Implementation of Ohm's Law using MATLAB Simulink

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Abstract: Simulink is a graphical extension of MATLAB. Using simulink we can analyze systems graphically. This paper covers a model designed to analyze one of the basic law of circuit theory that is Ohm's Law using simulink. Two simulink models are designed and result of each model is presented which shows a successful implementation of the system.

INTRODUCTION

Ohm's law is a fundamental law related to electric circuits. Electric circuits are represented as an interconnection of electric components. In this interconnection, within a closed path electric charges flow to perform some task. Electric circuits are composed of active and passive components. Active components are those with source of energy and passive components are without the source of energy. Diode, transistors are examples of active components whereas resistors, capacitors are examples of passive components. Resistor is simplest and basic passive circuit element among all the other passive elements. Resistors are used to resist current by dissipating energy as heat [1]. The term resistor comes from a basic law called Ohm's law. It is one of the fundamental law of elctric circuits. In our work we have implemented this law in Simulink environment.

Simulink is a commercial tool for modelling, simulating and analyzing dynamic systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the matlab environment and can either drive matlab or be scripted from it. Simulink is widely used in digital signal processing and control theory for simulation and design [2].

BACKGROUND

An electric circuit is formed when a conductive path is created to allow free electrons to continuously move. This continuous movement of free electrons through the conductors of a circuit is called a *current*, and it is often referred to in terms of "flow".The force motivating electrons to "flow" in a circuit is called *voltage*. Voltage is a specific measure of potential energy that is always relative between two points [3].

Free electrons tend to move through conductors with some degree of friction, or opposition to motion. This opposition to motion is more properly called *resistance*. The amount of current in a circuit depends on the amount of voltage available to motivate the electrons, and also the amount of resistance in the circuit to oppose electron flow. Ohm's law is a basic law of electric circuits that represents the effect of resistance. According to Ohm's law the current passing through a resistance is directly proportional to the potential difference across it [3].

Mathematically, $V=IR$ where V is the potential difference between two points which include a **resistance** R. I is the current flowing through the resistance. Graphically it can be represented as shown in Fig 1.
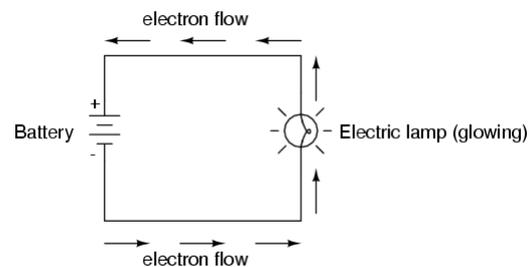

Fig 1: Graphical representation of Ohm's Law [3]

In the Fig 1, battery is the source of voltage; electric lamp is the source of resistance and across the entire circuit current is flowing. Here if we know the values of any two parameters then by applying Ohm's law we can easily calculate the third one.

The above two relationship can also be represented using simulink. Simulink is a graphical extension of MATLAB. It can represent mathematical equations, systems and signals graphically. Any linear or non linear systems can be analyzed using simulink. The system that follows Ohm's law is linear in nature. We can analyze it using simulink. In Simulink, different blocks are assembled to reproduce almost anything by using mathematical modelling [4].

METHODOLOGY

In our work we have implemented Ohm's law using Simulink in MATLAB environment. Two simulink model has been created to verify Ohm's law. One model is having resistance as a constant quantity and in the model a sinusoidal signal is

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used as a input to verify the law. Our work comprises of following steps—

A. Simulink model for Ohm's Law With Constant Input:

1. Defining the System: In our work since we are implementing Ohm's law that is why our system is a linear system with a few parameters.

2. Identifying System Components: In our work system components are voltage, current and resistance.

3. Modeling the System with Equations: Here system equation is V=IR.

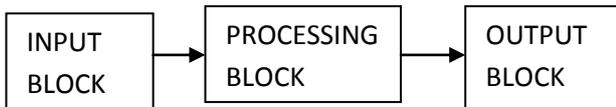4. Building the Simulink Block Diagram: The block diagram of our system is shown in Fig2—

Fig2: System Block Diagram

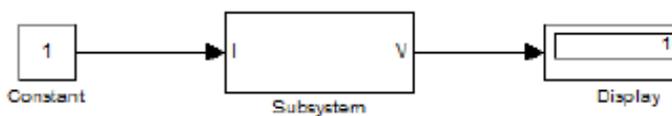5. Running the Simulation: Simulation can be run using the following simulink model as shown in Fig3—

Fig3: Simulink model for Ohm's Law

6. Validating the Simulation Results: Simulated results are validated with a circuit made using discrete components and the results are approximately same. The table below shows the values from the simulation and from the physical circuit—

Resistance (ohm)	Current (A)	Voltage (Volts) Simulated	Voltage (Volts) Physical Circuit
1	1	1	0.9
2	1	2	1.8
5	1	5	4.7
10	1	10	9.8

B. Simulink model for Ohm's Law With Variable Input:

All the steps of model A have to be followed in model B but the only difference is in this next model we have used one sinusoidal signal as an input. This block is shown in Fig4—
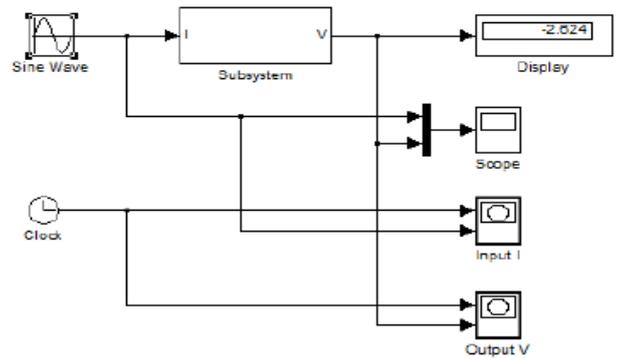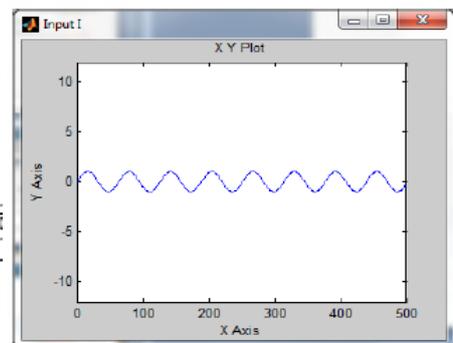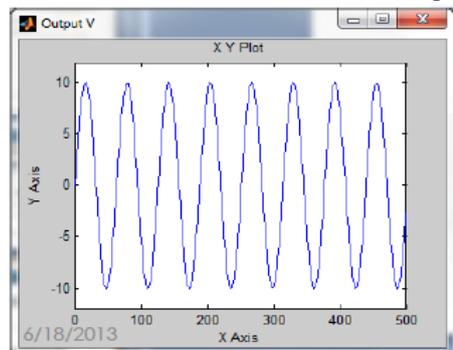
Fig4: Simulink model for Ohm's law using variable input (Sinusoidal Input)
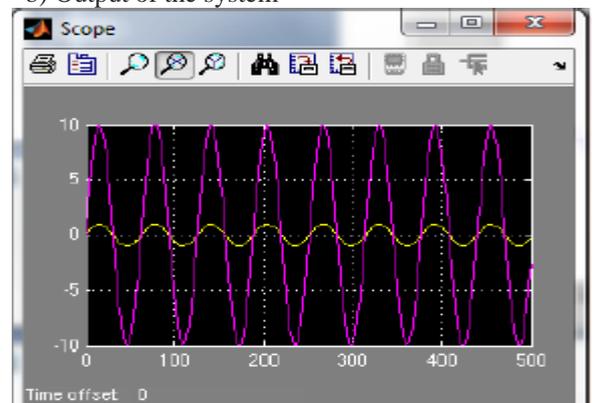
The outcome of this block is shown in Fig5—

a) Sine wave as an input

b) Output of the system

c) Input-Output of the system

CONCLUSION

Simulink provides a graphical user interface (GUI) for building models as block diagrams. Using simulink we can easily represent and verify any law of science. Same procedure can be used for other laws also for verification and analysis in terms of graphical means.

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