uebung_2.1.4

Student Group

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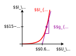
Exercise 2.1.4 Calculating the differential resistance of a diode

Fig. 1: Idealized Diode



The differential resistance $r_\rm D$ of a diode was already described in the chapter. This is necessary if a diode is to be simulated via a simplified diode model (voltage source + resistor + ideal diode, if applicable). In figure 1, see the differential conductance $g_{\rm D}={{1}\over{r_\rm D}}$ as the local slope at the desired operating point. Calculate the differential resistance $r_\rm D$ at forward current $I_\rm D=15 ~\rm mA$ for room temperature ($T=293~\rm K$) and $m=1$ from Shockley's equation: ${I_{\rm F} = I_{\rm S}(T)\cdot ({\rm e}^{\frac{U_\rm F}{m\cdot U_\rm T}}-1)}$ with $U_{\rm T} = \frac{k_{\rm B} \cdot T}{q}$ with $q=1~\rm e$. To do this, first, calculate the general formula for the differential resistance $r_\rm D$.

Steps:

1. First, simplify Shockley's equation for $U_{\rm F} \gg U_\rm T$
2. Find a formula for $\frac {{\rm d} I_{\rm F}}{{\rm d} U_\rm F}$.
3. Again, replace part of the result with $I_\rm F$ and rotate the fraction to calculate the differential resistance by $r_{\rm D} = \frac {{\rm d} U_\rm F}{{\rm d} I_\rm F}$.
   As a result, you should now have $r_{\rm D} = \frac {{\rm d} U_\rm F}{{\rm d} I_\rm F} = \frac {m \cdot U_\rm T}{I_\rm F} $
4. Calculate $r_\rm D$.