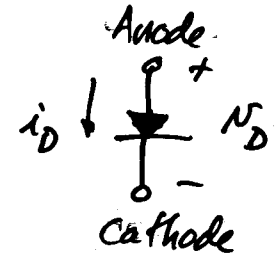
Review of ECE 3040

Chapter 3 - Diodes and Diode Circuits:

Diode

Two-terminal device



I-V characteristics -

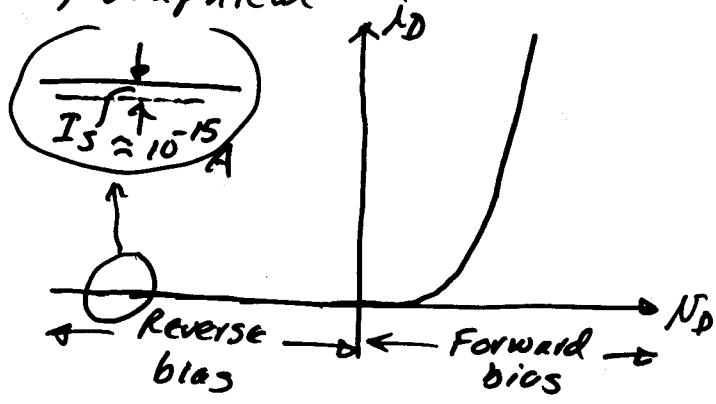
1.) Mathematical

$$i_D = I_S\left[\exp\left(\frac{v_D}{V_T}\right) - 1\right] \quad \text{where } V_T = \frac{kT}{q}$$

$$\& \quad I_S = KT^3 \exp\left(-\frac{V_{GO}}{V_T}\right)$$

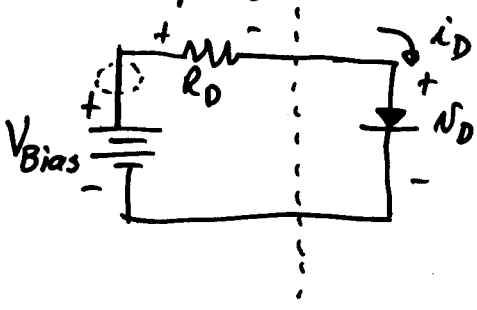
V_{GO}: Bandgap voltage ≈ 1.2 V

2.) Graphical



Application of the Diode Model -

Example:



a.) $V_{Bias} = i_D R_D + v_D$

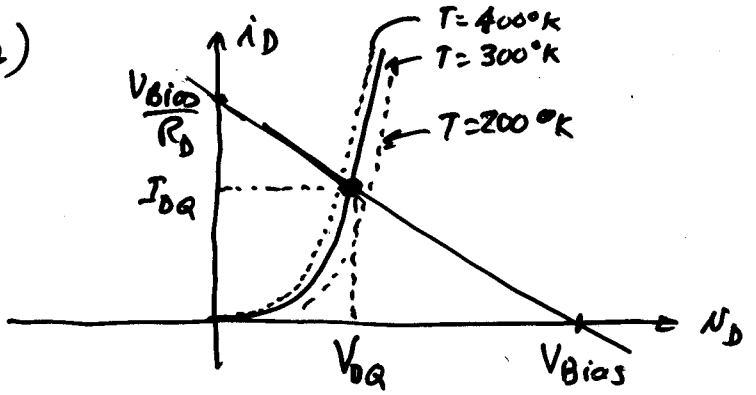
$\left(i_D \cong I_S \exp\left(\frac{v_D}{V_T}\right) \leftarrow v_D > 0\right.$

$$i_D = \frac{V_{Bias} - v_D}{R_D} \approx \frac{V_{Bias}}{R_D}$$

where $v_D << V_D$

or iterate

b)



Temperature Characteristics

Dependence of i_D & v_D as a function of temperature

Forward bias: 0.7 (0.025) 1.2

$$\frac{dv_D}{dT} = \frac{V_D + 3V_T + V_{GO}}{T = 300°K} \approx -2\,mV/°C$$

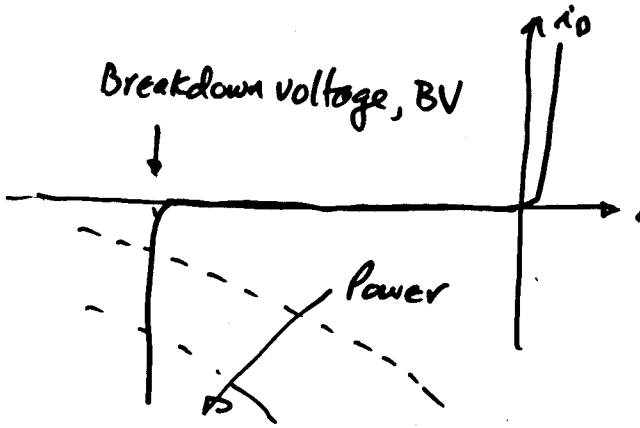
$$\frac{\partial i_D}{\partial T} > 0$$

Reverse bias:

$$i_D = -I_S \longrightarrow \frac{1}{I_S}\frac{\partial I_S}{\partial T} \left(ppm/°C\right) \approx \frac{3}{T} + \frac{V_{GO}}{T V_T}$$

I_S approx. doubles for every 10°C increase

Breakdown Characteristics



Electric field in the depletion region reaches a critical level and the diode goes into a high conduction state.

Mechanicisms

1.) Avalanche - higher voltages

2.) Zener - low voltage & high doping