Exercise 1

The purpose of this exercise is to model an electrical circuit using only your own code implementation. You will learn how to create connectors, partial models, models and how to re-use your code.

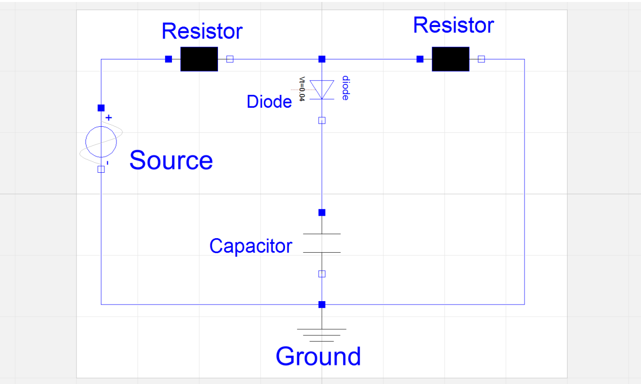

Figure 1: Electrical circuit.

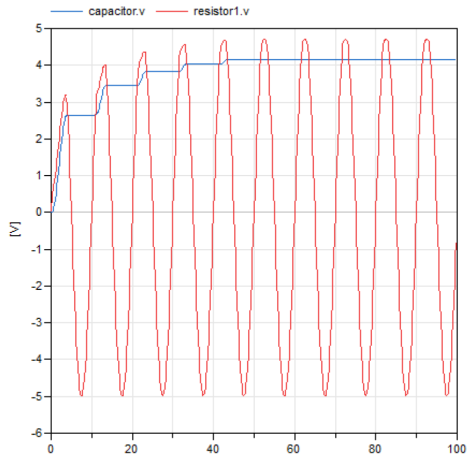

Figure 2: Result of simulation

Consider the electrical circuit depicted in Fig. 1. It is composed of a sinusoidal source, a resistor, a diode, a capacitor and the ground. Create this circuit from scratch by following the following steps:

1. Create a new *package* called *MyLib*
2. Each component uses electrical connectors. Create a partial connector called *Pin* which contains the variables i (current) and v (voltage). Which is a *flow* and which is a *potential* variable? Create then the connectors *Pin_a* and *Pin_b* for the positive and negative pins. Make two different graphical illustrations for the pins.
3. Create a partial model *OnePin* which contains the variables i (current) and v (voltage) and a connector *Pin_a*. This model will later be extended by all *OnePin* component. Create also a partial model *TwoPin* with the same variables and two *Pin* connectors. The variable v should give the voltage drop between the two pins and the variable i the current between them. Be careful with the sign of i!
4. Create the source, the resistor, the diode and the capacity by extending *OnePin* or *TwoPin*. Make use of the following equations:
   (a) Resistor: $Ri_{1\rightarrow 2} = v_1 - v_2$
   (b) Capacity: $C\frac{dv}{dt} = i$
   (c) source: $v = V sin(2\pi f t + \omega) + \beta$
   (d) diode: if $\frac{v}{V_t} \geq \alpha$: $i = I_{ds}(e^{\alpha}(1 + \frac{v}{V_t} - \alpha) - 1) + \frac{v}{R}$, else $i = I_{ds}(e^{\alpha} - 1) + \frac{v}{R}$
   (e) ground: $v = 0$

   Make use of following values for the diode: I_{ds} = 1.e-6, $V_t = 0.04$, $\alpha = 15$, $R = 1.e8$.
5. Create a model called *Circuit* which combined all these components.
6. Simulate the circuit for 100 seconds.