1. Krets

1.1. Elements

1.1.1. Diode

The diode is modeled as a nonlinear element with a current-voltage relationship defined by the Shockley diode equation:

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

Where I_D is the diode current, I_S is the reverse saturation current, V_D is the voltage across the diode, V_T is the thermal voltage, and, n is the ideality factor, also known as the quality factor, emission coefficient, or the material constant.

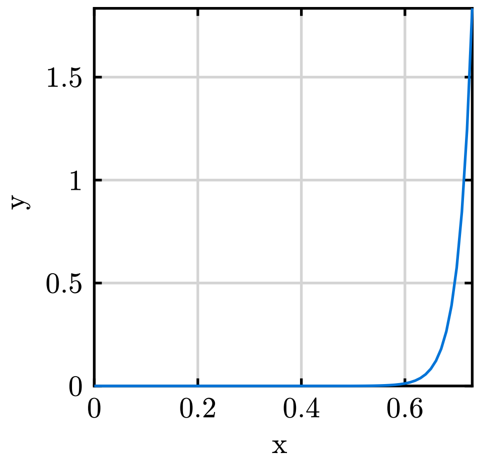

Figure 1: Diode IV Curve

The conductance of the diode is G_D and is given by the derivative of the Shockley diode equation with respect to the voltage:

$$G_D = \frac{dI_D}{dV_D} = \frac{I_S}{n V_T} e^{\frac{V_D}{n V_T}} \quad (2)$$

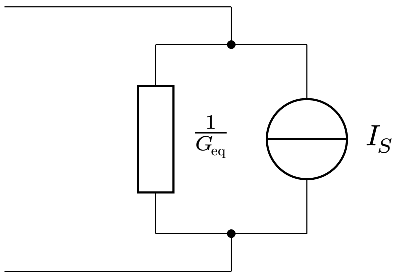

Figure 2: Diode Companion model

1.1.2. Voltage Source

In the conductance matrix the stamps for a voltage source are given by:

If the positive terminal is connect to node `i` and the node is not grounded, the stamp is: 1

1.2. Analyses

1.2.1. DC

During DC analysis, the circuit is analyzed under steady-state conditions with all capacitors treated as open circuits and all inductors treated as short circuits.

1.2.1.1. Diode IV Curve

$\begin{cases} V_1 = 1 \\ R_1 = 1000 \end{cases}$

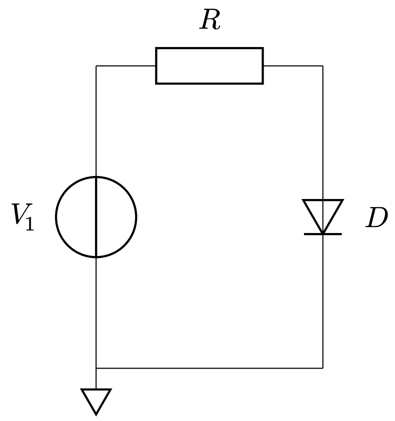

Figure 3: Diode IV Curve

Lets build the conductance matrix for this circuit.

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & \frac{1}{R} & -\frac{1}{R} \\ 0 & -\frac{1}{R} & \frac{1}{R} + G_D \end{pmatrix} \begin{vmatrix} I(V_1) \\ V_{\text{in}} \\ V_{\text{out}} \end{vmatrix} = \begin{pmatrix} 1 \\ 0 \\ I_D \end{pmatrix} \quad (3)$$

A Appendix

A.1 Constants

The following physical constants are used throughout this document:

$k_B = 1.380649 \cdot 10^{-23}$ (Boltzmann constant)

$q = 1.602176634 \cdot 10^{-19}$ (Elementary charge)

$T = 300$ (Standard temperature)

$V_T = \frac{k_B T}{q} \approx 0.02585$ (Thermal voltage at 300K)

$I_S = 1 \cdot 10^{-}12$ (reverse saturation current)

0.000000000001