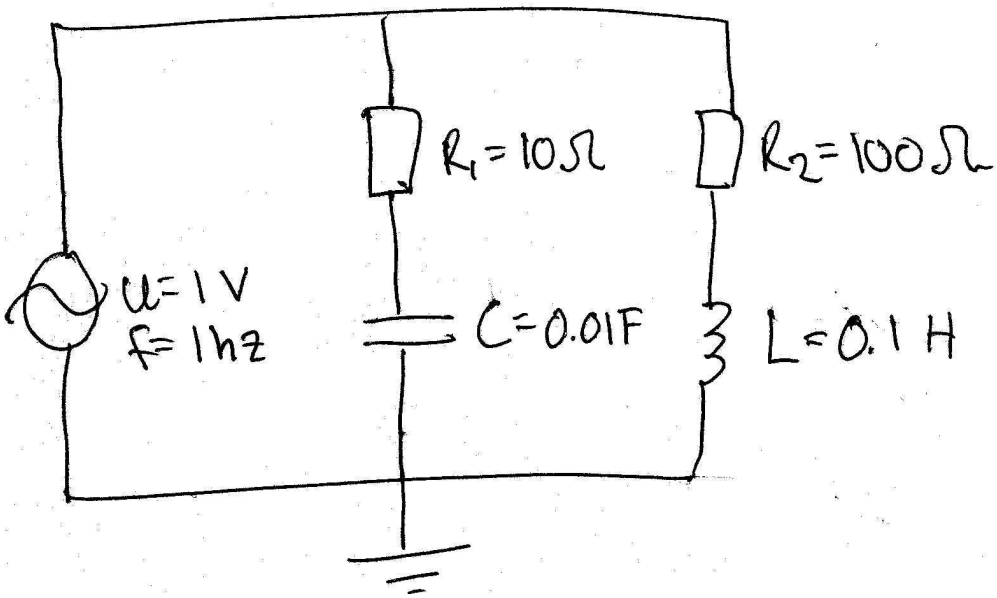
MathModelica® System Designer™

Simple Circuit

1 Introduction

Block based modeling is well suited for problems where you have a well defined causality, i.e. direction of flow. An example of this type of signal based systems is control systems. However in most cases the causality is not pre-defined, for instance a motor could also be used as a generator depending on if the input signal is the current or torque. Another basic example is the AC circuit below.



In this example the circuit above will be used to illustrate the difference between a block based approach and component based approach to model the circuit.

2 Block Based Circuit

To create a block based model we need to

1. Decide input and output signal for the system
2. Set up the system of equations
3. Derive the output as a function of the input
4. Implement the model

In this case we want to study the current through the signal voltage as a function of the voltage, and to calculate this we have three equations

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$$u(t) = R_1 i_1(t) + \frac{1}{C}\int i_1(t)dt$$

$$u(t) = R_2 i_2(t) + L\frac{di_2(t)}{dt}$$

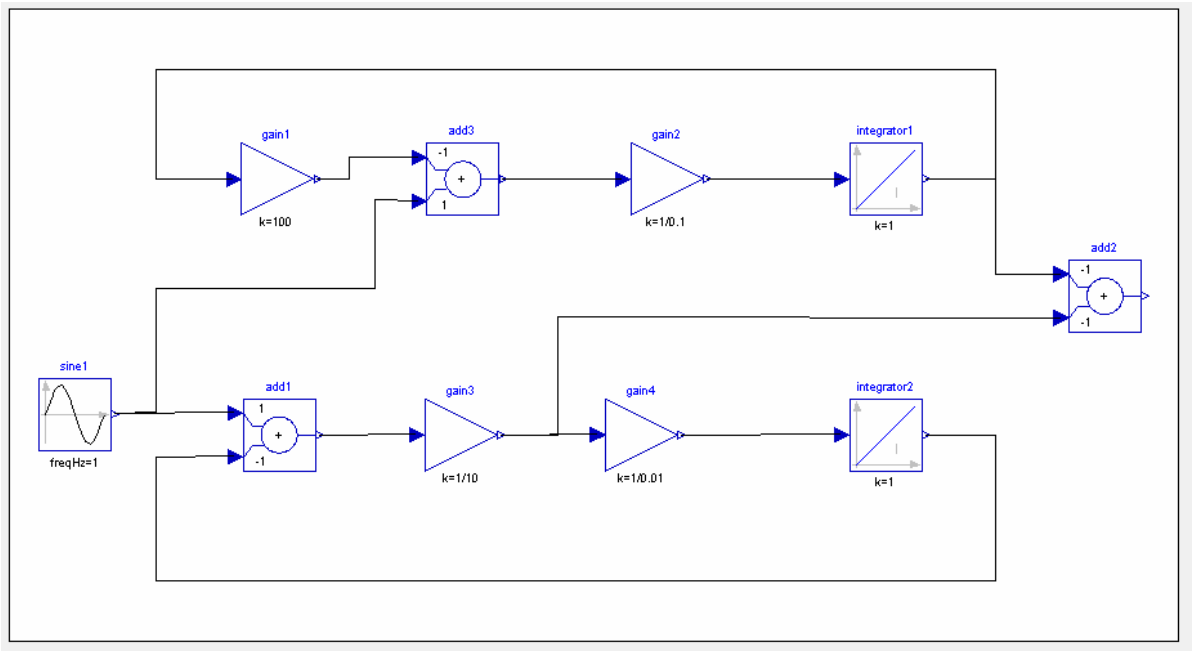
$$i(t) = i_1(t) + i_2(t)$$

Where *i*, is the total current through the signal voltage, i_1 and i_2 are the currents running through resistor 1 and 2 respectively. Using the Laplace transform the above equations and resolve *i* as a function of *u*.

$$i_1(t) = \frac{1}{R_1}\left(u(t) - \frac{1}{C}\int i_1(t)dt\right)$$

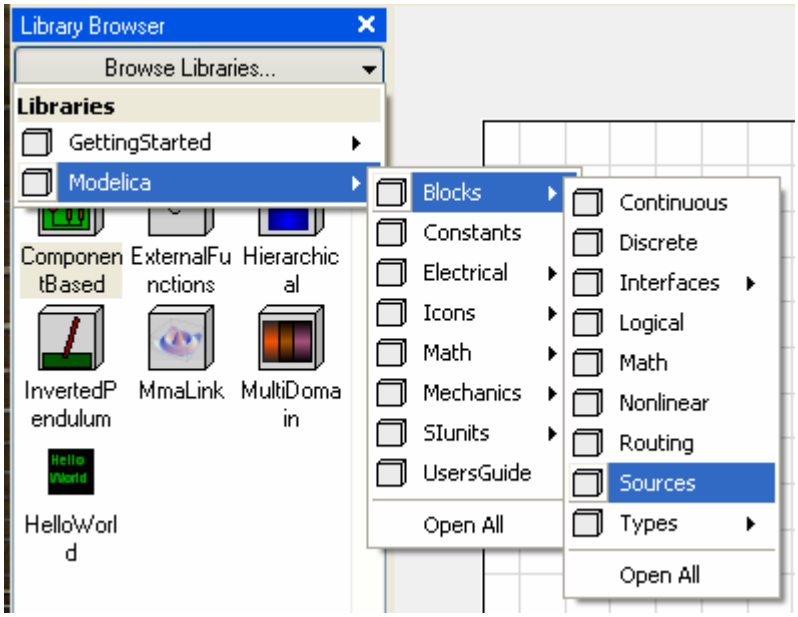
$$i_2(t) = \frac{1}{R_2}\left(U(s) - L\frac{di_2(t)}{dt}\right)$$

With these equations we can develop the block based model below.

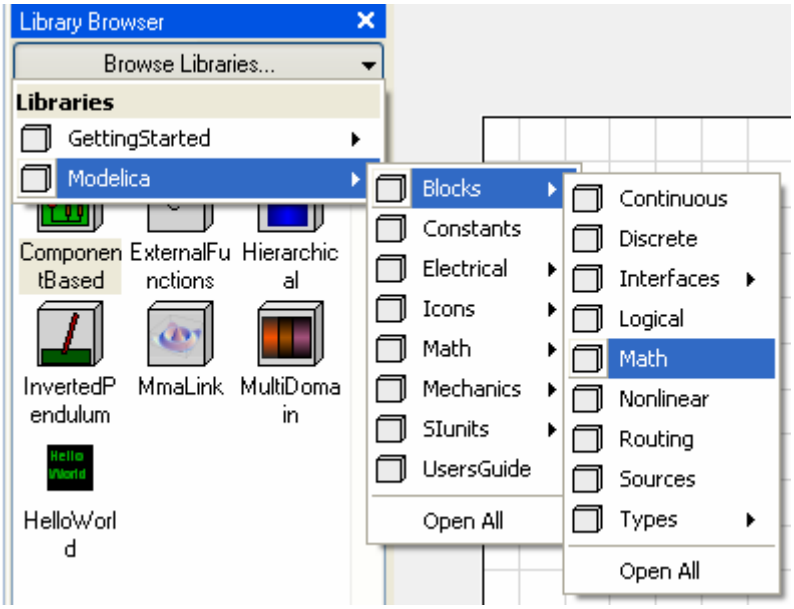


All the needed components to implement the system with a block based approach can be found in the following Blocks libraries.

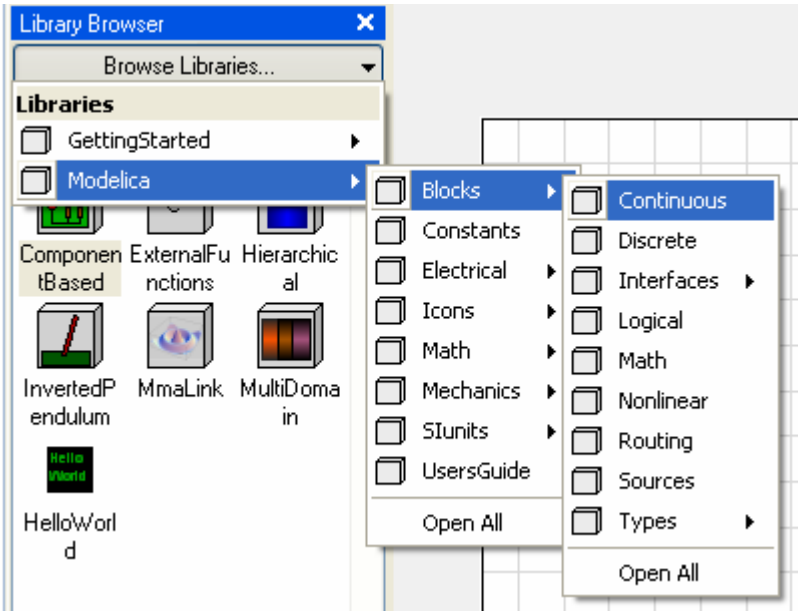
Modelica.Blocks.Sources:



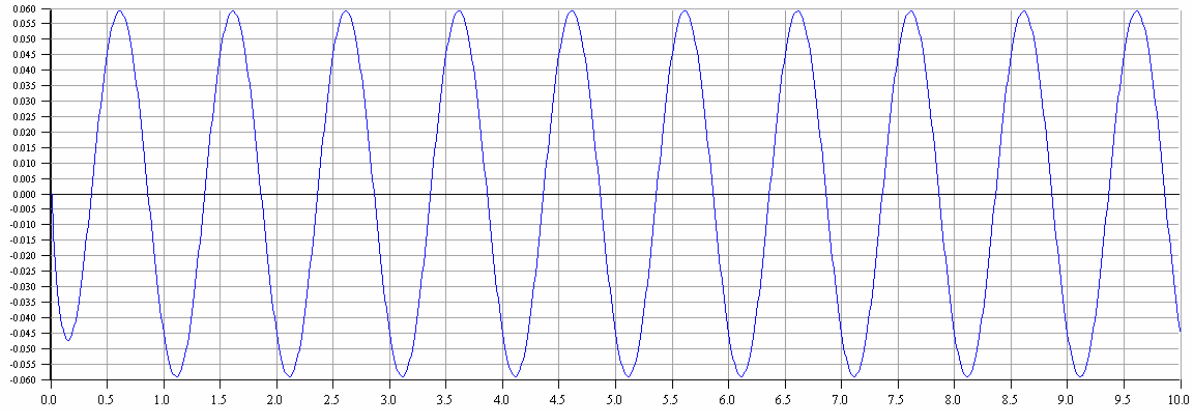
Modelica.Blocks.Math:



Modelica.Blocks.Continous:

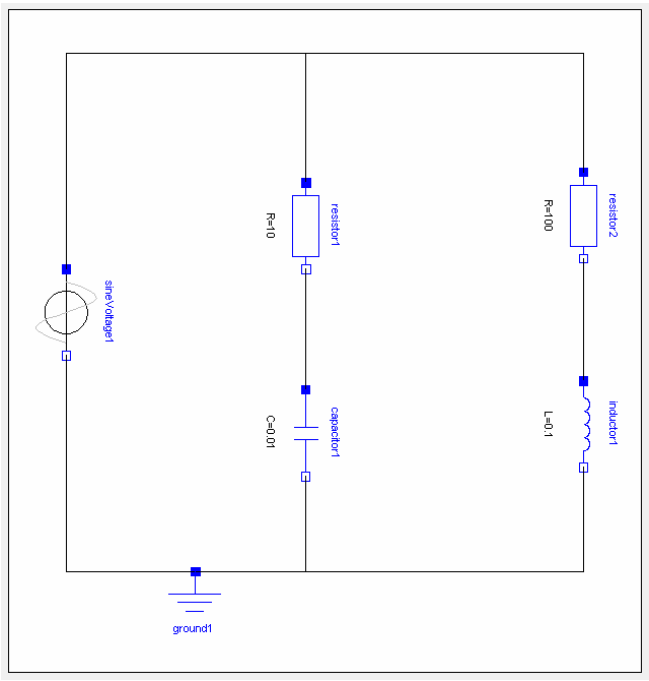


The output current is the result of add2, i_1 and i_2 are the signals from gain3 and integrator1 respectively. The picture below shows the resulting current.

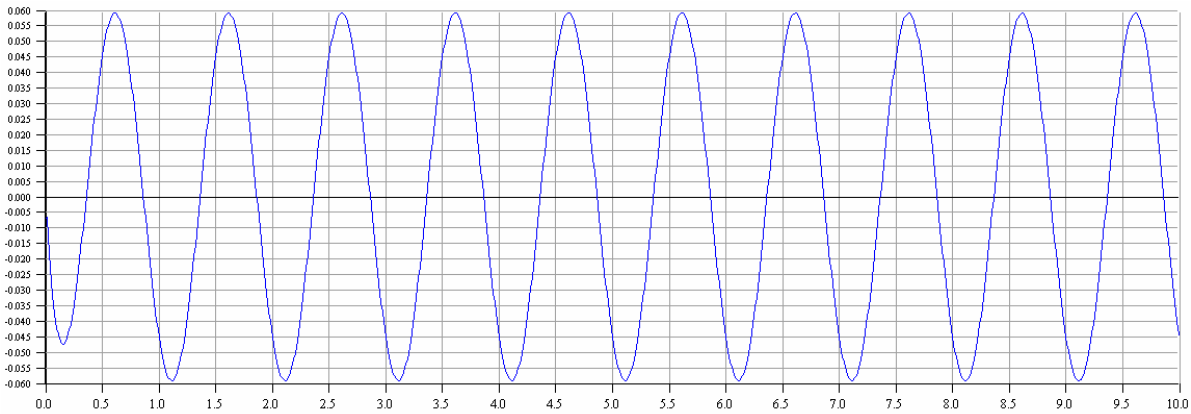


3 Component Based Circuit

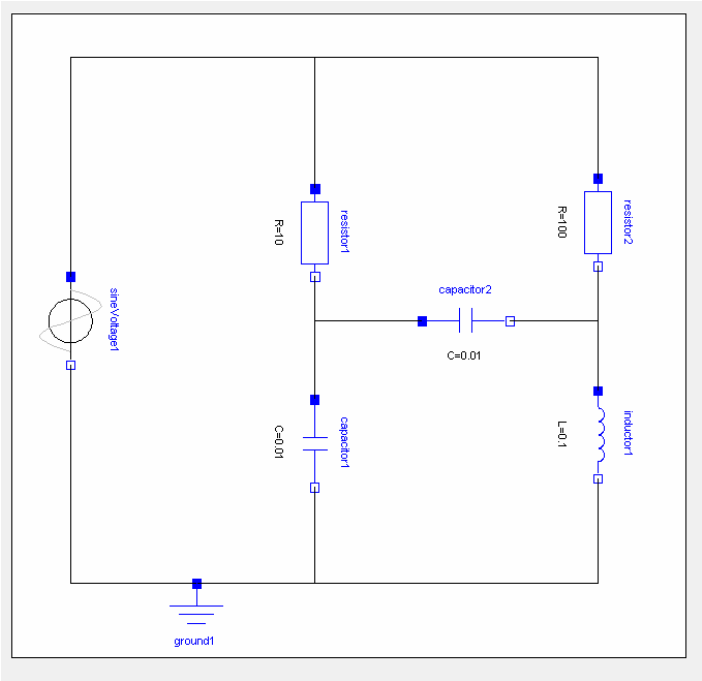
Naturally, to implement a component based model of the system above is only about drag-and-drop, connecting the components and setting parameters, leaving us with a model that looks just like the drawing we begun with



Now we can simulate and plot the resulting current through the signal voltage, and as expected it looks just like the result plotted from the block model.



Finally we add a capacitance to the model as shown below.



After simulation we can compare the resulting currents with each other. An exercise for the interested reader is to develop a block based model for the new circuit.