'

$R_f = 50\Omega$

$R_L = 950\Omega$

By comparing eqn (i) & (ii), we get,

$V_m = 10V$, $\omega = 200\pi$

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = 5\sqrt{2}\,V$$

$$I_{max}(I_m) = \frac{V_m}{R_f + R_L}$$

$$= \frac{10}{50 + 950} = 0.01A$$

$$I_{av} = I_{dc} = \frac{2I_m}{\pi}$$

$$= \frac{2 \times 0.01}{\pi} = 6.366 \times 10^{-3} A$$

$$I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{0.01}{\sqrt{2}} = 7.07 \times 10^{-3} A$$

$$\eta = 81.3 \times \frac{R_L}{R_f + R_L}$$

$$= 81.3 \times \frac{950}{50 + 950}$$

$$= 77.235\,\%$$

$$\gamma = \sqrt{\frac{I^2_{AC}}{I^2_{DC}} - 1}$$

$$= \sqrt{\frac{(7.07 \times 10^{-3})^2}{(6.366 \times 10^{-3})^2} - 1}$$

$$= 0.48$$

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4. Explain the characteristics of a zener diode and discuss how it can be used as voltage regulator.

=> A zener diode is a special type of diode designed to operate in the reverse breakdown region of its voltage-current characteristic curve. It is designed to maintain a constant voltage across its terminals over a wide range of currents.

The characteristics of a zener diode are as follow:-

1. Breakdown voltage:- The zener diode is designed to operate in the breakdown region, which is called the zener breakdown region. At a certain voltage, the diode starts to conduct heavily in the reverse direction, allowing current to flow through it.

2. Voltage regulation:- The zener diode can maintain a constant voltage across its terminals over a wide range of current variations. This makes it an ideal device for voltage regulation.

3. Low zener impedance :- The zener diode has a low zener impedance, which means it can pass a large current for a small change in voltage.

4. High stability :- The zener diode has high stability in terms of its voltage regulation characteristics. This mean that it can maintain a constant voltage across its terminals over a wide range of temperature and load variations.

Zener diode can be used as voltage regulator in two different ways:. as a shunt regulator or as a series regulator. In a shunt regulator, the Zener diode is connected in parallel with the load, while in a series regulator, the zener diode is connected in series with the load.