



Review Paper

Simulation of R-L-C Series and Parallel Resonance in Basic Electrical Engineering with LabVIEW

Ashok Kumar Rajput

Department of Electrical Engineering, Radha Govind Group of Institutions, Meerut-25004, INDIA

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Abstract

R-L-C Series and Parallel circuit at resonance is a part of basic electrical engineering course which is mandatory for all discipline students to aware the idea of resonance in all technical universities in India and abroad. This topic is also a part of in laboratory of their curriculum. Now day by day students have different modes to perform the practical in the lab session. Software based 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 results, which is better understanding of students in learning concepts of basic electrical engineering course. Today software based different laboratory experiments can 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 and user-friendly interaction.

Keywords: Basic electrical engineering, laboratory, LabVIEW, parallel, series resonance, simulation, software.

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. R-L-C Series and Parallel circuit at resonance is a part of Sinusoidal steady state analysis of A.C. circuits 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 RCET⁵⁻¹⁰. Simulation of Synchronous machines have already been implemented in LabVIEW¹¹, 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 others¹². The list of some experiments of Basic Electrical Engineering course which has been simulated during this course work are as follows: i. Series Resonance and Analysis of Resonance Curve.

ii. Parallel Resonance and Analysis of Resonance Curve.

About The LabVIEW

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 labelled as Virtual instruments (VIs,) owing to their operational replica of physical instruments, like oscilloscopes, multi-meters, mathematical tools etc. A Virtual Instrument is the combination two panel generally known as windows. i. Front panel or window, ii. 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.

Simulation with LabVIEW

R-L-C Series Resonance: In a series RLC circuit there becomes a frequency point where the inductive reactance of the inductor becomes equal in value to the capacitive reactance of the capacitor. In other words, $X_L = X_C$. The point at which this occurs is called the Resonant Frequency point (f_o) of the circuit, and as we are analyzing a series R-L-C circuit this resonance frequency produces a series resonance.

Series Resonance circuits are one of the most important circuits used electrical and electronic circuits. They can be found in

various forms such as in A.C mains filters, noise filters and also in radio and television tuning circuits producing a very selective tuning circuit for the receiving of the different frequency channels. Consider the simple R-L-C series circuit shown in figure 1.

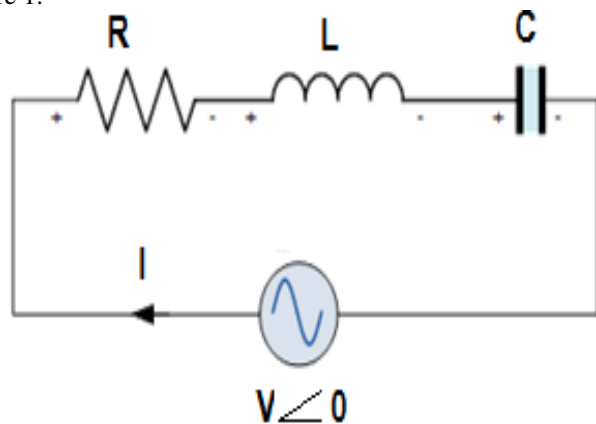


Figure-1
Circuit Diagram for Series Circuit

We know about R-L-C series circuits: i. Inductive Reactance i.e X_L ($X_L = \omega L = 2\pi fL$), ii. Capacitive Reactance i.e X_C ($X_C = 1/\omega C = 1/2\pi fC$).

Condition for obtaining the resonance in R-L-C series circuit i.e $X_L = X_C$

Resonant Frequency would be $f_0 = 1/2\pi(LC)^{1/2}$

Our aim is to obtain response (current) in R-L-C circuit at resonance and also draw the resonance curve. It is simulated in LabVIEW with two different windows one is its block diagram window shown in figure 2 and results are indicated in front panel window shown in figure 3.

R-L-C Parallel Resonance: A series resistor with the inductor in a parallel LC circuit as shown in figure 4 is a topology commonly encountered where there is a need to take into account the resistance of the coil winding. Parallel LC circuits are frequently used for band pass filtering and the Q is largely governed by this resistance. The resonant frequency of this circuit is

$$\omega_0 = \sqrt{\frac{1}{LC} - \left(\frac{R}{L}\right)^2}$$

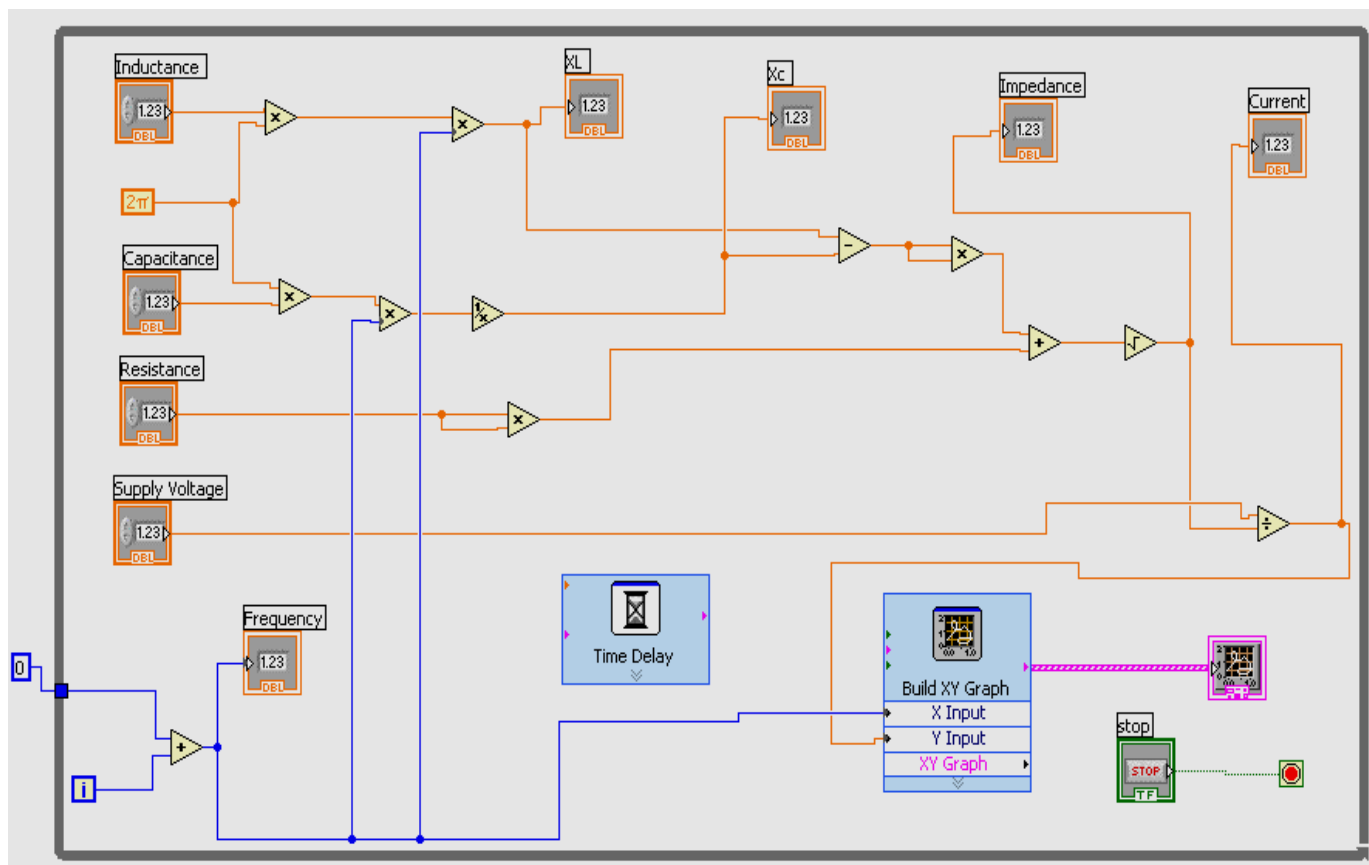


Figure-2
Block Diagram of R-L-C Series Circuit

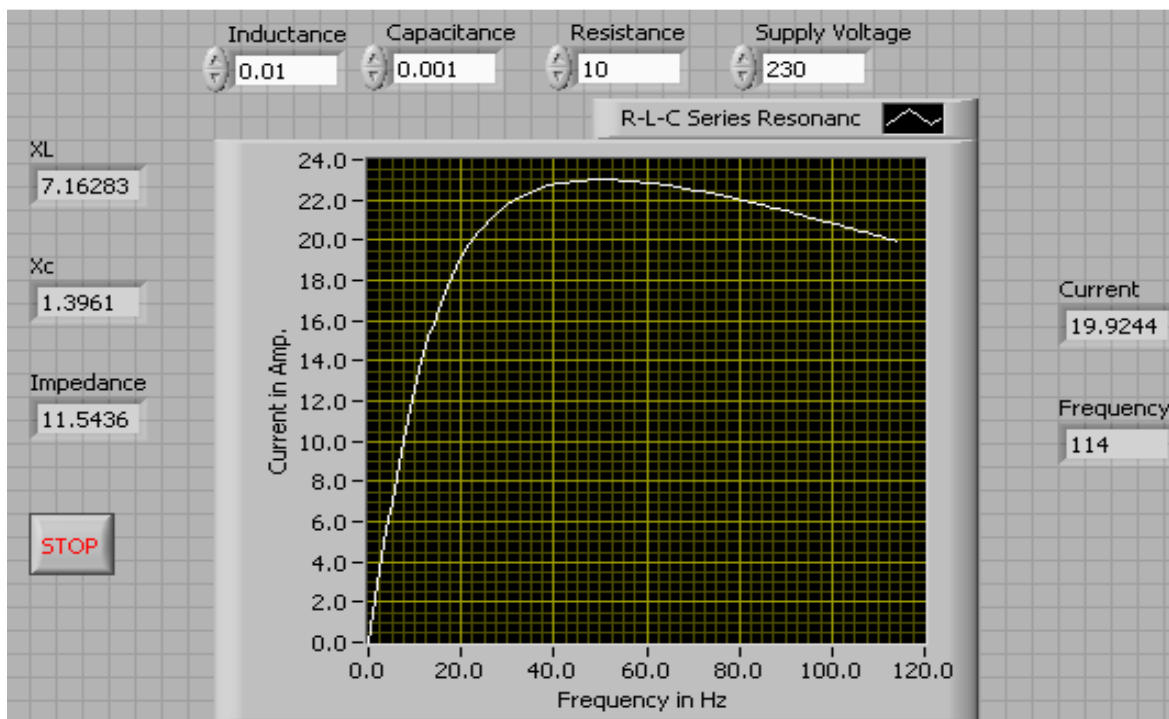


Figure-3
Front Panel of R-L-C Series Circuit

This is the resonant frequency of the circuit defined as the frequency at which the admittance has zero imaginary part. The frequency that appears in the generalized form of the characteristic equation.

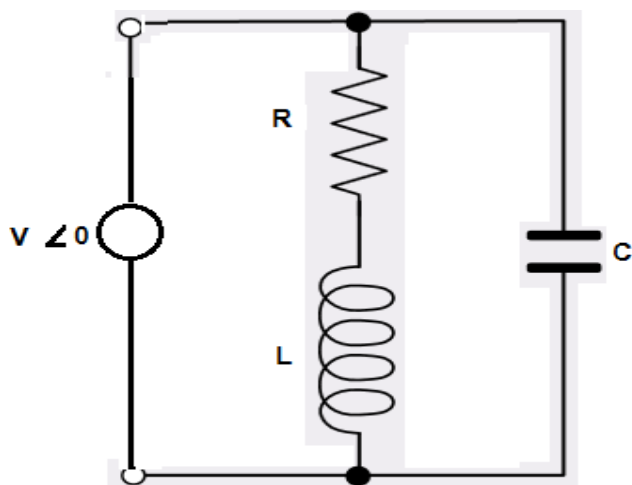


Figure-4
Circuit Diagram for Parallel Circuit

Condition for obtaining the resonant frequency i.e. $I_C = I_L \sin \Phi_L$. At resonance the following features will occur: i. Impedance

should be maximum, ii. Current should be minimum, iii. Power factor should be unity.

Simulation of this parallel circuit in LabVIEW shown in figure 5 resonance curve and all result are shown in figure 6.

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 with in campus and abroad.

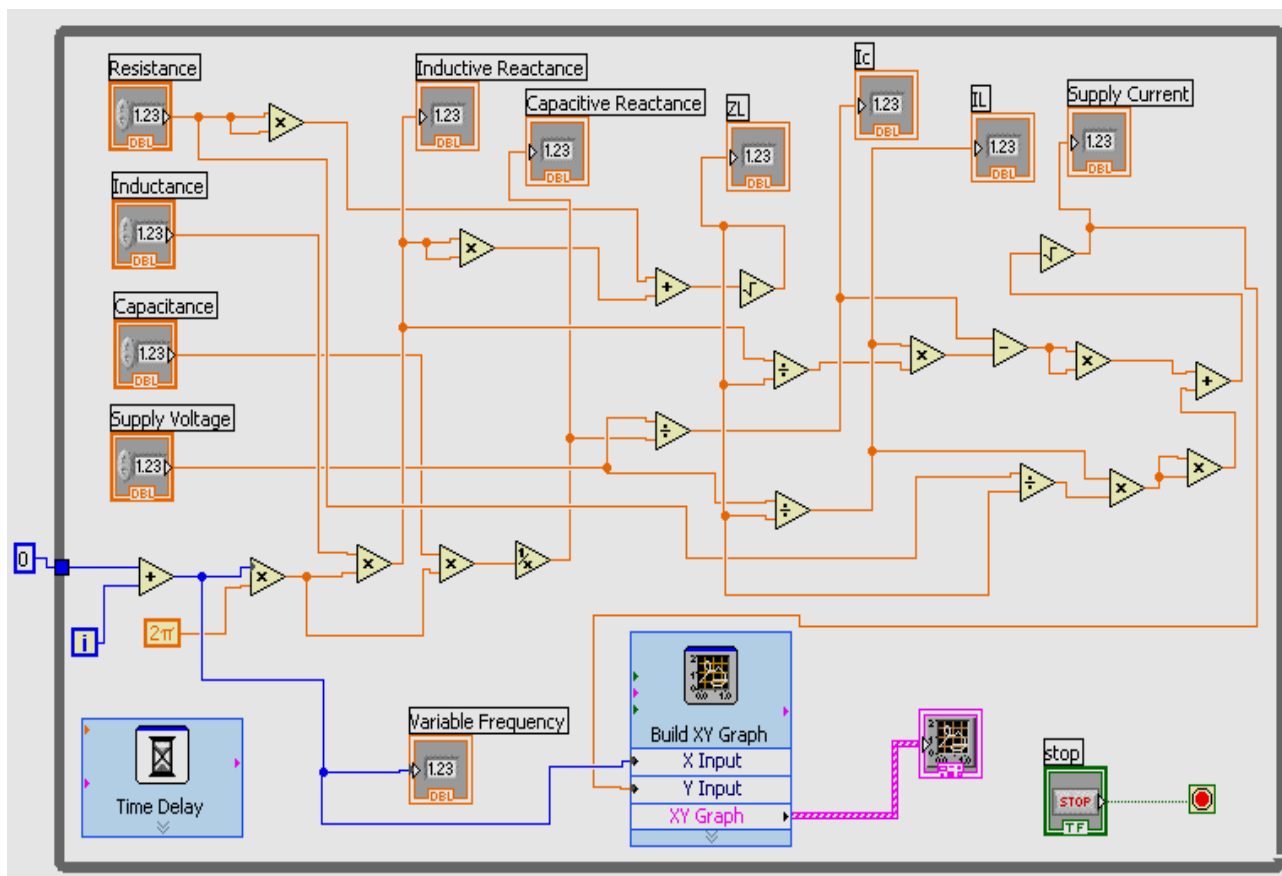


Figure-5
Block Diagram of R-L-C Parallel Circuit

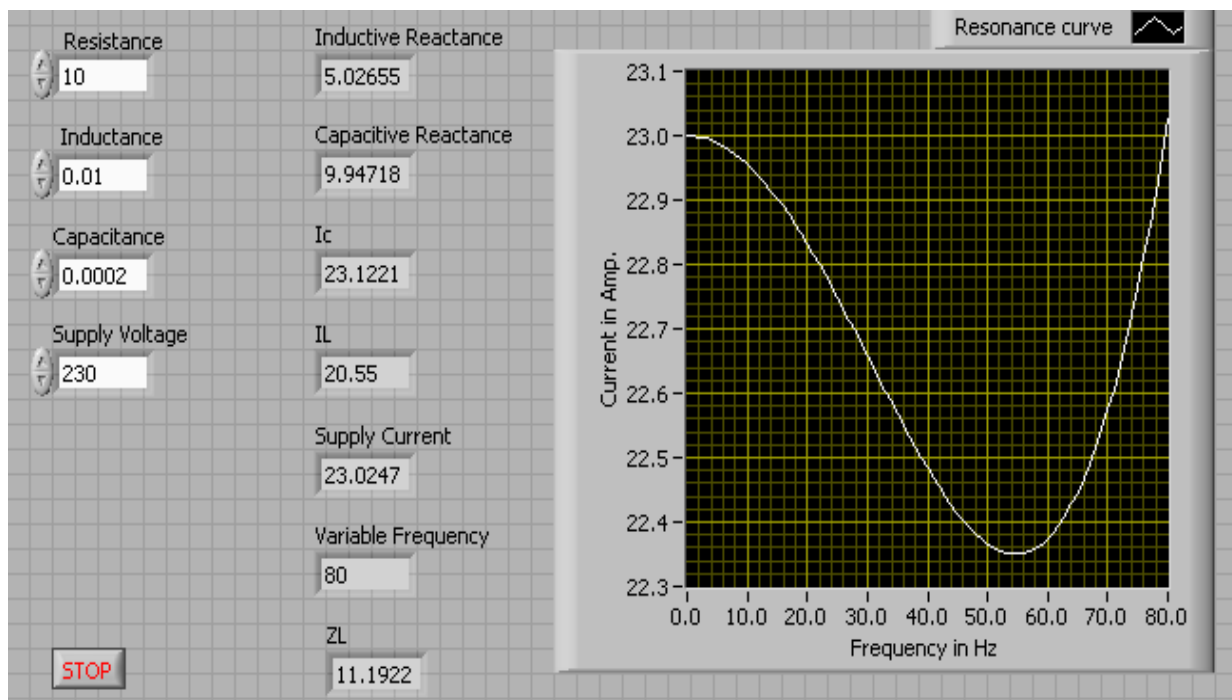


Figure-6
Front Panel of R-L-C Parallel Circuit

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