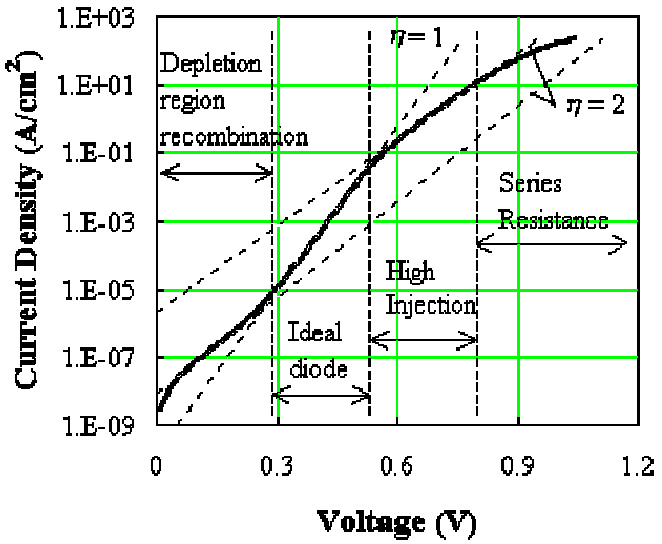
Exercise for PN Junction Lab:

Non-idealities in a long PN-diode

The forward biased *I-V* characteristics of real p-n diodes are affected by generation-recombination mechanisms in the depletion region, by the high injection and the series resistance of the diode. The *I-V* characteristics of a prototypical diode are plotted on a semi-logarithmic scale and four different regions can be distinguished as indicated on the figure below.



From the results presented in this figure it is evident that there is the ideal diode region where the current increases by one order of magnitude as the voltage is increased by 60 mV. This region is referred to as having an ideality factor, *n*, of one. The ideality factor is obtained by fitting a section of the curve to the following expression for the current:

$$I = I_s \exp\left(\frac{V}{nV_T}\right)$$

Looking at the slope of the curve, to the left of the ideal diode region there is the region where the current is dominated by the trap-assisted recombination in the depletion region. This part of the curve has an ideality factor of two. To the right of the ideal diode region, the current becomes limited by high injection effects and by the series resistance.

The purpose of this exercise is to examine how pronounced are each of the four regions for a diode with $N_A=10^{18}$ cm^{-3} and $N_D=10^{14}$ cm^{-3}. The user is required to vary the minority carrier lifetime such that:

(a) $\tau_n = \tau_p = 1\mu s$

(b) $\tau_n = \tau_p = 0.1\mu s$

Comment on the results obtained. Under what condition the recombination mechanism in the depletion region becomes significant. Vary the anode voltage from $V_A=0$ V to $V_A=1$ V.