

## Lab #5

### Modeling Of an Electrical System in SIMULINK

#### Objective:

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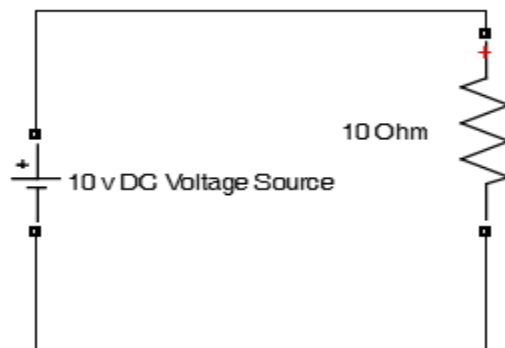
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#### Electrical Models

Electrical libraries contain blocks for the electrical domain, organized into elements, sources, and sensors. Connect these blocks together just as you would assemble a physical system. Use these blocks, along with the blocks from other Foundation libraries and the add-on products, to model multi domain physical systems.

#### Example:

A circuit with a dc battery source of 10 volt and a resistor of 10 ohm is shown below.



To create kvl or kcl equation. We use ohm's law i.e.

$$V = IR$$

Because of only one circuit element with a voltage source is used in the circuit. To find current

$$I = V/R$$

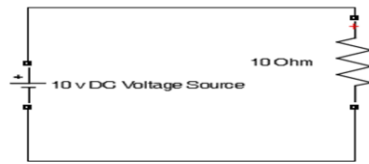
And for Power we have

$$P = V^2/R$$

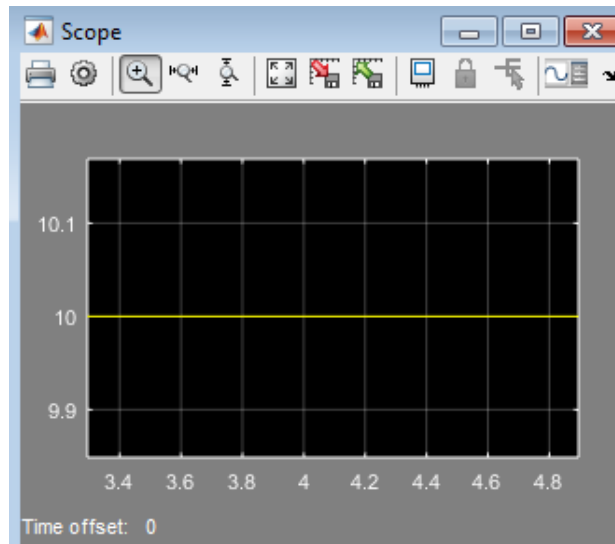
Now let us simulate this circuit with the set of these equations. Now let us go to MATLAB.

When we are about to do modeling we are not needed to take the elements from Simulink library for modeling purpose. For mathematical modeling of a circuit we only needed the element from the Simulink

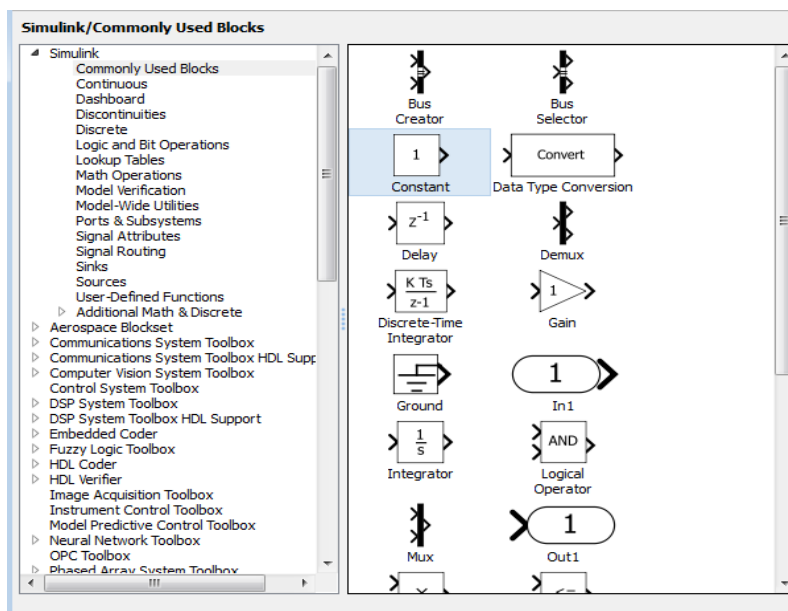
because these components are enough for mathematical modeling of a circuit. Now we have a circuit which is shown below as,



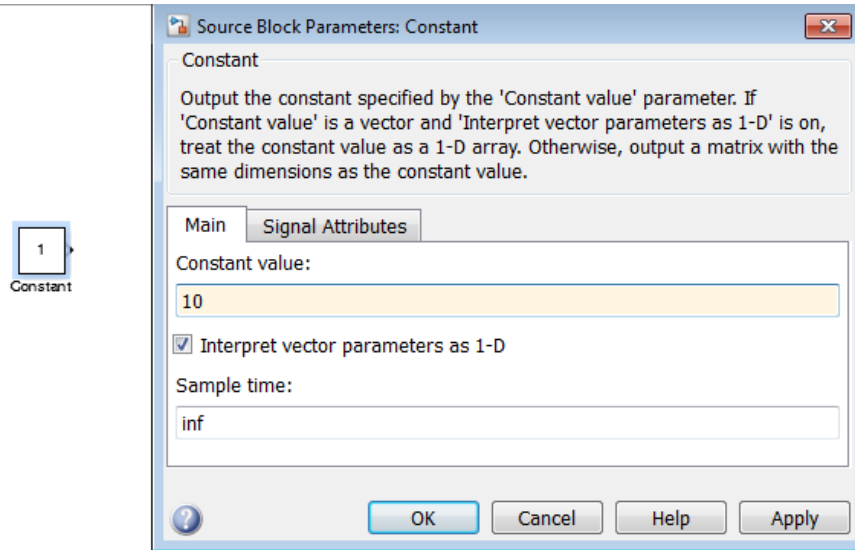
As we have a Dc voltage source. To see the characteristics of Dc source we have a constant waveform like that for a steady state,



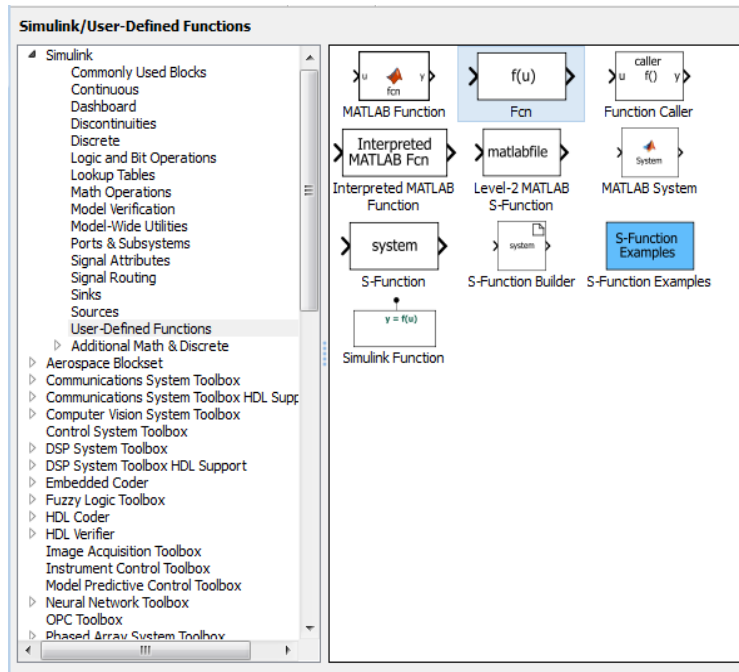
So we can take a constant value for Dc. So from Simulink go to commonly used block and pick out constant block and drag it to your workspace.



Now give the value by double clicking on the constant block and give it to the value of 10v.



Now once again open the Simulink library browser and go to Simulink and then go to user define function and then select Fcn. It is represented by f(u) function.

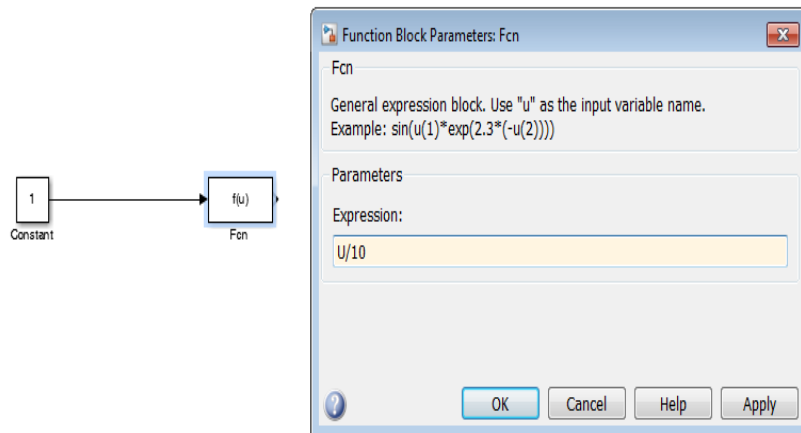


Now see the equation if you want the value of current we have

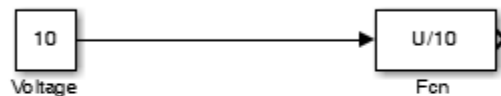
$$I=V/R$$

There are two parameters one is voltage and one is resistor. We have entered the value of voltage by a constant block. Now double click the fcn function and clear the pre-define expression and simply type  $u/10$ . This  $u/10$  is nothing but this function has input as well as output the input is taken as  $u$ . while the divided by 10 is nothing but the value of resistor. So, the output from the function block will be current because the voltage is divided by the resistance i.e.

$$u/10 \text{ or } V/R$$



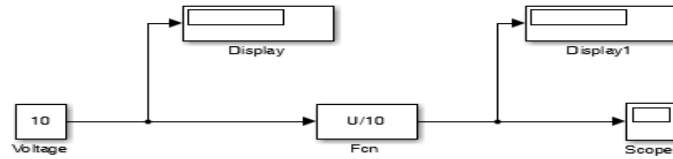
Enter the voltage at the constant block. And this value of voltage is entering into the function block.



Now take the scope and connect it to the output of the function block. So, that you will find the value of current flowing through the circuit.



Also take the display element and connect it after the constant block it will show you the voltage and also after the function block so it will show you the current.



If you want to enter the value of R from the beginning type R=10 in the MATLAB command window and then use R instead of its value in the blocks you will get the same result.

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Command Window
New to MATLAB? See resources for Getting Started.

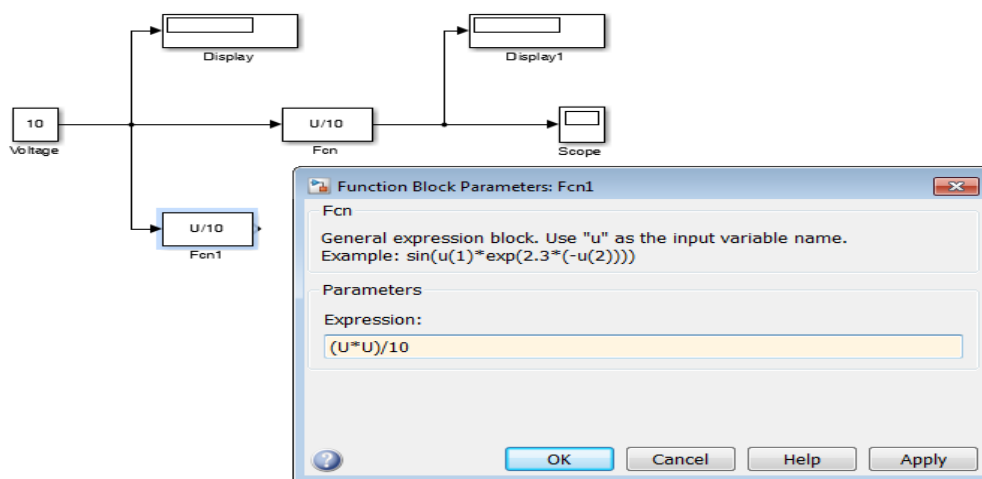
>> R=10

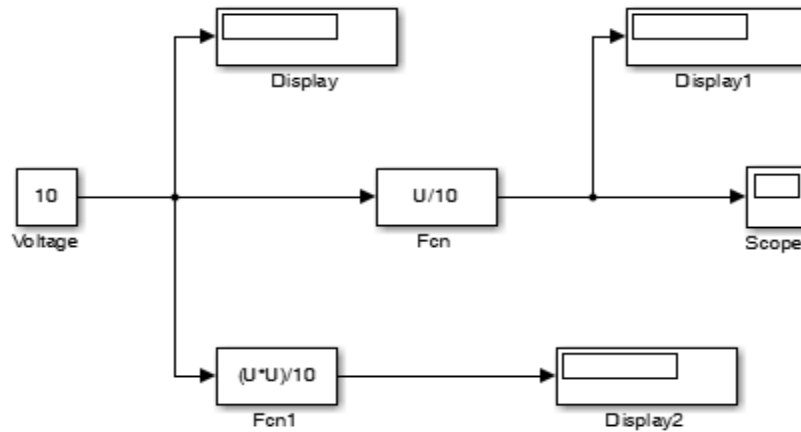
R =

    10

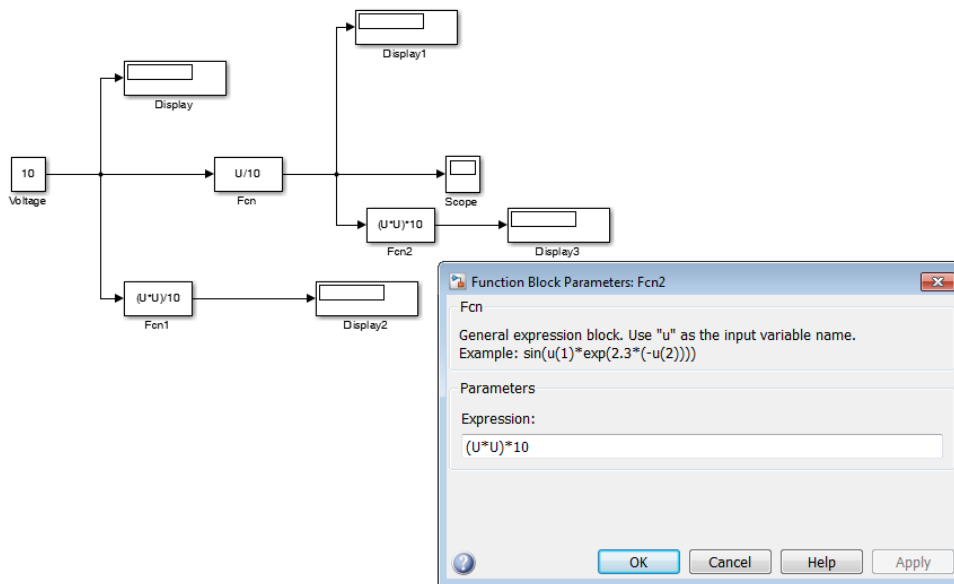
fx >>
  
```

Also we need to find the power. For that we simply copy the function block and double click on it and write in the expression block  $(u*u)/10$  or  $V^2/R$ . Connect it after the constant block. Also connect the display block after that function block.

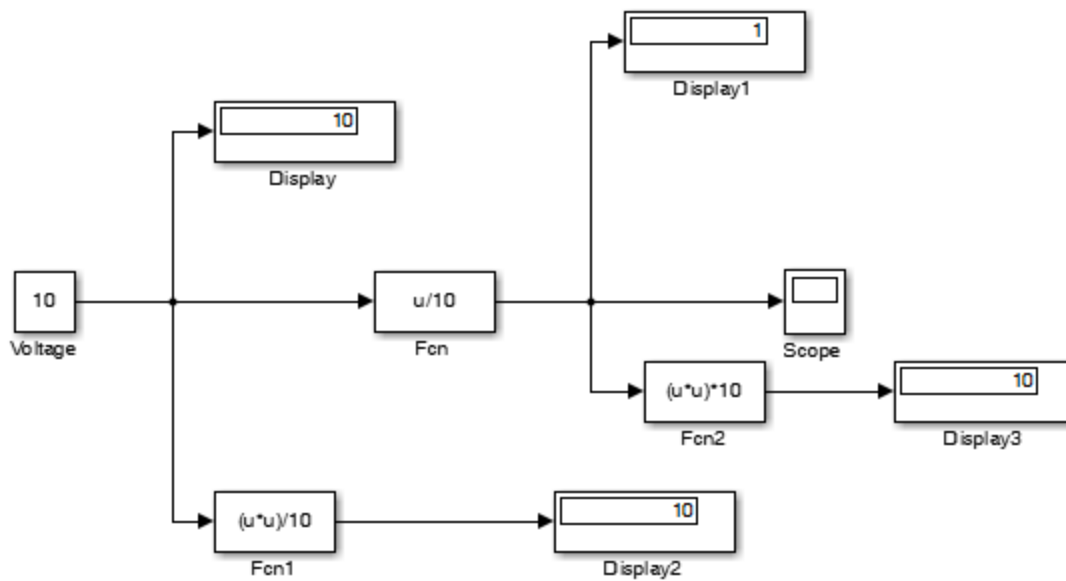




We have one more relation i.e.  $I^2R$ . So copy the function block and place it before the scope and after the function block because the output of this block is the value of current. So you get the same result by connecting the display block after that block. Change the value of  $u^2/R$  to  $(u*u)*R$ .

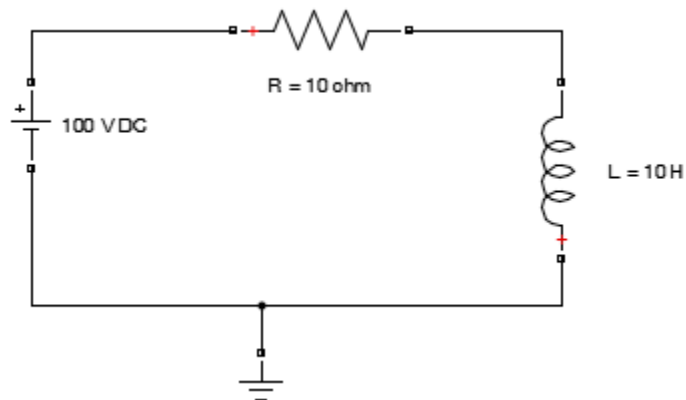


Now run the circuit simulation. We got the value of voltage, current and power.



### RL Circuit:

A circuit with a dc battery source of 100 volt, with a resistor of 10 ohm and an inductor of 10 Henry is shown below.



As we know voltage across the resistor will be

$$V = IR$$

and current across the resistor will be

$$I = V/R$$

Similarly if we find voltage across inductor it will be

$$V = Ldi/dt$$

And for current we have

$$I = 1/L(\int V dt)$$

If we apply the KVL across the loop we get equation i.e.

$$V = IR + L di/dt$$

And for current

$$I = \int S \left( \frac{V-IR}{L} \right) dt$$

As S is multiplied here for the switching purpose i.e. S = 0 (Off State) and S = 1 (On State)

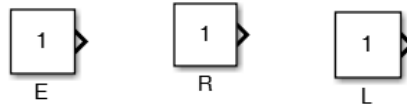
And for Power we have

$$P = VI$$

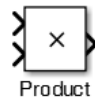
Now let us simulate this circuit with the set of these equations. The following components will be used.

**Components Used:**

- Three Constants Blocks one block for each i.e. for Dc voltage source, Resistor and for Inductor



- Product Block



- Add Block



- Divide Block



- Derivative Block





- Integrator Block



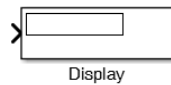
- Unit Step Block for Switching Purpose set the step time to 0.5.



- Scope



- Display



Now first of all enter the values of V (as here in Matlab Voltage is denoted by E), R and L in the Matlab Command window.

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>> E = 100
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E =
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100
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>> R = 10
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R =
```

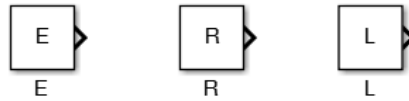
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10
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>> L = 10
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L =
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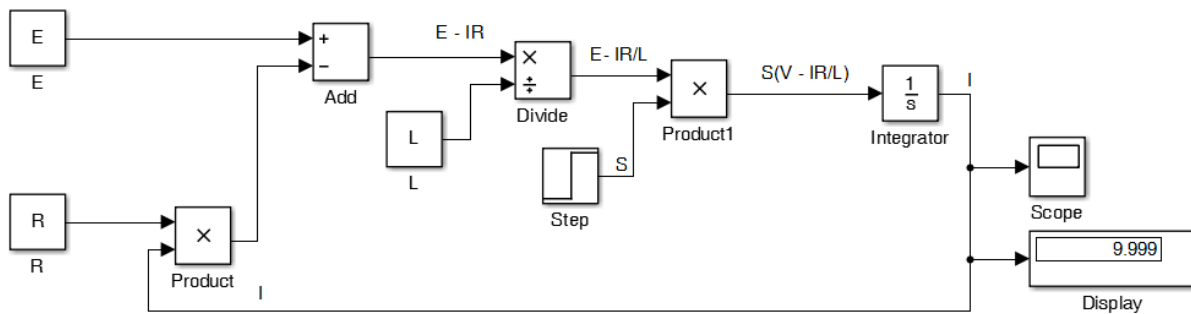
```
10
```

Now give the values to the constant blocks by double clicking on the constant blocks and give it simple E, R and L in the constant value block respectively.

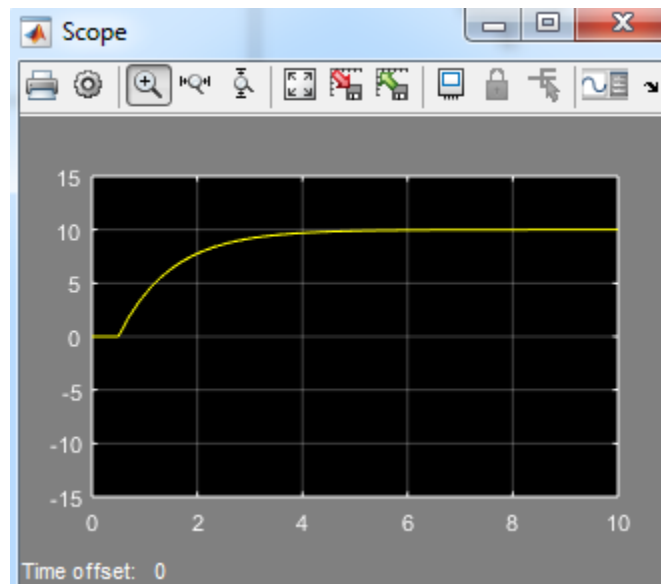


Now to find current across the RL circuit we have the following mathematical model from the current equation.

$$I = \int S \left( \frac{V-IR}{L} \right) dt$$



To check the output current characteristics through RL circuit click on scope you will get the following result.



This output shows two regions/states the Transient state and the Steady state. These states are dependent on the value of inductor used in the circuit.

## Post Lab Questions

a) What is a RL circuit?

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b) Which block can be used for DC source?

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c) What is display used for?

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## Lab Tasks

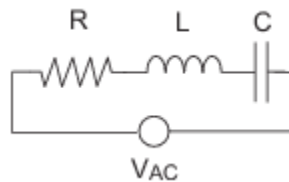
### Task 1

Simulate the circuit by modeling method. Find the parameters (voltage, current and power) across Resistor. Give the sum of your Id number as the values for the constant blocks.



### Task 2

For the given circuit , find the resistor current when  $R$  is 70,  $C$  is 0.00003, and  $L$  is 0.04



**Hint:** Use the following equations for the model:

*The resistor voltage is the sum of the voltage source, the capacitor voltage, and the inductor voltage.*

$$Ri = V_{AC} - L \frac{di}{dt} - \frac{1}{C} \int_{-\infty}^t i(t) dt$$