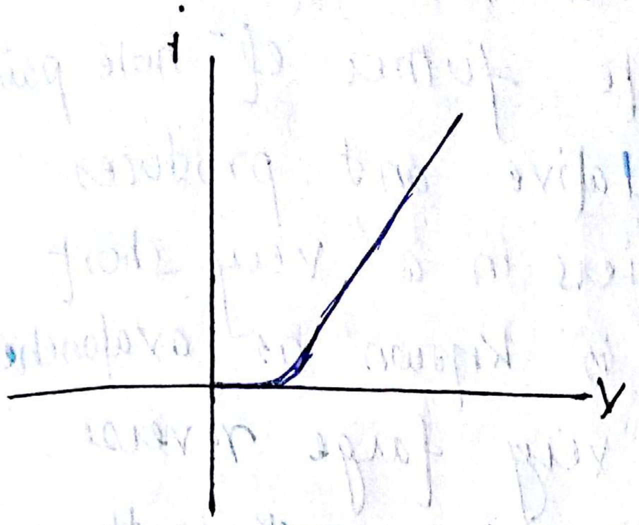
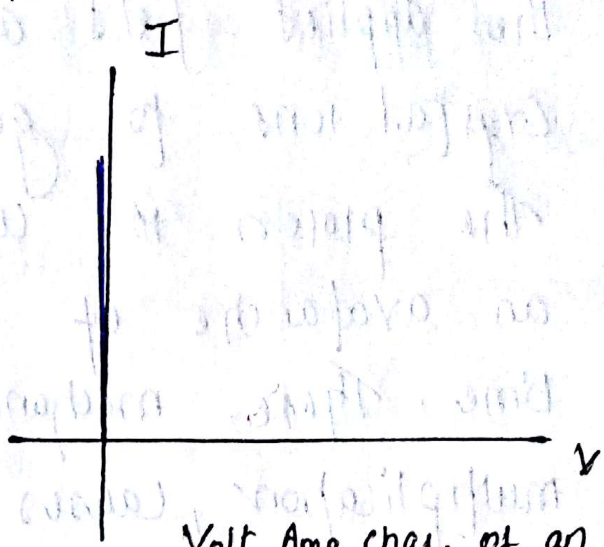
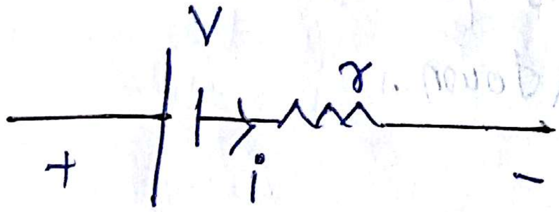
Piecewise linear approximation





Volt Amp char. of an ideal diode



equivalent circuit of conducting junction diode

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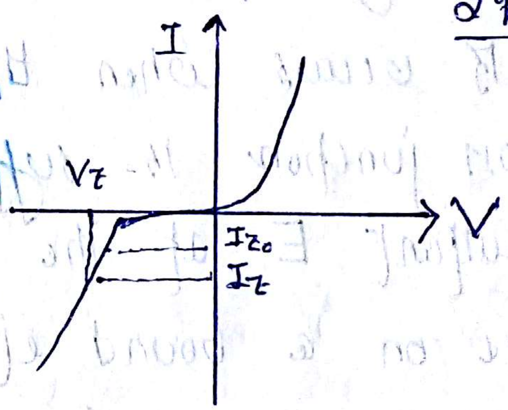


Special diodes

a) Breakdown diodes

i) Avalanche Breakdown:

With increasing reverse bias voltage, the E across the pn diode increases. At a certain reverse bias, the E imparts a sufficient high energy to a thermally generated carrier crossing the junction. The carrier, on colliding with a crystal ion on its way disrupts a covalent bond and produces a new e⁻ hole pair.

These carriers can also gain sufficient energy from the applied field and collide with other crystal ions to generate further el⁻ hole pairs. The process is cumulative and produces an avalanche of carriers in a very short time. These mechanism is known as avalanche multiplication, causes a very large reverse current, the diode is said to work in the region of avalanche breakdown.

2) Zener Breakdown:

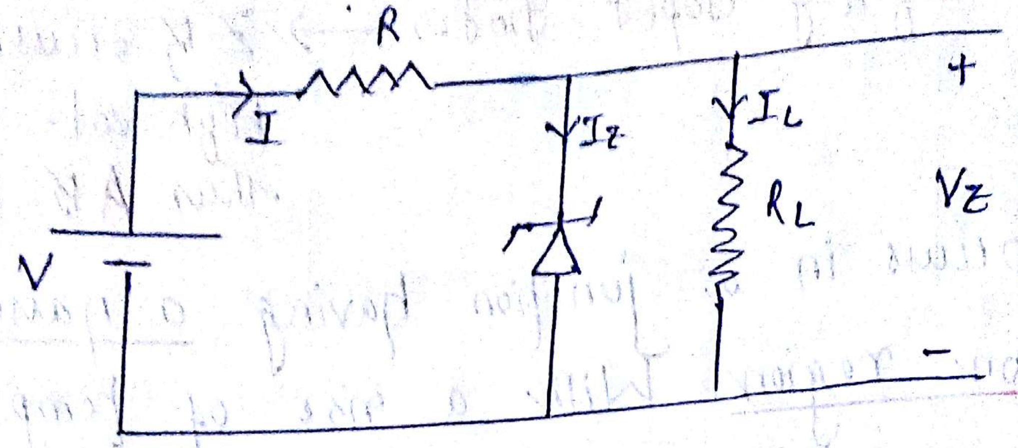
Z.B occurs when the reverse bias vol. across a pn junction is sufficiently high so that the resultant E at the junction exerts a large force on a bound el⁻ to tear it out of its covalent bond. Thus a direct rupture of the covalent bonds produces a large no. of el⁻ hole pairs, thereby increasing the reverse current. This process is referred to as Zener breakdown. Unlike AB, ZB does not originate from the collision of carriers with the crystal ions.

Note: Heavily doped diodes → ZB occurs at vol. below 6V.

lightly doped diodes → ZB occurs at very high vol. Thus AB is predominant

ZB occurs in a junction having a narrow depletion region. With a rise of temp, the energy of the valence el⁻ increases so that the lower applied vol. can pull these el⁻ out of their covalent bonds. So, the ZB vol (which is less than 6V) decreases with increasing temp. i.e the temp coeff of the ZB vol is negative. On the other hand AB takes place in a junction having a wide depletion layer. With a rise of temp, the crystal ions vibrate with a greater amplitude increasing the possibility of collisions of the carrier and the crystal ions. The carriers thus have less opportunity to pick up enough energy b/w collisions to trigger the avalanche process consequently, the AB vol. (which is higher than 6V) Increases with the rise of temp. Thus temp coeff. is +ve.

Q15) Why Zener diode is said to work as a reference diode ?



It is because dc resistance r_Z i.e V_Z/I_Z is small, the vol. across the Zd changes very little for a large change in the Zener current.

$$I = I_Z + I_L$$

$$V_Z = V - IR = I_L R_L$$

$I_{Zm} = W/V_Z$ where W is the power dissipation rating.

Max allowable diode current.

In ideal case V_Z remains const.

V → const

Since $\Delta V_Z = 0$ $\Delta V = 0$ $\Delta I = 0$

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

And when R_L is const

$\Delta V = R \Delta I$ since $\Delta V_Z = 0 \Rightarrow \Delta I_L = 0$

$$\boxed{\therefore \Delta I = \Delta I_Z}$$