I_s : is the reverse saturation current

V_D is the applied forward-bias voltage across the diode.

n is an ideality factor, which is a function of the operating Conditions and physical Construction; it has a range between 1 and 2 depending a wide variety of factors ($n=1$ will be assumed throughout this text unless otherwise noted)

The voltage V_T in Eq(1-1) is called the thermal voltage is determined

by $$V_T = \frac{kT}{q} \ (v) \quad \text{------- (1-2)}$$

where

K is Boltzmann's constant $= 1.38 \times 10^{-23}$ J/K

T is the absolute temperature in Kelvins = 273 + temperature °C

q is the magnitude of electronic charge $= 1.6 \times 10^{-19}$ C .

<u>Example 1.1</u> : At a temperature of 27 °C (common temperature for components in an enclosed operating system) determine the thermal voltage V_T

<u>solution</u> : Substituting in to Eq(1-2), we obtain

$$T = 273 + °C = 273 + 27 = 300\,K$$

$$V_T = \frac{KT}{q} = \frac{(1.38 \times 10^{-23}\ J/K)(300\,K)}{1.6 \times 10^{-19}\ C} = 25.875\ mV \cong 26\ mV$$

* $$I_D = I_s(e^{V_D/nV_T} - 1) = I_s e^{V_D/nV_T} - I_s$$

for positive values of V_D the first term of the above equation will grow very quickly

$$I_D \cong I_s\ e^{V_D/nV_T} \quad (V_D \text{ positive})$$

16 For negative values of V_D the current is at the level of $-I_s$

at V = 0 V , Eq(1-1) becomes

$$I_D = I_s(e^0 - 1) = I_s(1-1) = 0\ mA$$

Zener Region

As the voltage across the diode increases in the reverse-bias region, the velocity of minority carriers will increase and Kinetic energy ($W_k = \frac{1}{2} mv^2$) will sufficient to release additional carriers to point that high avalanche current