جامعة القاهرة

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The project of Electrical Power System (EPE3010)

Transmission Line Measurement

Submitted by

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Introduction:

Power system is formed of three essential parts (Generation, transmission and distribution) (fig 1).

Generation:

In generating station, the fuel (coal, water and nuclear energy) is converted into electrical energy. The electrical power is generated in the range of 11kV to 25kV, which is step-up for long distance transmission.

The generator and the transformer are the main components of the generating station. The generator converts the mechanical energy into electrical energy. The transformer transfers the power with very high efficiency from one level to another.

Transmission:

The transmission substation carries the overhead lines which transfer the generated electrical energy from generation to the distribution substations. It only supplies the large bulk of power to bulk power substations or very big consumers.

The transmission voltage is operating at more than 66kv and is standardized at 69kv, 115KV, 138KV, 161KV, 230KV, 345KV, 500KV, and 765KV, line-to-line.

Transmission system that connects the high voltage substations through the step-down transformer to the distribution substations is called the sub-transmission system. Its voltage level ranges from 90 to 138KV and directly serves some large industries.

Distribution:

It is the component of an electrical power system connecting all the consumers in an area to the bulk power sources.

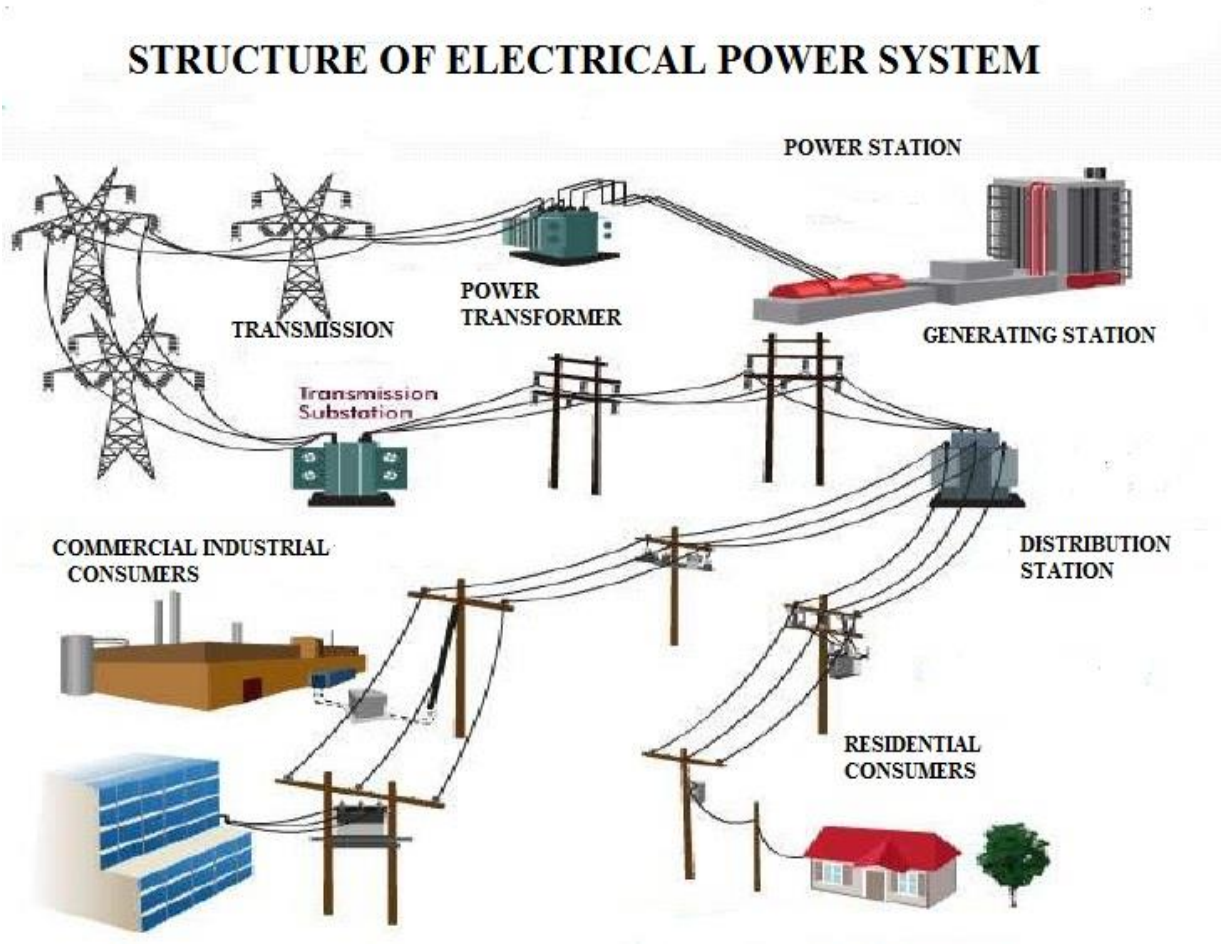

Fig 1

Here we are focusing on transmission and the designing of transmission lines.

To design a transmission line there are different parameters required for transmitting the power needed, these parameters include transmission voltage, conductor type, bundles per phase and number of circuits.

Some constrains should be satisfied (electric, environmental, mechanical and economical constrains).

Electric constrains:

Includes stability, reliability, thermal capacity, voltage profile, corona and over voltages

Electric constrains content calculations of efficiency and voltage regulation

Efficiency = receiving end power (P_R) / sending end power (P_s)

Voltage regulation: is the rise in voltage at the receiving end expressed in percent of full-load voltage.

$$\varepsilon = \frac{|v_s| - |v_{R\,@FL}|}{|v_{R\,@FL}|}$$

Environmental constrains:

Which guarantee the protection of the people and their health surrounding the transmission line if it passes near a living area.

Mechanical constrains:

The different forces existing on the conductors (string and the tower)

Economical constrains:

The minimum cost possible to satisfy the requirements required for transmission line.

Our focus here are on Electrical constrains as first we try to choose a material of transmission line and make our calculations and see its efficiency, voltage regulation, power factor at receiving end, current at sending / receiving end and line impedance / capacitance / inductance then try another material and see if it would do better until we get the best material to satisfy us then try to increase the design performance by increasing the bundles and circuits and get the best performance.

So, we created a program to do the calculations for us at fast speed without any effort from us.

Description of the program:

After you start the program, you see a simple interference where you press the start button to start the program (fig 2).

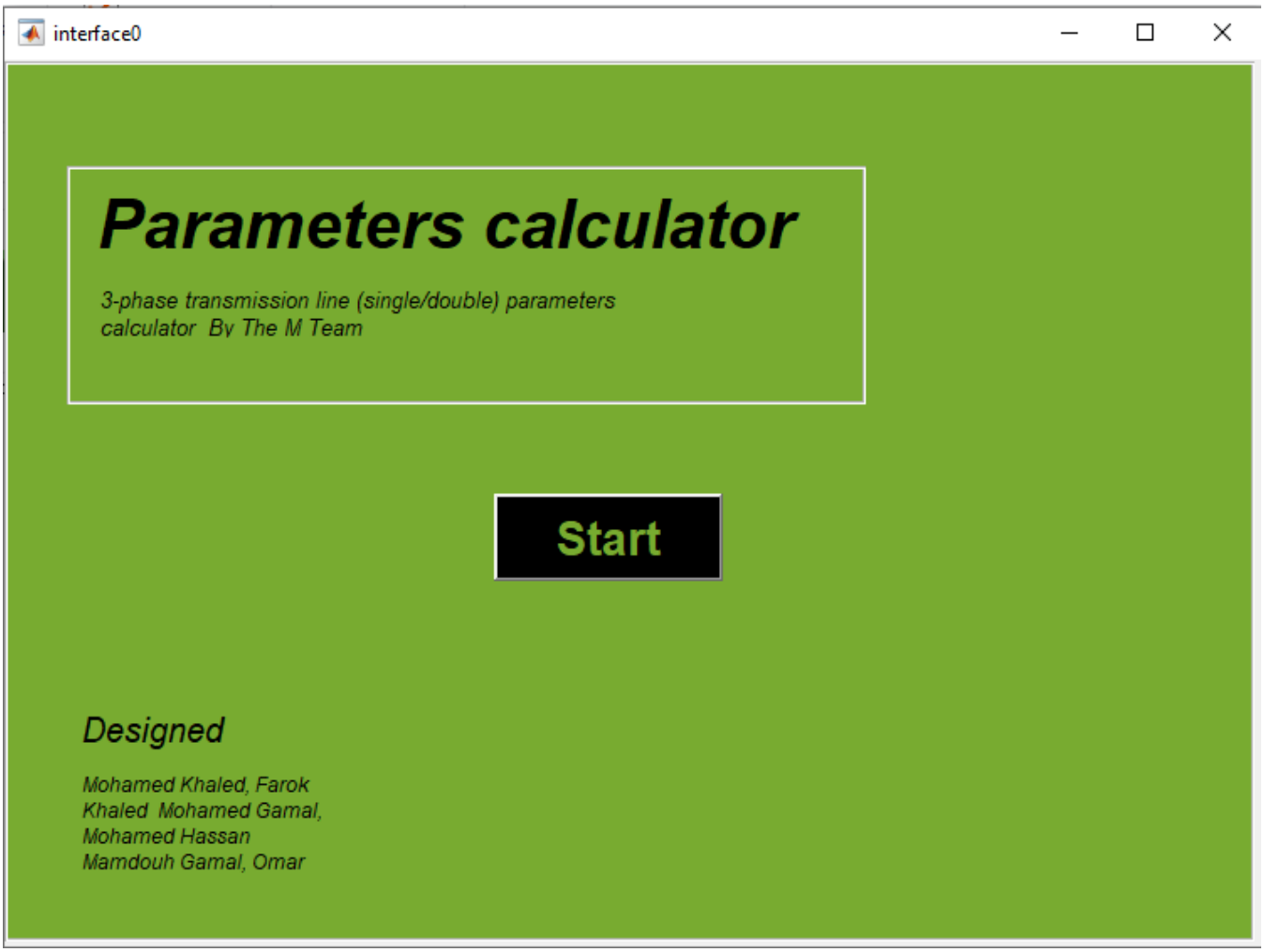

Fig 2

Then you see a text box where you write the length of the transmission line of the test.

If you input a negative or zero or blank input it shows a warning to enter a positive value (fig 3).

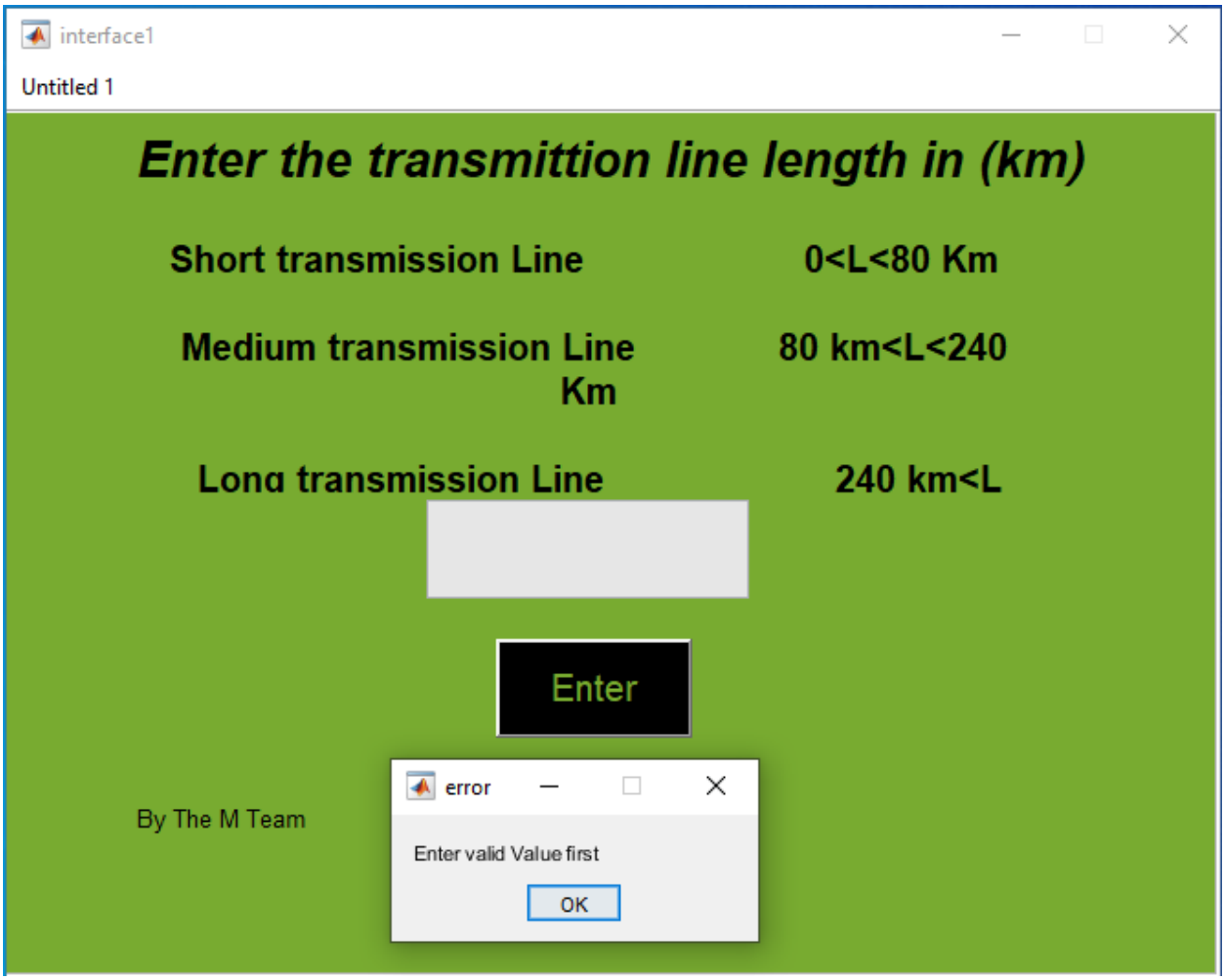

Fig 3

We divided our program into three phases according to the transmission line length as:

less than 80 km is a short transmission line

From more than 80 to 240 km is a medium transmission line

More than 240 km is a long transmission line.

Minimum Inputs:

Frequency: the frequency that the transmission line is operating at.

Distance between a and b / b and c / c and a: the distance between the three phases Cables of the transmission line.

Diameter of phases: the diameter of the Cables of the phases.

Receiving end power factor: the power factor required at the receiving end.

Receiving end power: the power required at receiving end.

Receiving end voltage: the voltage required at receiving end.

Resistance of phases: the AC resistance of the Cables at 50C from the used Cables data chart.

in single circuit: R per phase

in double circuit: R per phase per circuit

in bundle option: R per phase per circuit per conductor

The three-phase diagram (fig 4).

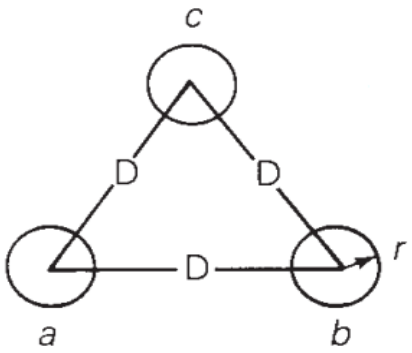

Fig 4

Bundle and Double circuit inputs:

The program is originally selected at single bundle option, but you can choose more bundles to increase the performance of the system and you would need to input the distance between the bundles (fig 5).

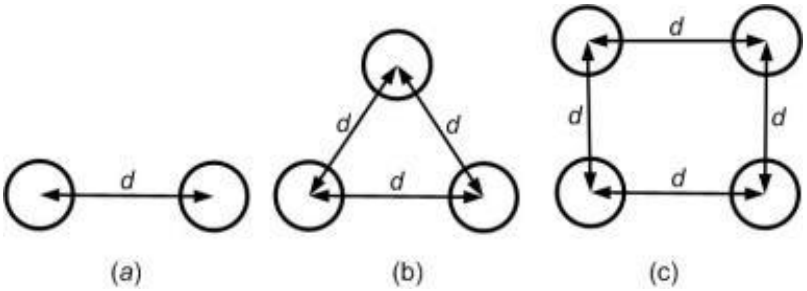

Fig 5

The program is originally selected at single circuit option, but you can choose double circuit option to increase the stability of the system and you would need to input the distance between every two conductors (fig 6).

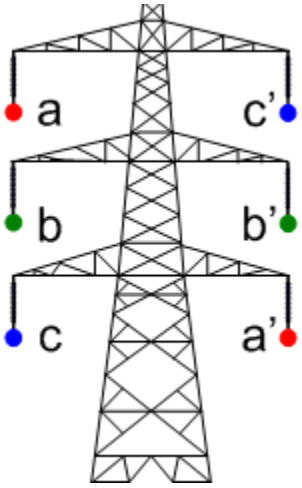

Fig 6

Short transmission line:

By putting the value of the length of the transmission line 50 km and its parameters we press the button calculate then we get the outputs of the program.

We can check all the outputs from the program in an easy-to-read box (fig 7).

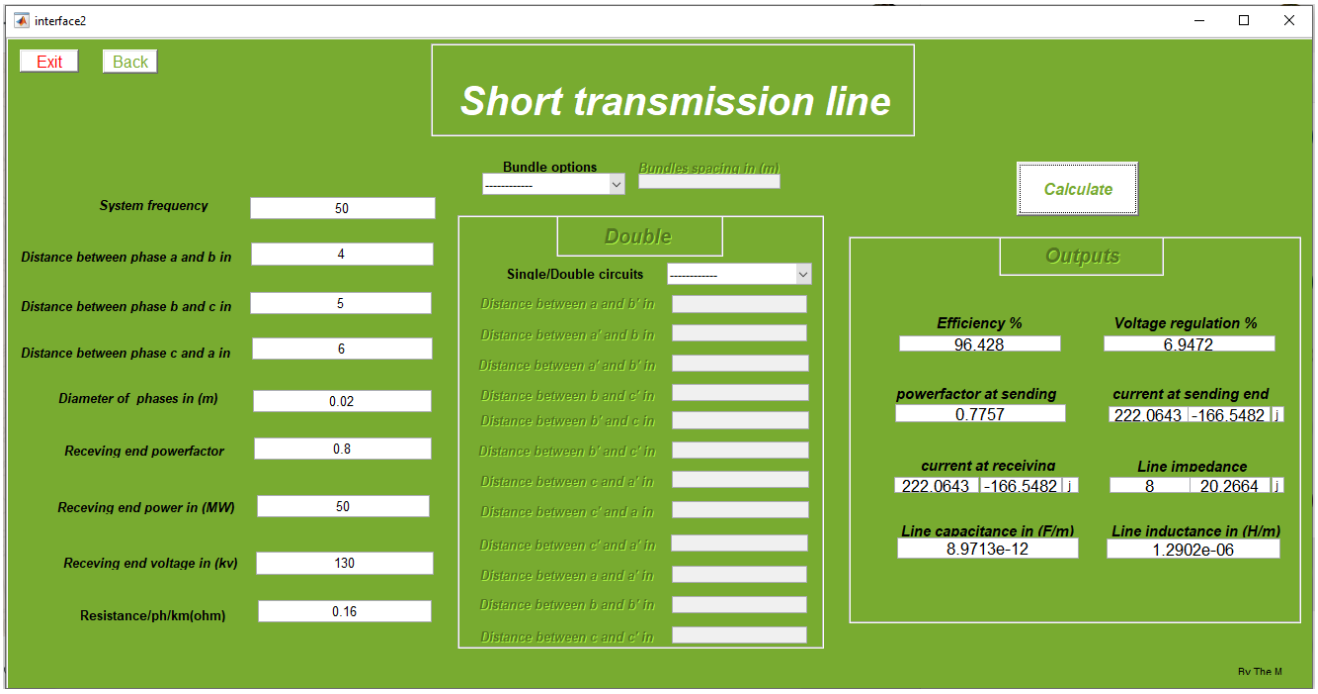

Fig 7

we can activate bundle option by choosing the number of bundles from 1 to 4 bundles where we can see the efficiency increases and voltage regulation decreases as we increase the number of bundles (fig 8).

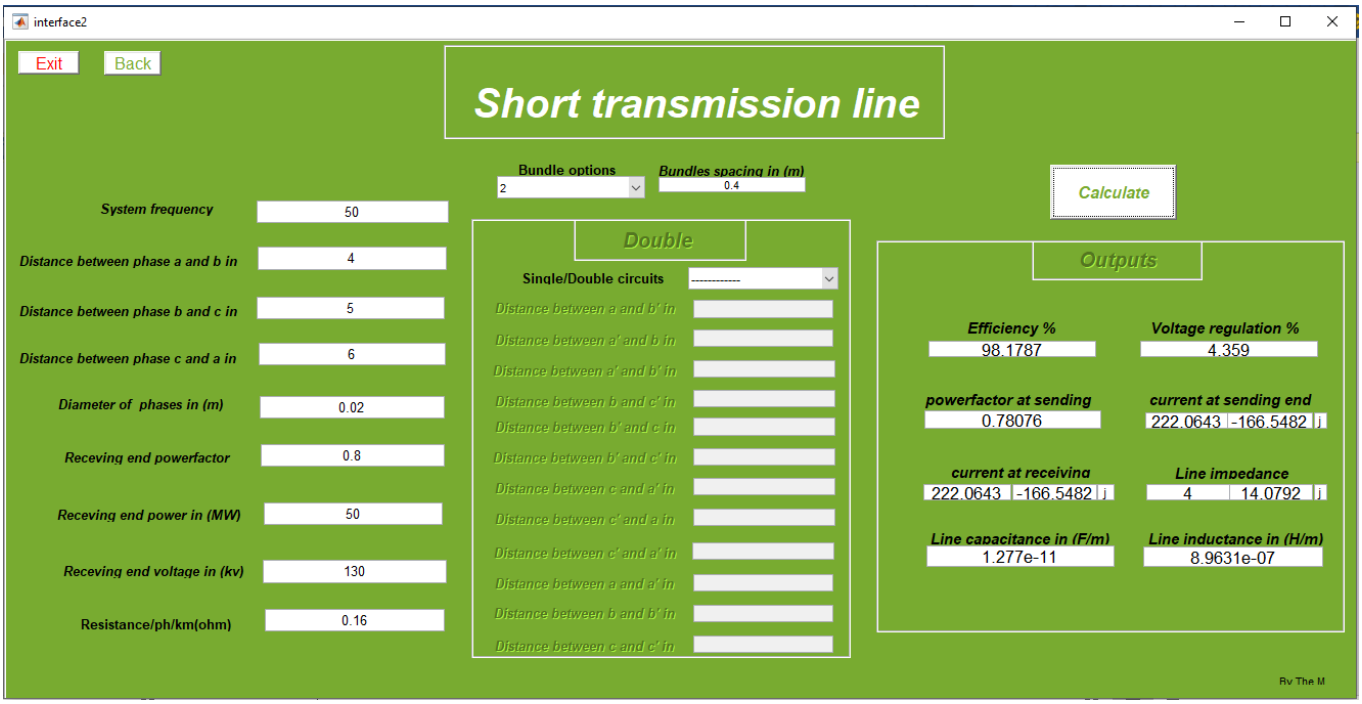

Fig 8

We can choose a double circuit option and insert the distances between the conductors to improve the efficiency, voltage regulation, increase the safety in case of fault and increase stability of the system.

Medium transmission line:

By putting the value of the length of the transmission line 120 km and its parameters and the model we press calculate to get the output values we need.

If we didn't choose the model type the program will show a warning massage to warn us to choose it (fig 9).

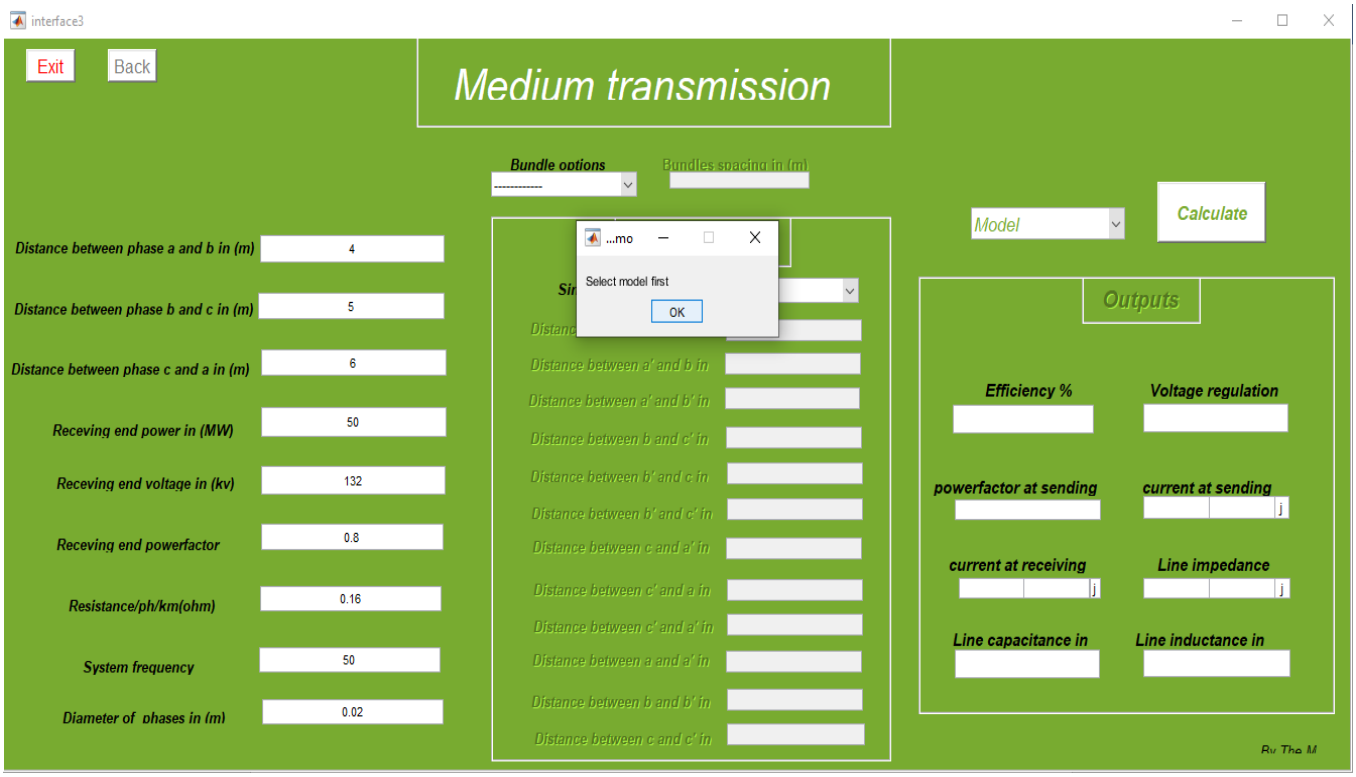

Fig 9

After we choose the model type (pie/T) and press calculate we get the output values we need.

If the model is pie (fig 10).

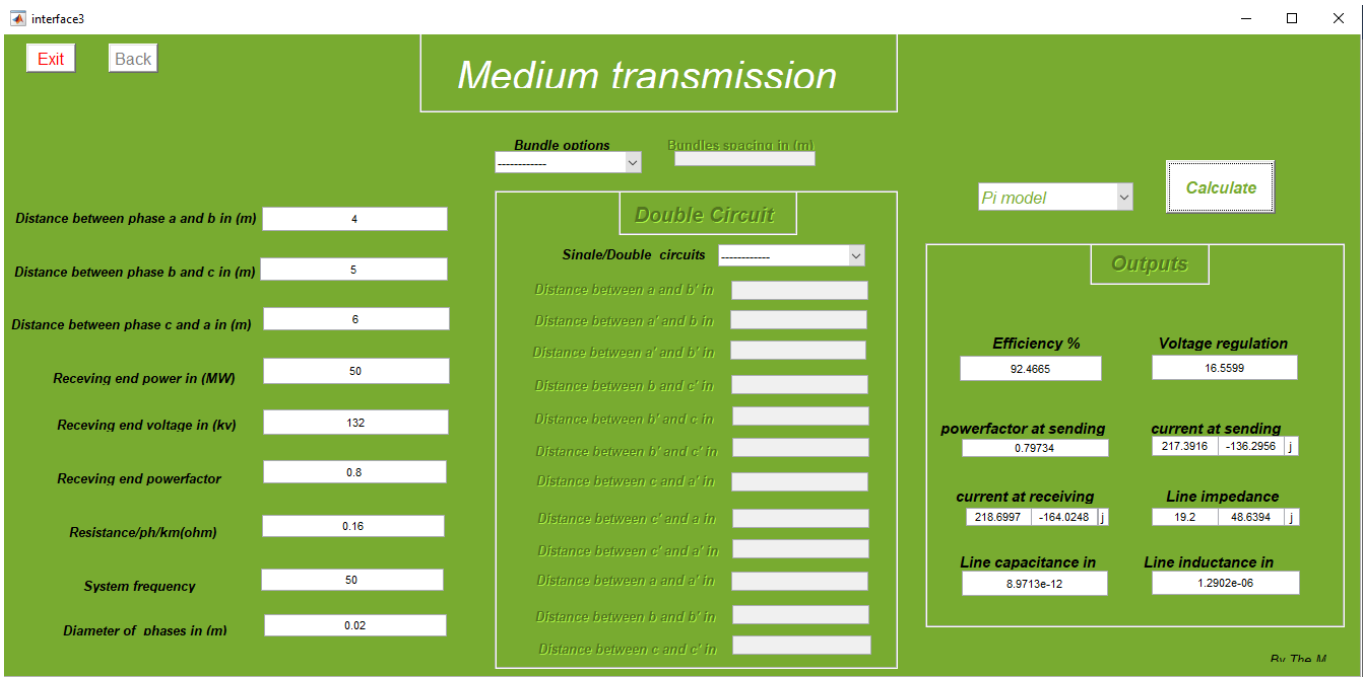

Fig 10

If the model is T (fig 11).

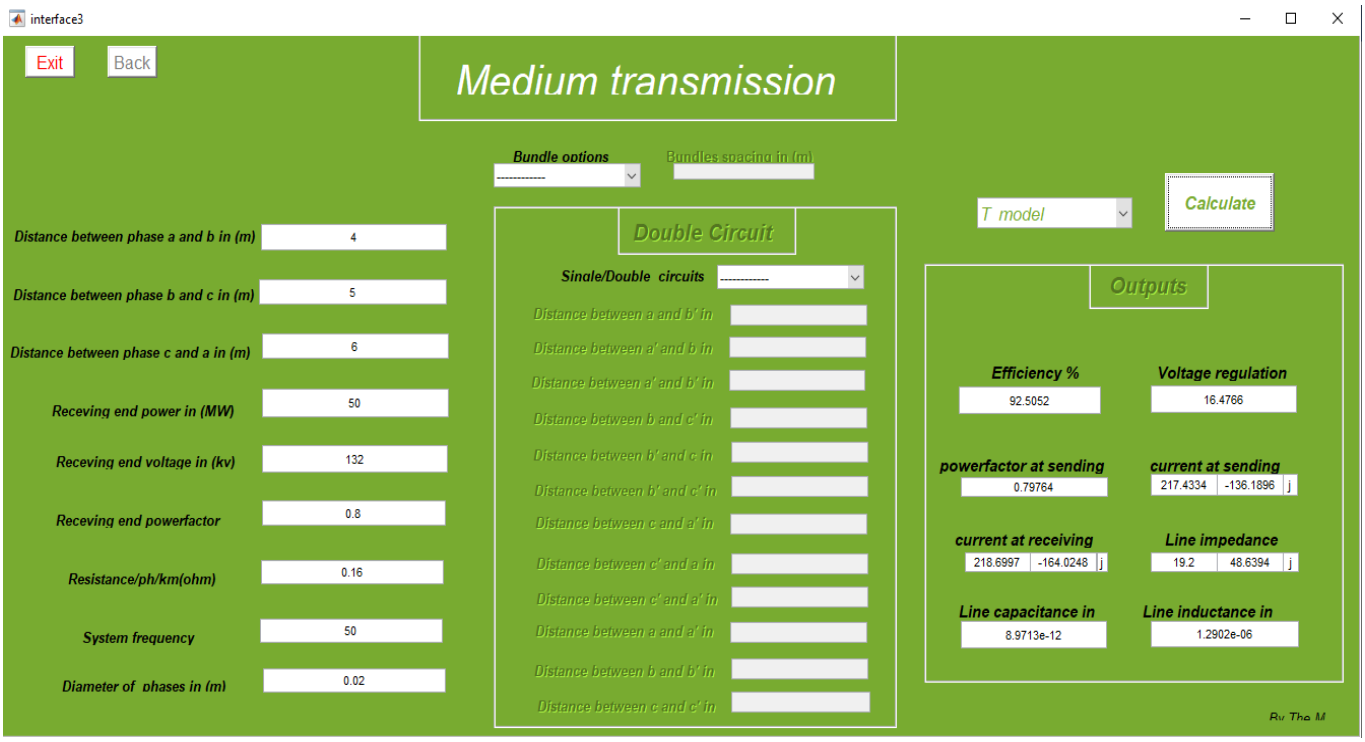

Fig 11

We find that there isn't much difference between the two models.

We can activate bundle option and double circuit, that improve the system (increase the efficiency, decrease voltage regulation and increase stability of the system), same as short transmission line.

Long transmission line:

By putting the value of the length of the transmission line 300 km and its parameters we press the button calculate then we get the outputs of the program (fig 12).

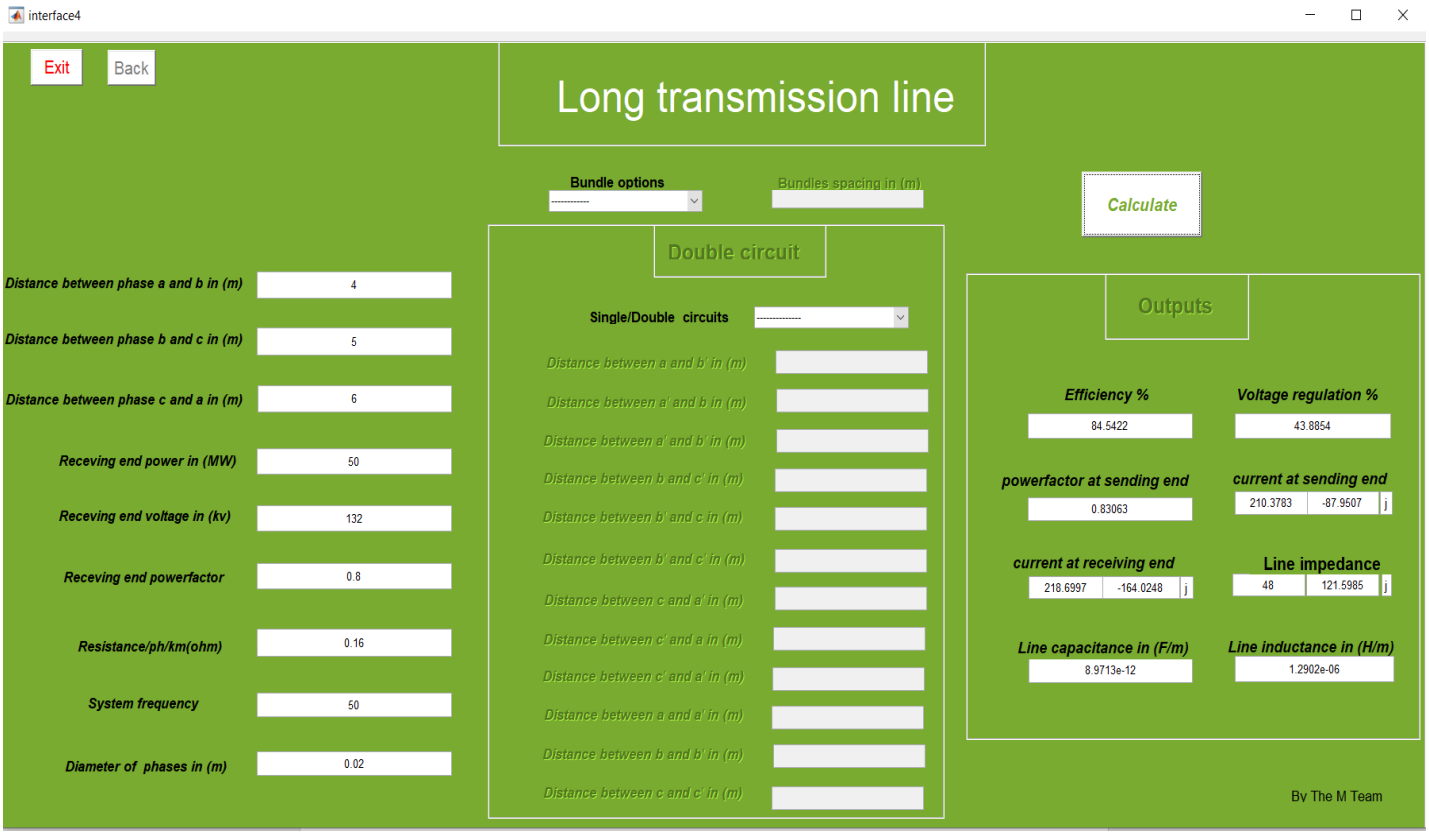

Fig 12

We can activate bundle option and double circuit, that improve the system (increase the efficiency, decrease voltage regulation and increase stability of the system), same as short and medium transmission line.

Advantages & disadvantages:

Advantages:

- The program is easy to use for all users and doesn't need experience or knowledge to operate it.
- If you aren't using bundle option or circuit option, the program is automatically choosing single bundle and single circuit options.
- if you didn't choose bundle option or double circuit The text boxes aren't valid.
- High accuracy of the program.
- Fast calculation speed.

Disadvantages:

- The program needs MATLAB runtime to start or high version of MATLAB program.