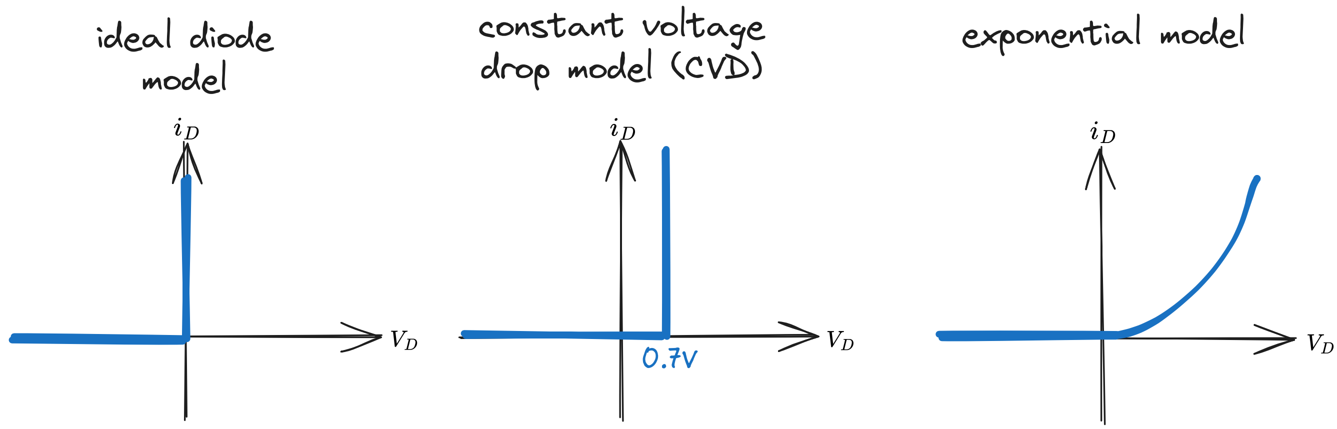
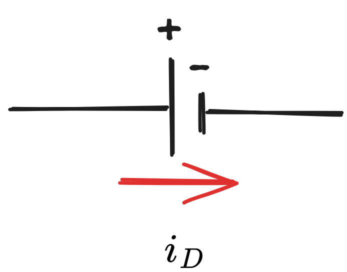
Three types of diode models:



We have already seen the ideal diode model.

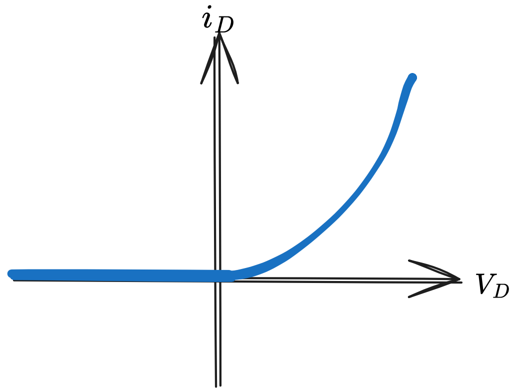
Constant Voltage Drop Model

Under the constant voltage drop model, we assume that when the diode is in forward bias, it has a constant voltage drop of around $0.7\mathrm{V}$. So, instead of modelling the diode simply as a short circuit during circuit analysis, we model it as a voltage source of $0.7\mathrm{V}$ that resists the current. This also means, that the difference in voltage between the cathode and the anode **must be** greater than $0.7\mathrm{V}$. Below is how to do a CVD model of a diode in forward bias.



As we will learn with the exponential model below, the voltage drop is not *always* $0.7\mathrm{V}$.

Exponential Model



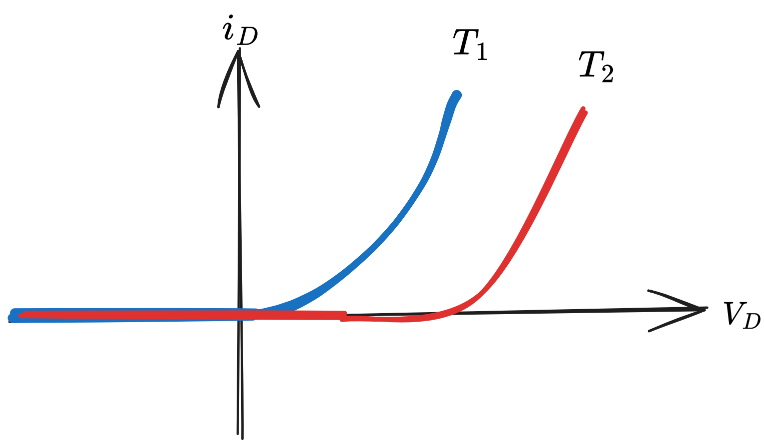
$$i_D = I_s(e^{V_d/V_t} - 1) = I_s e^{V_d/V_t}$$

I_s is the scale or saturation current, typical value of $10^{-15} - 10^{-18}\text{A}$. It is temperature dependent (roughly doubles for every 5°C rise in temperature) as well directly proportional to the junction area.

V_T is the thermal voltage:

$$V_T = \frac{kT}{q}$$

Where T is the temperature in Kelvin, k is Boltzmann's constant and q is the elementary charge. At room temperature, $V_T \approx 25\text{ mV}$.
Here is an example of the temperature-dependent behaviour, where $T_2 > T_1$



Theres a useful formula for determining how the voltage drop of the diode changes as the current does:

$$V_2 - V_1 = V_T \ln\left(\frac{i_2}{i_1}\right)$$

Using the fact that $\ln(x) \approx 2.3 \log_{10}(x)$ and $V_T = 25\text{mV}$ at room temperature, we can also rewrite this as:

$$V_2 - V_1 \approx 60\log_{10}\left(\frac{i_2}{i_1}\right)$$

We can use this to obverse that even with MASSIVE changes in current, the voltage drop changes are not nearly as large, hence why the CVD model is not a bad approximation of a diode.