TEACHWARE DEVELOPED FOR STUDENTS OF UWB POWER ENGINEERING STUDY PROGRAMME

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ABSTRACT

The developed software for the short-circuit analysis is intended for the students of the power engineering study programme offered by the University of West Bohemia. The program is based on the method of symmetrical components. The power system elements are modelled by equivalent π-circuits. The software was developed in Borland Delphi. The results are recorded into text files and also displayed graphically as the phase vector diagrams that are suitable for teaching purposes.

1. INTRODUCTION

The University of West Bohemia (UWB) represented by the Department of Electric Power Engineering and Environmental Engineering offers the Bc., MSc. and PhD. study programmes directed towards the electric power engineering. The short-circuit calculation belongs to the fundamental knowledge of the graduate engineers, so that the practical knowledge of short-circuit calculations are required within the framework of several courses. Computer-based training has become an integral part of the seminars.

The software tools used in the courses up to now are out-of-date at present time. Due to running in the DOS the data input and control of the former softwares is somewhat "user-unfriendly". From this reason we decided to develop new software tool, user-friendly computer program with special reference to clearly displayed results that would be suitable for teaching purposes and understanding solved problems.

2. DESCRIPTION OF THE SOFTWARE

The developed software for the short-circuit analysis is called TeNeCo (according to the names of its authors). The computer program is based on the principle of superposition and the method of symmetrical components [1], [3]. There are several approximations that have been used to simplify the fault calculations: a balanced power system is assumed; shunt elements except the earth capacitance of power lines are neglected; the middle position of transformer tap changers is set; the voltage magnitude of generators and infeeds is constant. The complex numbers and proportional units are used in the program. The power system elements are modelled by equivalent π-circuits, and the power system by the admitance matrix Ybus. The use of the bus impedance matrix Zbus provides a convenient means for calculating the fault currents and the post-fault voltages associated with various types of faults. The bus impedance matrix Zbus is obtained by using the LU decomposition method.

Because the Windows is widespread operating system, we have decided for the Borland Delphi that is appropriate tool for developing Windows-orientated applications. The Borland Delphi is well known object-oriented programming system. At present the Object Oriented Programming (OOP) is also used in the power system analysis [2]. Particular network elements, matrices, faults etc. are defined as the objects with its own structure and methods (similar to the functions and procedures). From view of a programmer the definition of the objects and the programming of the methods is very demanding and time-consuming work. On the other hand the advantages connected with the future extensibility are very considerable.

3. DATA-INPUT EDITOR

For data input, the interactive editor with full support of Drag&Drop technology was developed (Fig.1). The icons on the panel allow data entering. In the second group of icons there are icons for entering the parameters of nodes, power lines, transformers, supply networks and generators.
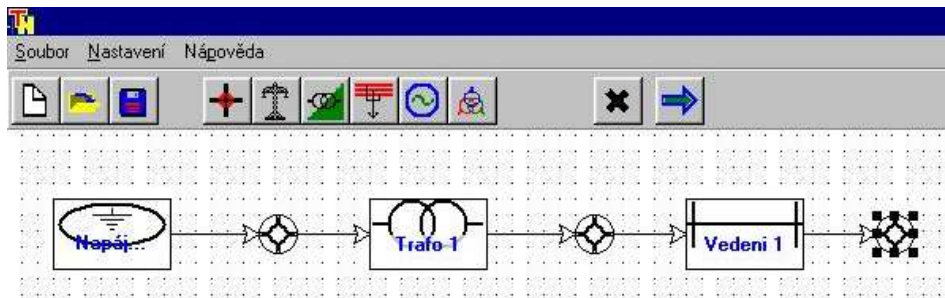

Fig.1 Data input editor (supply network – transformer – power line)

After clicking on an icon the data form of given network element is displayed. The data form contains lines for entering parameters of the network element. The data form of a power line is shown on Fig.2.

Fig.2 Data form of power line parameters

The identification, the nominal voltage, the sending-end and receiving-end nodes, the length and the parameters of the power line can be written. For facilitation of data entering the data form contains the list box of the most frequently used power lines (so called the type power lines). The editor for entering the parameters of the type lines is also built in the computer program. Similar data forms are developed also for the other network elements.

The network elements displayed on the panel as boxes with their symbols should be connected by mouse clicking.

4. SHORT-CIRCUIT ANALYSIS UNIT

The software is designed for solving the three-phase, two-phase, single phase and two-phase to ground faults and also the earth faults. The fault resistance and the pre-fault voltages can be taken into account. In the check box (Fig.3) the user can select also the fault position (the node where the fault is occurring).
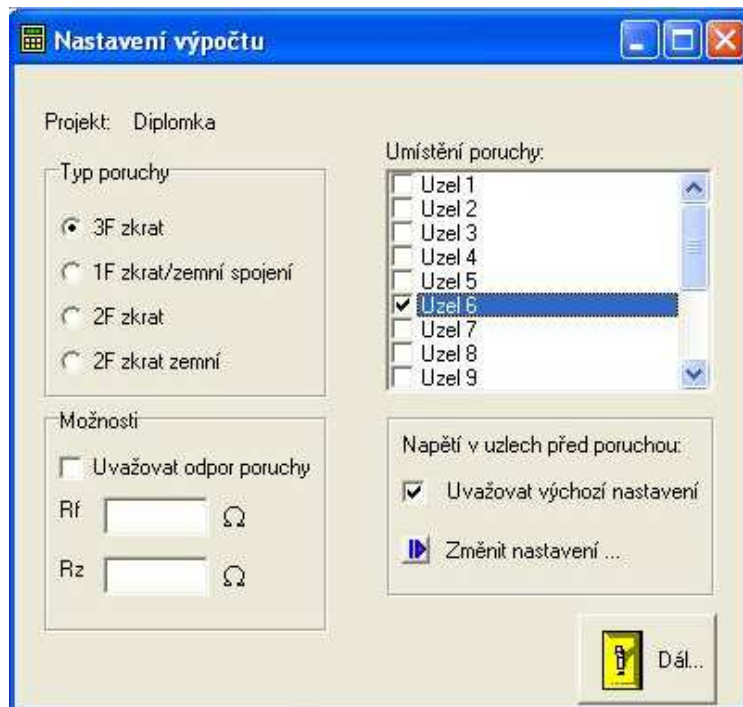

Fig.3 Set-up of calculation process

After setting-up the calculation process will run. For unsymmetrical faults the sequence admitace matrices $Y_{\text{bus}}^{(1)}, Y_{\text{bus}}^{(2)}$ and $Y_{\text{bus}}^{(0)}$ are built and then the sequence impedance matrices $Z_{\text{bus}}^{(1)}, Z_{\text{bus}}^{(2)}$ and $Z_{\text{bus}}^{(0)}$ are obtained by using the LU decomposition method. For symmetrical faults only the positive-sequence matrices are required. The zero-sequence network of the power system can differ from positive and negative-sequence ones as a consequence of transformer-winding arrangements. Despite it the dimension of positive, negative and zero-sequence admitance/impedance matrices are the same. The open-circuit in the zero-sequence network (e.g. a wye-connected transformer) is modelled as a fictitious impedance of large numerical value (in this case 1015) so that the configuration of zero-sequence network is consistent with positive or negative-sequence ones.

Finally, the fault current and the during-fault voltages in all nodes are calculated. Theoretical background of the short-circuit analysis is described in [1], [3].

5. UNIT FOR DISPLAYING THE RESULTS

The results are written into text files, which allow the students next data processing. There are recorded the fault impedance, and sequence/phase fault currents and post-fault voltages at all nodes.

The results are also displayed graphically as the phase vector diagrams that are very suitable for understanding the solved problems. For displaying the results the special built-in viewer was developed (Fig.4). The built-in result viewer allows displaying both the sequence voltages and the phase voltages at selected nodes. The phasors of the sequence voltages have different colour. There is also possible to save displayed diagram into an image file.
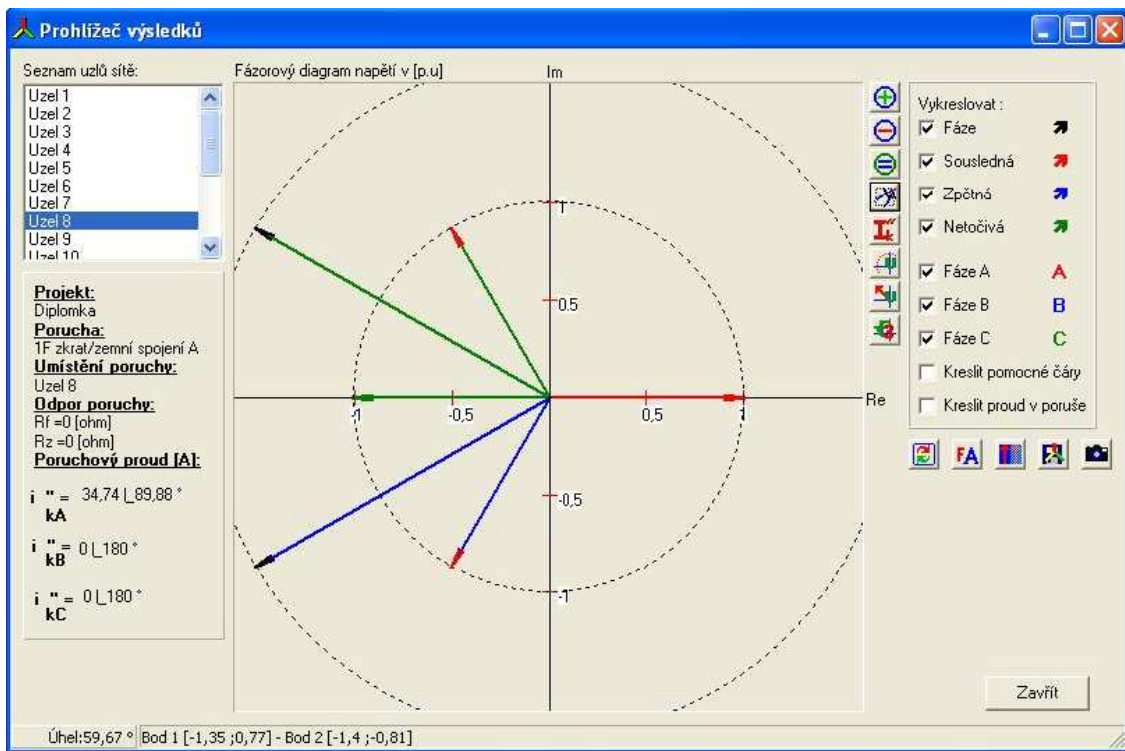
Fig.4 Result viewer (earth fault is displayed)

6. CONCLUSIONS

TENECO is user-friendly application for the short-circuit analysis. Due to easy data input editor and the graphical result viewer it is very suitable for teaching purposes.

The developed software is intended for the computer-based training. We suppose it will enrich the classwork, meet the demanding requirements of the students, and improve their knowledge and also level of the courses offered by UWB.

7. REFERENCES

[1]   Anderson P.M.: Analysis of faulted power systems. IEEE Press, 1995.
[2]   Soman M., Khaparde M., Pandit S.: Computational methods for large sparse power systems analysis - an object oriented approach. Kluwer academic publishers, 2001.
[3]   Tesařová M.: Using the short-circuit analysis algorithm/software for the estimation of voltage dips, Conference Zastosowania komputerów w elektrotechnice ZkwE 2004, Poznaň, Poland, pp. 195 –198
[4]   Tesařová M., Němeček M.: Tutorial software for short-circuit analysis in power system (in Czech), Conference ELEN (Power Engineering) Czech Technical University in Prague, 2004.

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