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GUI based Testing Tool for Transformer

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ABSTRACT

The objective of this paper is to develop an educational toolbox using GUI for analysis of transformers for students and lecturers. GUI figure file is developed for Open Circuit & Short Circuit Test, Sumpner's Test, All day efficiency (Energy efficiency) of transformer and parallel operation of two transformers. All this kinds of problems consists of various methods of mathematical calculation which is difficult to perform by using manual calculation (formula and calculator). The existence of this educational toolbox will help the user to calculate the parameter hence the calculation become faster and easier. The user can enter the data and obtained the results quickly in the form of data or figures. The students can also observe the effect of variation of input parameters on performance of transformer. This educational toolbox was developed by using MATLAB software.

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1. INTRODUCTION

Transformer is one of the most important electrical machines. There are various tests conducted on transformer to determine the performance and equivalent circuit of transformer. Efficiency and regulation are very important performance parameters in transformer. These parameters can be obtained by conducting Open circuit and short circuit test and by Sumpner's test.

Open circuit and short circuit test are used to analyses the single phase transformer for obtaining the equivalent circuit parameters and to obtain the characteristic such as efficiency of the transformer. In case of open circuit test the secondary winding of the transformer is kept open circuited and primary is excited by rated voltage. The power measured under this case is Iron losses as the current drawn is less (2 to 5% of rated current). In case of short circuit test the secondary winding is short circuited and primary is supply with a rated current. The power measured under this case is Copper losses as iron loss is less (supply voltage is less). Using these data we can calculate efficiency and regulation for any load condition and power factor [1]

While OC and SC tests on a transformer yield its equivalent circuit parameters, these cannot be used for the heat run test wherein the purpose is to determine the steady temperature rise if the transformer was fully loaded continuously; this is so because under each of these tests the power loss to which the transformer is subjected is either the core loss or copper loss but not both. The way out of this impasse without conducting an actual test is the Sumpner's test which can only be conducted simultaneously on two identical transformers [2].

For a distribution transformer measuring power efficiency yields wrong judging of performance of transformer since these transformers secondary supply little or no load much of the time during the day. For this transformer the primary is energized all twenty four hours and copper loss occurs when the transformer is loaded. The performance of such transformers is compared on the basis of energy consumed during a certain time period, usually a day or 24 hours. To determine energy efficiency load cycle on the transformer and power factor is known [3].

If the rating of an existing transformer is more than the load then a second transformer may be connected in parallel. When operating two or more transformers in parallel, their satisfactory performance requires that they have (i) same voltage ratio (b) same per unit impedance (c) same polarity (d) same phase sequence. The load division between the several transformers takes by equal voltage ratios and unequal voltage ratio. In case of equal voltage ratio there will no circulate current between two transformer. If the impedance of both transformer are same both transformer will share a load equally. If they have same per unit impedance they will share a load in proportion to their ratings. In case of unequal voltage ratio, then a circulating current flows between the two transformers [4].

To understand analysis of transformer in computers one should have good mathematical knowledge and Problem solving skills. Most of the topics require lot of calculations which takes lot of time. To analysis problems in computers the user has to go for programming. But this way of analysis is complex as it involves change of program for every case. In order to reduce this GUI based tool is developed for the analysis and testing of Transformers in MATLAB/GUI environment.

2. MATLAB and GUI

2.1 MATLAB

MATLAB is well known for its numerical problem solving power. Traditionally programs written by engineers have very simple interfaces, and often only the author is the one who uses the program once it is completed. There are occasions where a more polished user interface, specifically a graphical user interface (GUI) is desired.

2.2 Graphical user Interface

A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks. The GUI components can be menus, toolbars, push buttons, radio buttons, list boxes, and sliders. In MATLAB, a GUI can also display data in tabular form or as plots, and can group related components.

A graphical user interface (GUI) is a pictorial interface to a program. A good GUI can make programs easier to use by providing them with a consistent appearance and with intuitive. The GUI should behave in an understandable and predictable manner, so that a user knows what to expect when he or she performs an action. For example, when a mouse click occurs on a pushbutton, the GUI should initiate the action described on the label of the button [4].

The three principal elements required to create a MATLAB Graphical User Interface are:

i) Components.

Each item on a MATLAB GUI (pushbuttons, labels, edit boxes, etc.) is a graphical component. The types of components include graphical controls (pushbuttons, edit boxes, lists, sliders, etc.), static elements (frames and text strings), menus, and axes.

ii) Figures.

The components of a GUI must be arranged within a figure, which is window on the computer screen.

iii) Callbacks.

Finally, there must be some way to perform an action if a user clicks a mouse on a button or types information on a keyboard. A mouse click or a key press is an event, and the MATLAB program must respond to each event if the program is to perform its function. For example, if a user clicks on a button, that event must cause the MATLAB code that implements the function of the button to be executed. The code executed in response to an event is known as a call back. There must be a callback to implement the function of each graphical component on the GUI [5].

3. STRUCTURE OF DEVELOPED GUI

The GUI figure file is developed for analysis of transformer by (a) Open circuit and short circuit test (b) Sumpner's test (c) All day efficiency of distribution transformer (d) Parallel operation of transformer. The structure of the proposed model is as shown in Figure 1. Here four pushbuttons are there for this model. When the particular pushbutton is pressed it will cause that particular figure file to open.

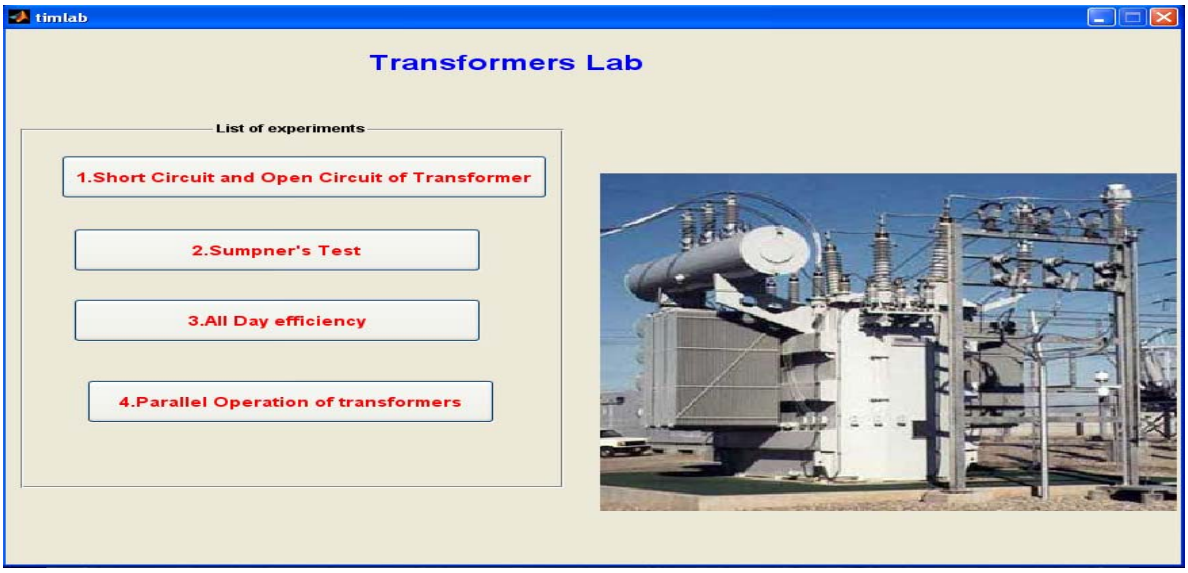

Figure 1. Structure of Developed gui

(a) Open circuit and short circuit test

When S.C and O.C. test pushbutton is pressed on tim lab figure file Figure 2 is opened. This figure file accepts rating of transformer (kva rating, voltage rating), open circuit test data and short circuit test data as inputs. In the Load details fraction of load current (x), value of power factor and type of load (lagging and leading) is specified. After entering all values press display button to display the equivalent circuit of transformer as seen on open and short circuit. This figure file also calculates the value of efficiency and regulation for the specified load conditions. This figure file also displays the graph of efficiency versus load current and regulation versus power factor. This figure is as shown in Figure 3.

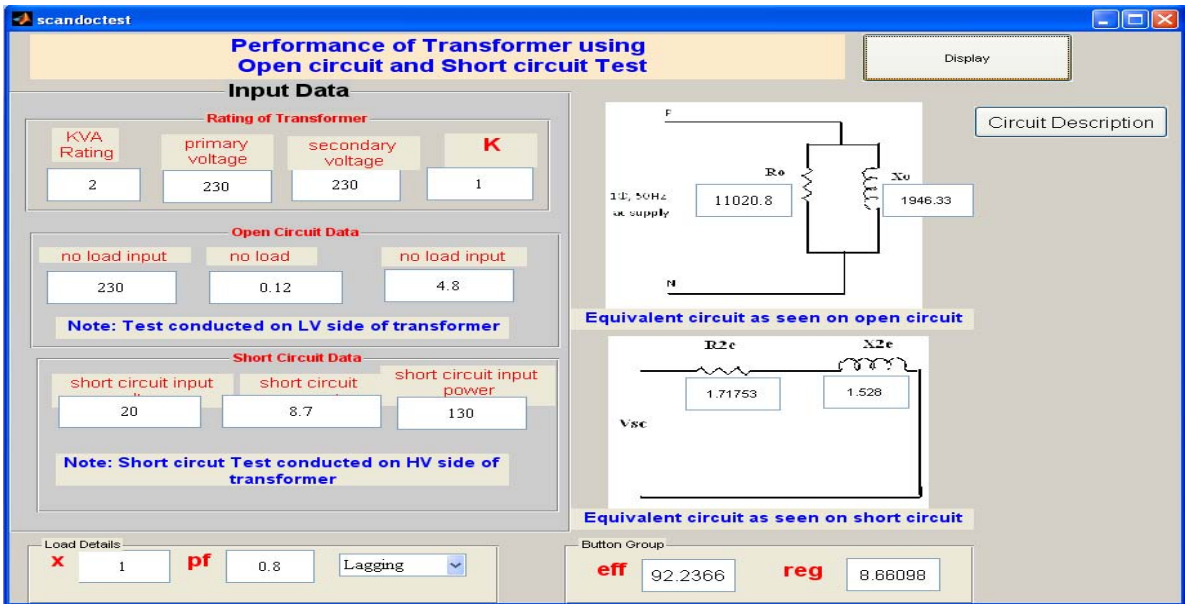

Figure 2. Open circuit and short circuit figure file

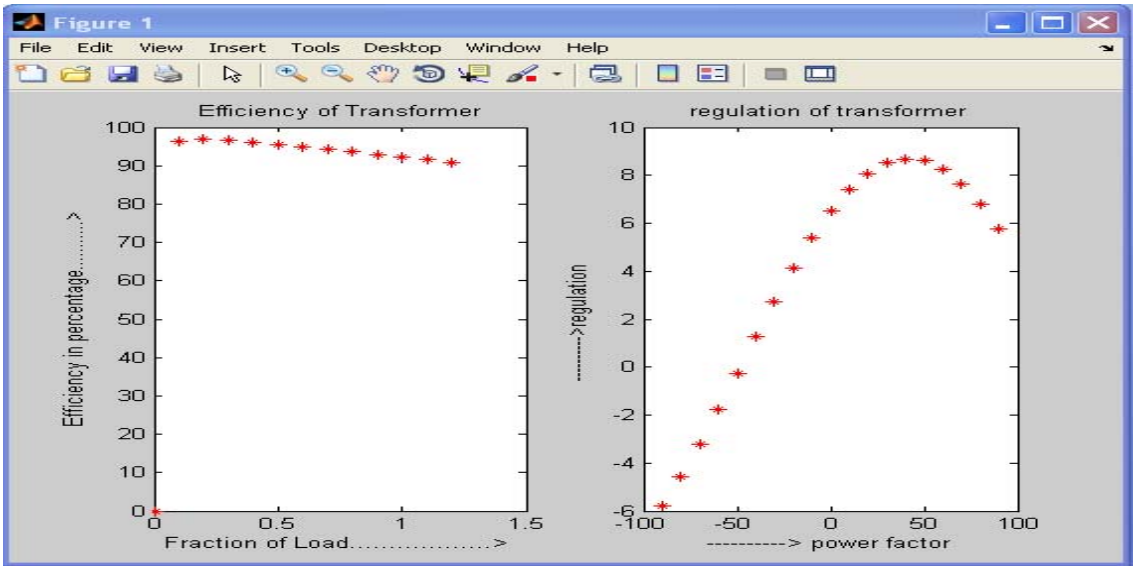

Figure 3. Efficiency versus load current and Regulation versus power factor angle

(b) Sumpner's Test

When the sumpner's test pushbutton is pressed on Tim lab figure file Figure 4 is opened. This figure file accepts rating of transformer (kva rating, primary and secondary voltage), Sumpner's Test data (Primary input voltage, Total No load current, Iron loss for both transformer, Secondary short circuited voltage, Short circuited current, copper losses for both machines) and load conditions (fraction of load current, power factor and type of load lagging or leading) as inputs. After entering all the values press Execute pushbutton to display equivalent circuit parameters Ro, Xo and R2eq, X2eq. It will also calculate the value of efficiency and regulation for this load conditions. This figure file also displays the graph of efficiency versus load current and regulation versus power factor. This figure is as shown in Figure 5.

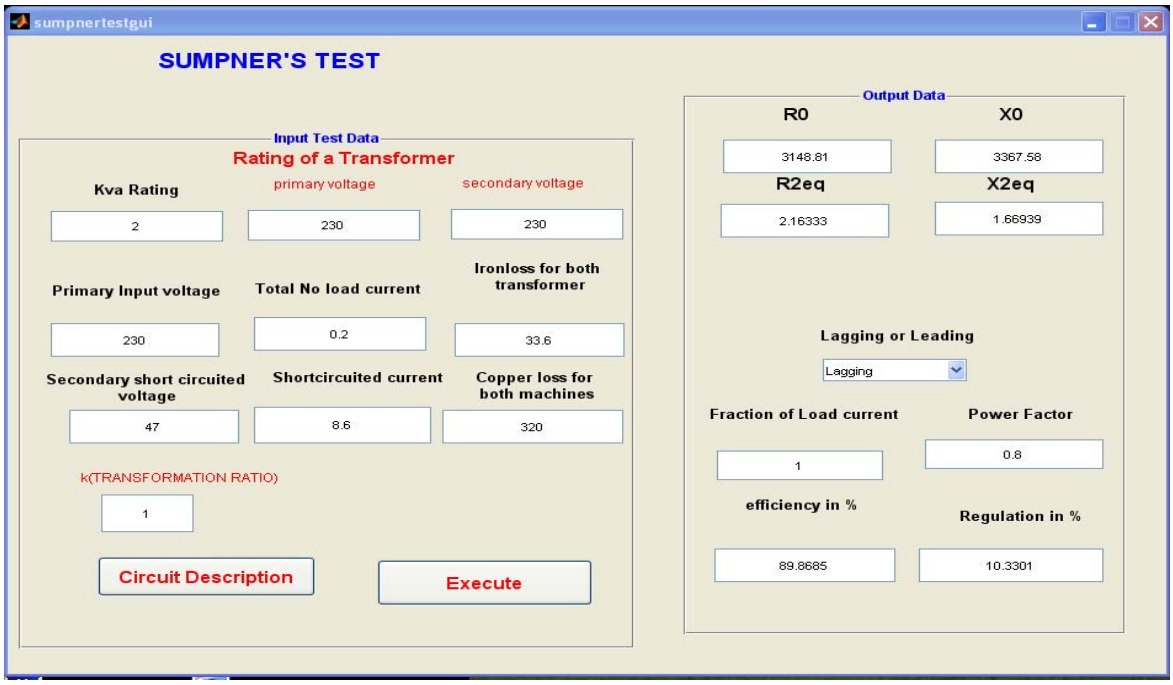

Figure 4. Sumpner's Test Figure File

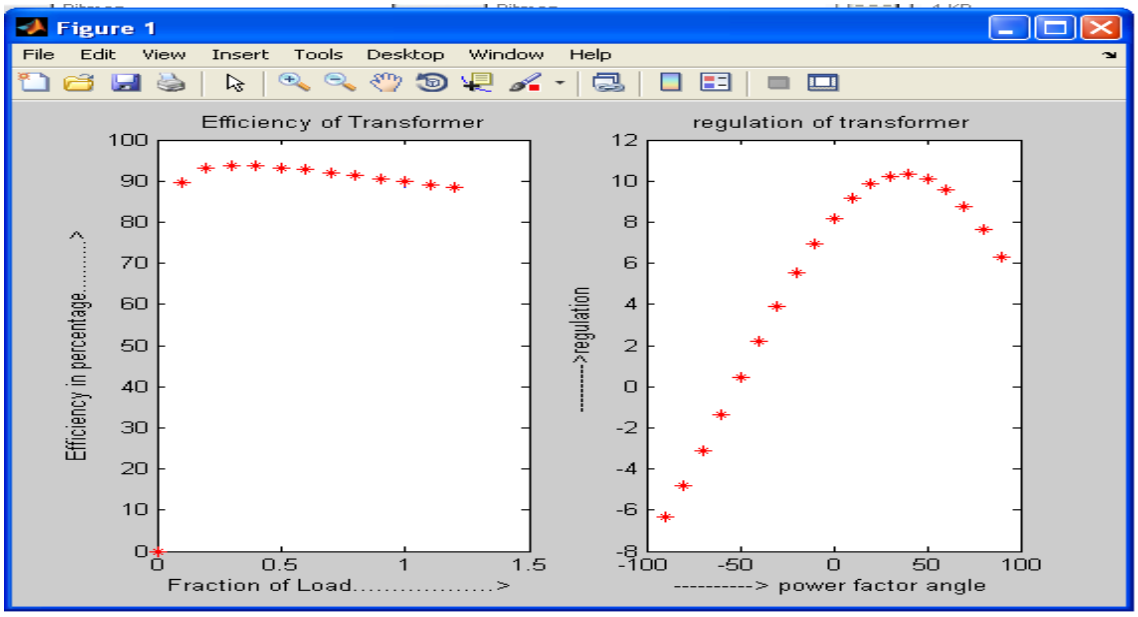

Figure 5. Efficiency versus load current and regulation versus power factor angle

(c) All day efficiency of transformer

When the All-day efficiency pushbutton is pressed on Tim lab figure file Figure 6 is opened. This figure file accepts kva rating of transformer, Iron losses and full load copper losses of the transformer, number of load steps. After entering number of load steps load number is initialised to this value. The daily load variation is entered; power at this load and power factor of this load is entered. After this, press save button to save this value. Now change pop-up menu to enter data for next loads. After entering all the load details press Execute button to display total iron losses, total copper losses, total output in kilowatt-hour and Energy efficiency of the transformer. If the daily variation is not entered for 24 hours then a warning message will be displayed which is as shown in Figure 7.

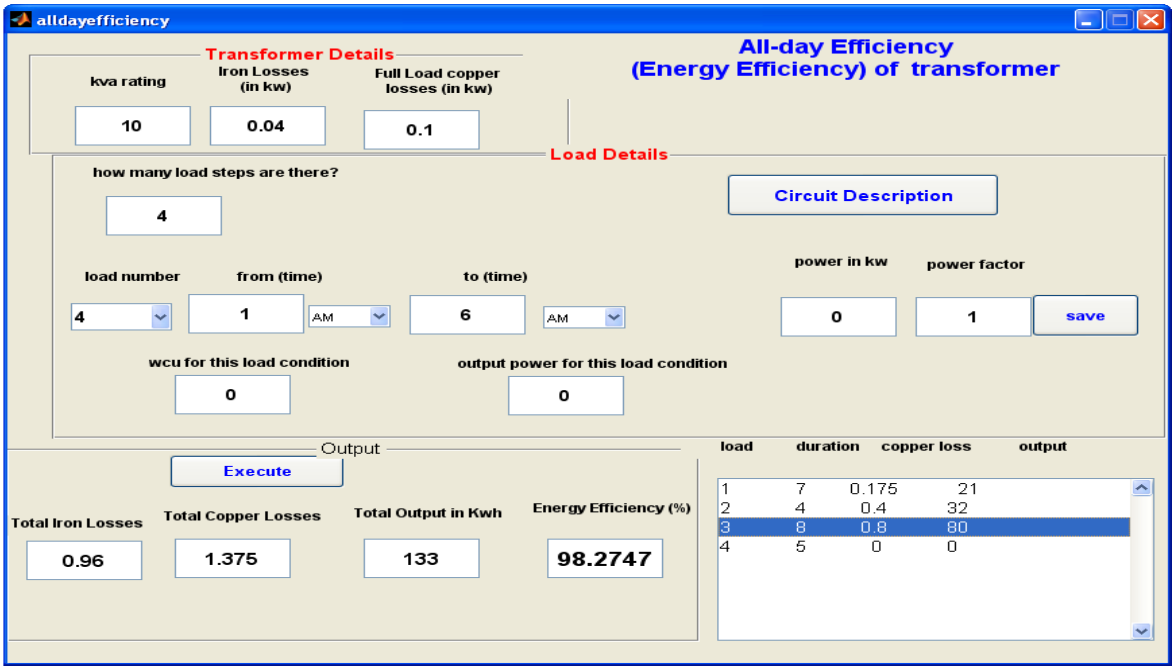

Figure 6. All-day efficiency (Energy Efficiency) figure file

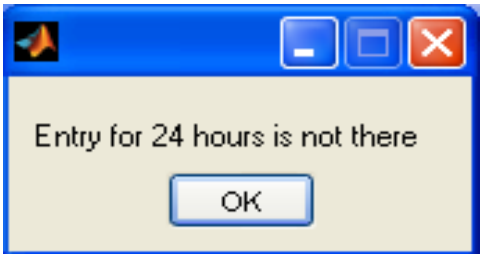

Figure 7. Warning Message

(d) Parallel operation of transformer

When the Parallel operation pushbutton is pressed on Tim lab figure file Figure 8 is opened. This figure file accepts kva rating and impedance of both transformers, load power in kva or kW is specified with load power factor with load condition (lagging / loading). Now press Execute button to see how two transformers will share the specified load demand. The value of real and reactive power shared by both the transformer is displayed and conclusion is displayed as which transformer is loaded more. An option is given for changing from equal voltage ratio to unequal voltage ratio.

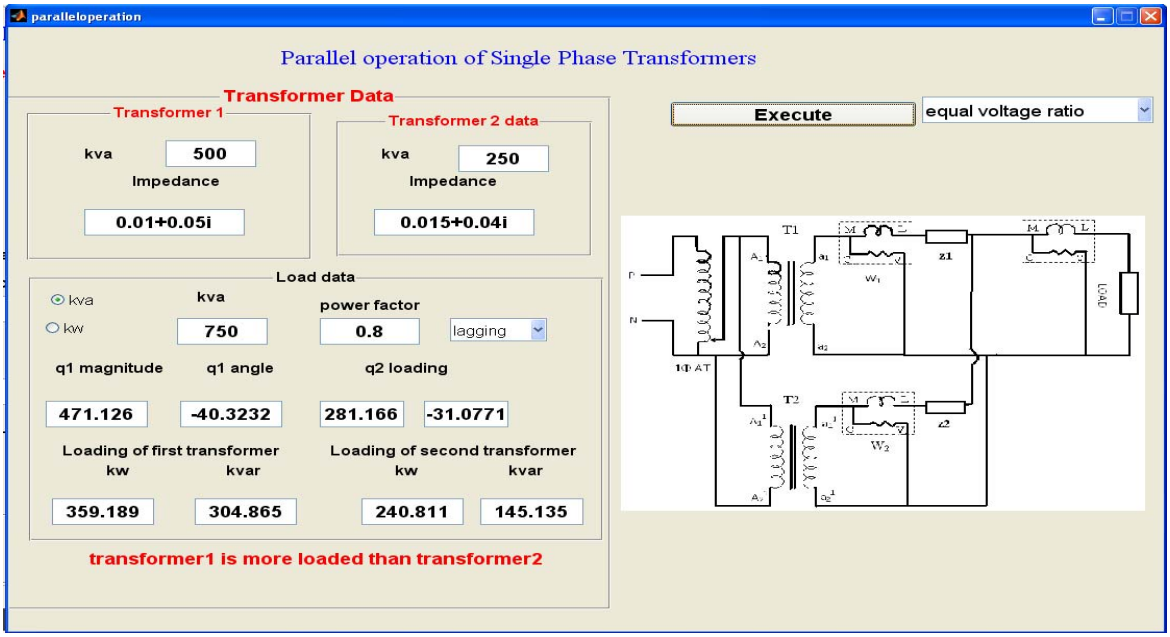

Figure 8. Parallel operation of two transformers

4. CONCLUSION

A MATLAB/GUI based education tool has been developed to demonstrate the testing of transformers. This GUI will demonstrate testing of transformer by open circuit and short circuit, sumpner's test, all day efficiency and parallel operation of two transformers. This software provides a user-friendly interface to help the student to analyze electrical machines. After running the GUI the user can select the particular testing of machines, enter the data and display the results. The effect of variation of any input parameter can also be observed. Student can verify solution of any problem with this tool. This interface can be used as an educational tool for analysis of electrical machines. The only requirement for this is MATLAB.

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