28 May 2021 20:55

Todays topic:
Numerical on Diode equation

* Numerical 1

Find the forward current in a Si diode at a forward voltage of 0.6V, reverse saturation current of 0.1μA and temperature of 27°C $V_D = 0.6V$, $I_S = 0.1\mu A$, $V_T = 26mV$ $I_D = ?$

Now, if a reverse voltage of 10V is applied to the diode $\eta = Si = 2$

Find the reverse current flowing through the diode

Solution:

① Diode equation is

$$I_D = I_S \left(e^{\frac{V_D}{nV_T}} - 1 \right)$$

$T = 27°C = 300K$

For Si, $n = 2$ (for Si)

$$\rightarrow \frac{V_D}{nV_T} = \frac{0.6}{2 \times 26mV}$$

$$\rightarrow \frac{V_D}{nV_T} = X_1 \quad X_1 = 11.53$$

$$\rightarrow I_D = 0.1 \times 10^{-6} \times \left(e^{X_1} - 1 \right)$$

$I_D = X_2 = 10.179\ mA$

$I_D \approx X_2$ ..... Forward current in a Si diode

$$\rightarrow V_D = -10V \ ;$$

$$I_D = I_S \left(e^{\frac{-10}{2 \times 26mV}} - 1 \right)$$

$I_D = I_S (X_3 - 1)$ $X_3 = 0$

$I_D \approx -I_S = -0.1 \times 10^{-6}$ $I_D = -0.1\mu A$

$I_D = X_4$ .... reverse current in a Si diode

$V_T = \frac{KT}{q}$; $1eV = 1.6 \times 10^{-19} V$

$K = 8.617 \times 10^{-5} \frac{eV}{K}$ .... Boltzman's constant

$$V_T = \frac{8.617 \times 10^{-5} \times 1.6 \times 10^{-19} \times 300}{1.6 \times 10^{-19}}$$

$V_T = 25.851 \times 10^{-3} V$

$V_T \approx 26\ mV$ at $T = 27°C$

$I_D = I_S \left(e^{\frac{V_D}{nV_T}} - 1 \right)$

* Numerical 2

The reverse saturation current of a Ge diode at 27°C is 5μA Find the forward voltage at which the current is 25mA

Solution:

① Given: $T = 27°C = 300K$, $I_S = 5\mu A$

$I_D = 25mA$, $\eta = 1$ (for Ge)

② Diode equation is

$$I_D = I_S \left(e^{\frac{V_D}{nV_T}} - 1 \right) \ ; \ V_T = 26mV \text{ at } 27°C$$

$$I_D + I_S = I_S \, e^{\frac{V_D}{1 \times V_T}}$$

$$e^{\frac{V_D}{1 \times V_T}} = 1 + \frac{I_D}{I_S} = 1 + \frac{25 \times 10^{-3}}{5 \times 10^{-6}}$$

$$e^{\frac{V_D}{1 \times V_T}} = y1$$

$$\frac{V_D}{V_T} = \ln(y1) = y2$$

$V_D = y2 \times 26 \times 10^{-3}$

$V_D = y3$ .... Forward voltage of Ge diode