SUBJECT: BASIC ELECTRONICS

Diode Current Equation

Elementrix Classes

Diode Current Equation

The diode current equation, commonly known as the Shockley diode equation (after physicist William Shockley) , describes the current-voltage relationship in a semiconductor diode. The equation is given by:

$$I = I_s \left(e^{\frac{V}{nV_T}} - 1 \right)$$

- **I - Diode Current:**

  Represents the current flowing through the diode.

- **I_s - Reverse Saturation Current:**

- I_s is the reverse saturation current, a small current that flows when the diode is reverse-biased.
- It accounts for the minority carriers present in the semiconductor material even when there is no forward bias.
- Its value depends on the diode material and temperature.

❑ e - Euler's Number:

- e is a mathematical constant approximately equal to 2.71828.
- It is the base of the natural logarithm and appears in the exponential term of the equation.

❑ V - Voltage Across the Diode Terminals:

- V is the voltage applied across the diode terminals.
- In forward bias, V is positive; in reverse bias, V is negative.

❑ **n - Ideality Factor:**

- The ideality factor (n) is a dimensionless parameter reflecting the non-ideal behavior of the diode.
- It typically ranges from 1 to 2. For an ideal diode, n equals 1.
- A higher n value indicates increased non-ideal characteristics.

❑ **V_T - Thermal Voltage:**

- V_T is the thermal voltage, calculated as $\frac{KT}{q}$
- k (Boltzmann constant) ≈ $1.38 \times 10^{-23}\, J/K$
- q (elementary charge) ≈ $1.6 \times 10^{-19}\, C$
- T (temperature) ≈ $273\, K + 25°C = 298\, K$

Example:

An Si diode has I_s=10nA operating at 25 C. Calculate I_D for a forward bias of 0.6 V.

Solution:

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

Given: $I_s = 10 \times 10^{-9}\ A$

V_D **= 0.6 V**

n = 2

As we know, $V_T = \frac{KT}{q}$ $\boxed{T = 273\,K + 25^\circ C = 298\,K}$

$$V_T = \frac{1.38 \times 10^{-23} \times 298}{1.6 \times 10^{-19}} = 0.0257\,V$$

$$I_D = 10 \times 10^{-9} \left(e^{\frac{0.6}{2 \times 0.0257}} - 1 \right)$$

$$\boxed{I_D = 1.17mA}$$

पढ़िए और पढ़ाइये

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