

# Visualization Base Simulation of D.C Network Theorems in Basic Electrical Engineering with Lab VIEW

Ashok Kumar Rajput

**Abstract**—In an Electrical Engineering course work Practical plays a important role in Engineering Education to enhance the technical knowledge deeply. Now day by day students have different modes to perform the Practical in the Lab session. Software based Basic Electrical Engineering Practical are less costly than hardware base practical and also have a provision to change the circuit parameters as we need compared to hardware based practical, which results in better understanding of students in learning concepts of Basic Electrical Engineering course. Today Software based different Laboratory experiments can be performed by the student with a single place which impacts on flexible learning of students and under-standing abilities. This motivation deals with Simulation of Basic Electrical Engineering Laboratory experiments which are part of Lab session at Under Graduate Electrical Engineering students using Laboratory Virtual Instrument Engineering Workbench (LabVIEW) software. Lab-VIEW uses graphical language which allows a natural, error free result & user-friendly interaction

**Index Terms**—Basic Electrical Engineering, Laboratory, LabVIEW, Simulation, Software.

## I. INTRODUCTION

Basic Electrical Engineering is one of the tough subject being taught to the first year students in different Technical Universities curriculum in India and abroad. Course comprises the following units: Basic Fundamental of Electrical Engineering, D.C Network Theory, Sinusoidal steady state analysis of A.C. circuits, Measuring Instruments, Basic of Power System, Trans-former and A.C and D.C Machines with Laboratory. Laboratory Experiments have been simulated using LabVIEW software. In this series Electrical Machines experiments are simulated with LabVIEW under graduate Electrical Engineering [1], [2]. The fundamental equations of a Transformer, D.C machines and Induction motor and equivalent circuits have been imposed into the LabVIEW for Simulation purpose [3], [4]. The concept for the use of LabVIEW software in Engineering education is recognized internationally but the complete Lab Experiments of Electrical Machines course has been implemented in LabVIEW based upon the exact ratings and on-ground machines parameters as a pioneer and novel research at RCET [5]-[10]. Simulation of Synchronous machines have already been implemented in LabVIEW [11],

Other programming tools like MAT-LAB, PSCAD and SkyLab etc. are also used for Laboratory experiments simulation purpose but due to strong graphical user interface LabVIEW is preferred on all others [12].The list of some experiments for Basic Electrical Engineering course which has been simulated during this course work are as follows:

- Simulation of superposition theorem in D.C Network.
- Simulation of maximum power transfer theorem in D.C Network.
  - Simulation of Thevenin’s theorem in D.C Network.
  - Simulation of Norton’s theorem in D.C Network.

## II. Lab VIEW GUIDE

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) which is a graphical user friendly Language which is totally based upon icons/buttons instead of programming codes and code paragraph. This software has the ability to build user defined interface with set of objects and graphical tools. These programs are labeled as Virtual Instruments( VIs,) owing to their operational replica of physical instruments, like oscilloscopes, multi-meters ,mathe-matical tools etc. A Virtual Instrument is the combination two panel generally known as windows.

- Front panel or window
- Block diagram window

All control and indicator are the part of Front panel window and their Icon and connector pane lies in a Block diagram window.

## III. SIMULATION WITH LabVIEW

### A. Superposition Theorem

The strategy used in the Superposition Theorem is to eliminate all but one source of power within a network at a time, using series/parallel analysis to determine voltage drops (and/or currents) within the modified network for each power source separately. Then, once voltage drops and/or currents have been determined for each power source working separately, the values are all “superimposed” on top of each other i.e added algebraically to find the actual voltage drops/currents with all sources active. In this circuit diagram shown in fig.1. In which three resistances  $R_1$ ,  $R_2$ ,  $R_3$  and two voltages sources having source values  $V_1$  and  $V_2$ .

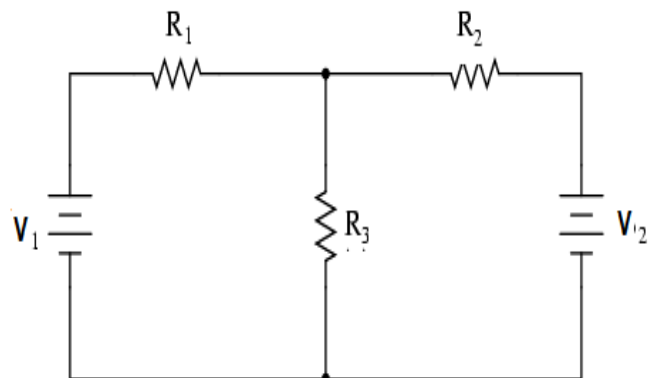


Fig.1 Circuit Diagram for Superposition Theorem.

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Our aim is to obtain response (current) in resistance  $R_3$ . It is simulated in LabVIEW with two different windows one is its block diagram window shown in fig. 2 and results are indicated in front panel window shown in fig.3 .

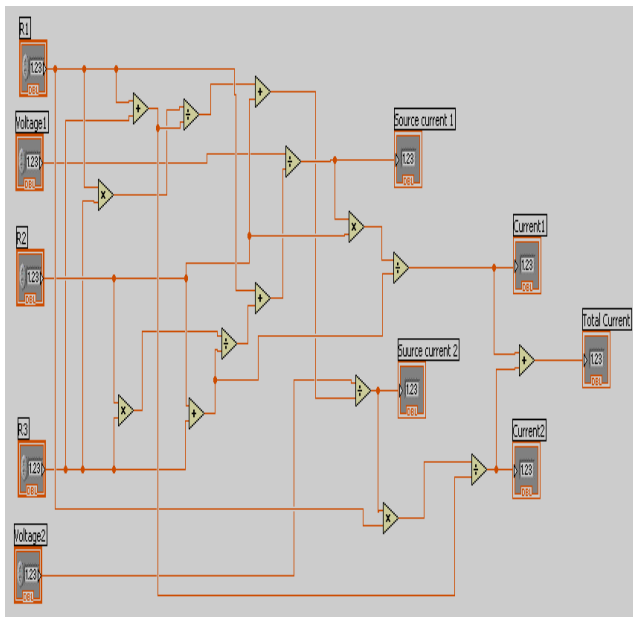


Fig.2 Block Diagram of Superposition Theorem

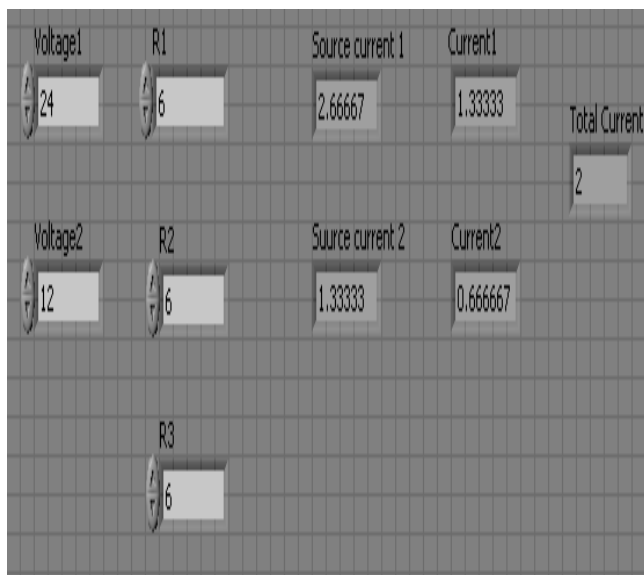


Fig.3 Front Panel of superposition Theorem

**B. Maximum Power Transfer Theorem**

The maximum power transfer theorem states the following: A load will receive maximum power from a network when its total resistive value is exactly equal to the Thévenin resistance of the network applied to the load. That is,  $R_L = R_i$  ( $R_{Th}$ )

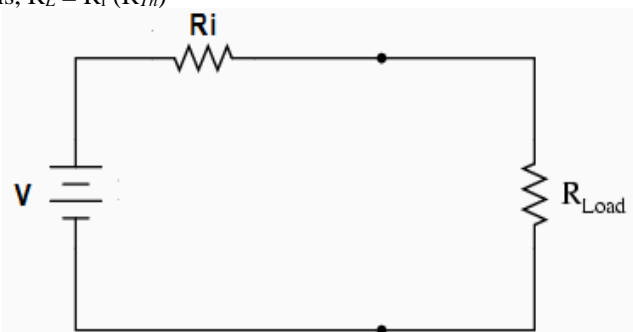


Fig.4 Circuit Diagram for Maximum Power Transfer Theorem

In this theorem let the supply voltage is constant and the load resistance is variable than it is simulated in LabVIEW shown in fig.5 and fig.6. It is clearly shown in front panel that if internal resistance ( $R_i$ ) of the source or thevenin's equivalent resistance of the network is equal to the load resistance ( $R_L$ ) than power which is transfer by the source should be maximum.

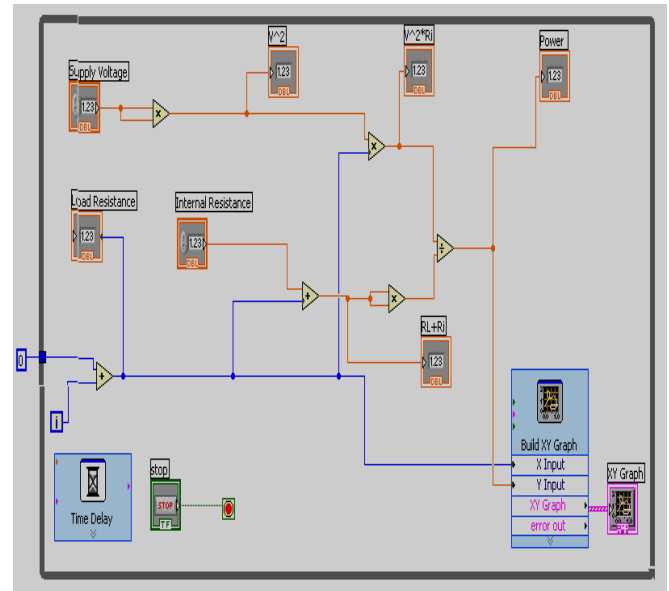


Fig.5 Block Diagram of Maximum Power Transfer Theorem

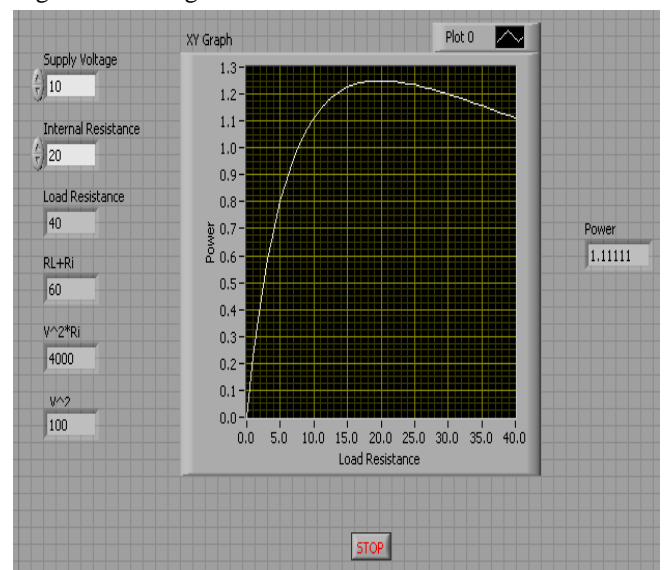


Fig.6 Front Panel of Maximum Power Transfer Theorem

**C. Thevenin's Theorem**

Thevenin's Theorem states that it is possible to simplify any linear circuit, to an equivalent circuit with just a single voltage source and series resistance connected to a load. The qualification of "linear" is identical to that found in the Superposition Theorem, where all the underlying equations must be linear (no exponents or roots). If we are dealing with passive components (resistors, inductors and capacitors), this is true. However, there are some components (especially certain gas-discharge and semiconductor components) which are nonlinear:



that is, their opposition to current changes with voltage and/or current. As such, we would call circuits containing these types of components, nonlinear circuits.

Thevenin's Theorem is especially useful in analyzing power systems and other circuits where one particular resistor in the circuit (called the "load" resistor) is subject to change, and re-calculation of the circuit is necessary with each trial value of load resistance, to determine voltage across it and current through it. Let's take another look at our example circuit shown in fig.7.

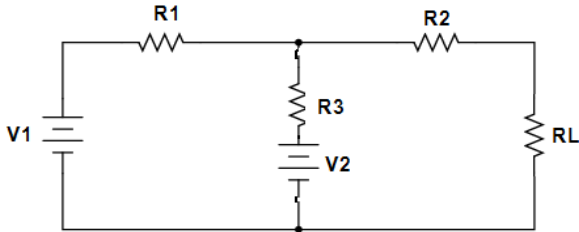


Fig.7 Circuit Diagram in Which Thevenin's Theorem is applied.

Let the supply voltage  $V_1$  and  $V_2$  are constant and the load resistance is which response (current) be calculated and it is simulated in LabVIEW shown in fig.8 and fig.9. It is clearly shown in front panel that thevenin's equivalent resistance ( $R_{th}$ ) and thevenin's equivalent voltage ( $V_{th}$ ) across the load resistance. By using thevenin's equivalent resistance ( $R_{th}$ ) and thevenin's equivalent voltage ( $V_{th}$ ) we can obtain current in the load resistance.

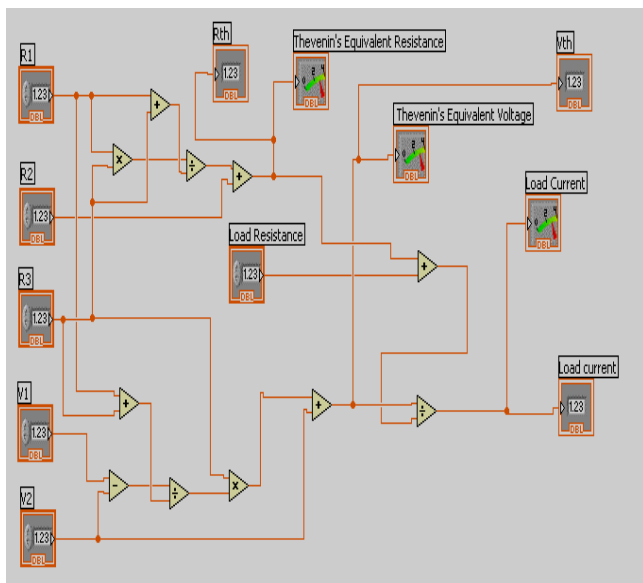


Fig.8 Block diagram for Thevenin's theorem

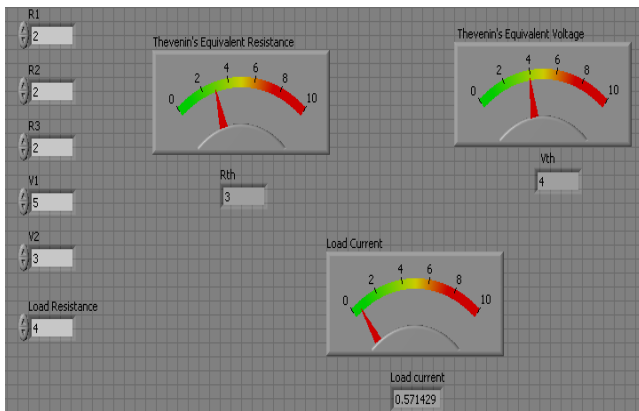


Fig.9 Front Panel for Thevenin's Theorem

#### D. Norton's Theorem

Norton's Theorem states that it is possible to simplify any linear circuit, to an equivalent circuit with just a single current source and parallel resistance connected to a load. Just like as a Thevenin's Theorem, the qualification of "linear" is identical to that found in the Superposition Theorem: all underlying equations must be linear.

In the LabVIEW simulation process, the same circuit we are using which is already used in Thevenin's Theorem shown in fig.6 and its simulation results are shown in fig.10 and fig.11.

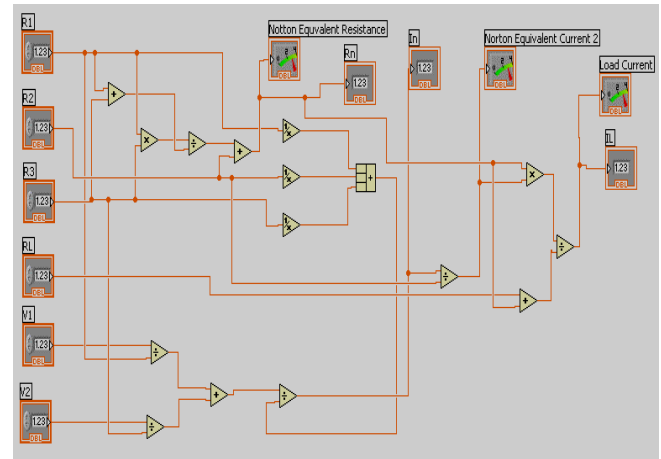


Fig.10 Block Diagram for Norton's Theorem

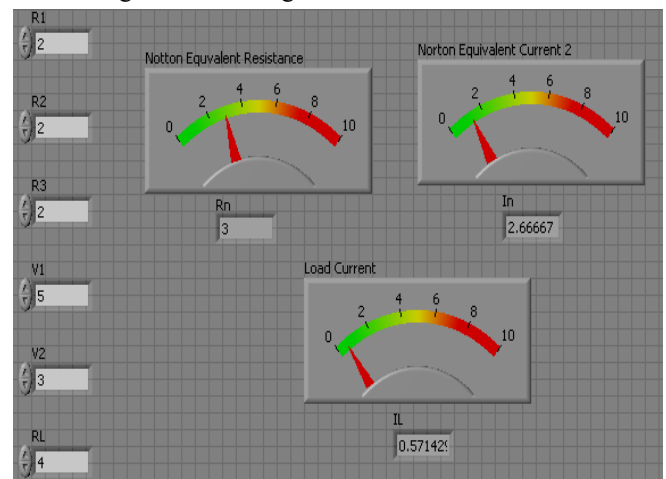


Fig.11 Front Panel for Norton's Theorem

#### IV. CONCLUSION

The idea of Basic Electrical Engineering Lab experiments Simulation using LabVIEW software is being successfully put into operation at RGGI, Meerut, India in the Department Electrical Engineering which results in outstanding feedback of students Lab work evaluation. The same idea can also be extended for other courses in future like as Control System, Network System, Electrical Machines etc. Software is a little bit tough to do work on LabVIEW for first year under Graduate technical students but basic idea can be given to them in which how to operate a LabVIEW, how to work in two windows i.e block diagram window and front panel window and how to use basic tools of the software.



In lab sessions hardware based practical can be performed physically and check their different results after simulation of their circuits in LabVIEW . The Simulation performed during this research work can also utilized as on-line experiments performance not only at Campus level but also at National and International levels using latest information technology tools.

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