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Almaty University of  
Power Engineering &  
Telecommunications

Department of Electrical Stations  
and Electric Power Systems

## **ELECTRICAL NETWORKS AND SYSTEMS**

Methodical instructions for the laboratory works  
for students of specialties 5B071800 - Power engineering, 5B081200 – Power  
supply of agriculture

Almaty 2017

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Electrical networks and systems methodical instructions for carrying out the  
laboratory works for students of specialties 5B071800-Power engineering,  
5B081200- Power supply of agriculture. – Almaty: AUPET, 2017. -31 p.

Methodical instructions contain general provisions for laboratory works,  
instructions on their implementation and execution.

Descriptions of laboratory works contain the name of the work, the purpose  
of the work, methods of their calculation and processing of data obtained from the  
calculation on the PC. Basic data of results for carrying out laboratory operations  
and also instructions for operation with the program PC "Raster".

Reviewer

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## Introduction

Discipline Electrical networks and systems is one of the majors in the preparation of bachelors electric-power industry. Laboratory operations are directed to recording the acquired earlier student's theoretical knowledge. Starting direct implementation of operation, the student should have clear idea of the tasks and the studied physical phenomena.

The subject of the study is electrical networks and transmission lines in the laboratory of electrical networks, large capacity that are passed by and which have a significant extent. In the laboratory works a lot of attention paid to the calculation of operating modes of transmission lines and electrical networks of various configurations.

### Preparation and performance of work

In preparation for the laboratory work is necessary to explore the sections of these guidelines and recommended literature.

After studying this material the student should clearly understand the purpose of the laboratory work, the procedure of its holding. Then you need to prepare a mathematical model of the investigated network, i.e.:

- Make equivalent circuit power line or power network;
- To define the parameters of the equivalent circuit;
- Carry out the necessary preliminary calculations;
- Prepare inputs for the calculation on a computer according to the instructions used by the program specified format.

The calculation results are presented in the form of tables and graphs.

Admission to the implementation of each laboratory work carried out in the presence of a teacher of a student appropriate preliminary calculations and theoretical knowledge.

### Protection of laboratory work

To protect student is allowed, perform the full scope of laboratory work and issue a report. A report issued by a single form on standard sheets (A4 size) white paper. Records are maintained by dark ink drawings - pencil. The report must be recorded:

- the purpose of laboratory work;
- the process of preparation for work;
- the order of execution of work;
- the results of computer calculations;
- the analysis and conclusions based on the results of calculation.

Protection of laboratory work is considered successful when the full answer to the questions the teacher questions, the knowledge of the theoretical part and the performance of work.

# 1 Laboratory work №1 Study transmission modes 220 kV

## 1.1 Purpose of the work

In this paper study the mode of idling line, and verify the law of the power loss and voltage change in power according to the power of load.

## 1.2 Scheme of the power transmission

We study the modes of operation of a double-circuit transmission line with step-down transformer at the end of the line (Figure 1.1).

Parameters of lines and transformers, load capacities are set by the instructor.

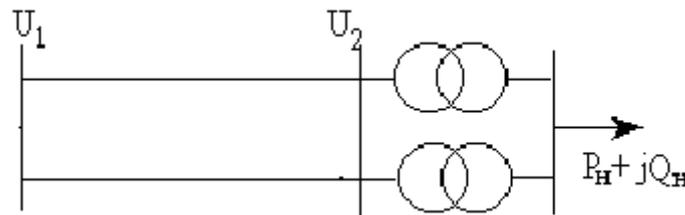


Figure 1.1

## 1.3 Preparation and content of work

a) to study necessary theoretical material on discipline "Electrical systems and networks". Get acquainted with instruction «RASTR» program of work.

b) for the studied electricity transmission by option of the input data given in table 1.1 to calculate parameters of lines and transformers.

c) to make the equivalent circuit of an electricity transmission

d) to carry out calculations a mode of idling, calculations for active load change at  $\text{tg}\varphi = 0$ , and also to find out influence of  $\text{tg}\varphi_2$  ( $Q$ ) on voltage mode at the end of the line at a constant voltage at the beginning and a constant active power of loading. It is assumed that  $\text{tg}\varphi_2$  varies from  $\text{tg}\varphi_2 = -1$  to  $\text{tg}\varphi_2 = 1$

d) according to the results of calculations construct modes of voltage at the end of the line, active power losses and power efficiency of a function in  $\text{tg}\varphi_2$ .

## 1.4 Procedure of work

1.4.1 Enter the prepared design data in the computer memory (in accordance with the «RASTR» program instruction).

1.4.2 To carry out calculations a mode of idling. Get the results of the calculation, and write them on a computer screen. Construct a vector diagram.

1.4.3 Make calculations the active of load power change and  $\text{tg}\varphi_2 = 0$ . (Of load power change within the  $1.0P_2$ ;  $0.8P_2$ ;  $0.6P_2$ ;  $0.4P_2$ ). The voltage at the beginning of the line is kept constant. Get the results of the calculation, and write them on a computer screen. Construct depending the  $U_2 = f(P_2)$ ,  $\Delta P = f(P_2)$ .

1.4.4 Make calculations the transmission mode to the extent and nature of the reactive of load power at constant active power and constant voltage at the beginning of the line. (Reactive power load change between  $1.0Q_2$ ;  $0.8Q_2$ ;  $0.6Q_2$ ;  $0.4Q_2$  to  $-1.0Q_2$ ;  $-0.8Q_2$ ;  $-0.6Q_2$ ;  $-0.4Q_2$ ). Construct a depending  $U_2 = f(\text{tg}\varphi_2)$ ,  $\Delta P = f(\text{tg}\varphi_2)$ . Determine the impact of changes in the reactive power efficiency line. Construct the dependence  $\eta = f(\text{tg}\varphi_2)$ .

1.4.5 To analyze the results and make conclusions.

Table 1.1- The initial data to perform work

№ variant	L, kilometers	mark wires	type transformer	load MBA
1	200	AC 400/51	* <sup>1</sup> TRDCN- 100000/220	150+j80
2	190	AC 300/39	* <sup>2</sup> TDC – 80000/220	110+j60
3	180	AC 300/39	TRDCN – 63000/220	90+j40
4	170	AC 240/32	TRDCN –100000/220	140+j70
5	160	AC 300/39	TDC – 80000/220	100+j50
6	150	AC 240/32	TRDCN 63000/220	80+j30
7	140	AC 240/32	TRDCN - 63000/220	90+j40
8	130	AC 240/32	TDC - 80000/200	120+j 60

\*<sup>1</sup> three-phase transformer winding LV split oil from blown and forced oil circulation cooling of the natural non-flammable liquid dielectric.

\*<sup>2</sup> three-phase transformer with oil-blown and forced circulation of oil

## 2 Laboratory work №2

### Modes of operation of closed electrical networks

#### 2.1 Objective

In this paper , the operation modes of two-way power line are investigated. We consider the balance and flow distribution of active and reactive power, voltage mode in the network under different conditions of its operation.

#### 2.2 The scheme of investigated network.

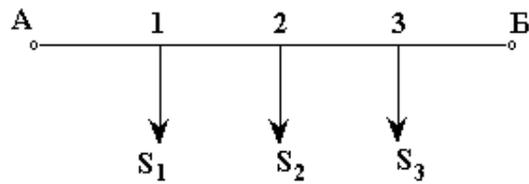


Figure 2.1

### 2.3 Preparation and content of the work

- a) to study the necessary theoretical material.
- b) in accordance with a variant of the original data in table 2.1 to determine the parameters of lines considered network sections.
- c) create an equivalent circuit of a closed network.
- d) determine the distribution of active and reactive power on the network section and to determine the levels of stresses in the load nodes with equal voltages in the supply nodes. Find a point of power section.
- f) determine the distribution of active and reactive power to parts of the network and the load voltage in the nodes in the post-emergency mode.

### 2.4 Procedure of work

- 2.4.1 Enter the prepared calculated data in a computer memory.
- 2.4.2 Conduct a normal mode calculation with equal voltages in the supply nodes. Get the results of the network operation mode and write them on a computer screen.
- 2.4.3 To calculate post-emergency mode (turns off the most downloaded head-section). Get the results of the network operation mode and write them on a computer screen.
- 2.4.4 The result of calculation are applied to the network diagram. Analyze the results and draw conclusions.

Table 2.1- The initial data to do the work

№ variant	U <sub>n</sub> , kV	length of the sections km				mark wires				load, MBA		
		A-1	1-2	2-3	3-Б	A-1	1-2	2-3	3-4	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>
1	220	50	40	60	50	AC 300/39	AC 240/32	AC 240/32	AC 300/39	90+j50	100+j60	80+j50
2	220	40	50	55	45	AC 300/29	AC 240/32	AC 240/32	AC 300/39	110+j60	90+j50	100+j60
3	220	45	40	35	40	AC 240/32	AC 240/32	AC 240/32	AC 240/32	80+j40	70+j40	85+j 45
4	110	30	25	35	30	AC 150/24	AC 120/19	AC 70/11	AC 150/24	30+j15	25+j15	35+j20
5	110	25	20	25	20	AC 120/19	AC 95/16	AC 95/16	AC 120/19	40+j20	30+j 15	35+j 20
6	110	30	25	35	20	AC 95/16	AC 70/11	AC 70/11	AC 95/16	20+j10	25+j12	20+j12
7	220	60	55	50	60	AC 300/39	AC 240/32	AC 240/32	AC 300/39	120+j60	100+j55	110+j60
8	220	50	40	45	55	AC 240/32	AC 240/32	AC 240/32	AC 240/32	80+j 45	70+ j30	85+j 50

### 3 Laboratory №3 Study modes of meshed system

#### 3.1 Objective

To study of operating modes of meshed system.  
Determine the flow distribution of active and reactive power and the voltage levels at the network nodes.

#### 3.2 The scheme of investigated network

Each section of the network represented a U-shaped equivalent circuit. Parameters of the lines, voltage power supplies and power loads are given by the teacher.

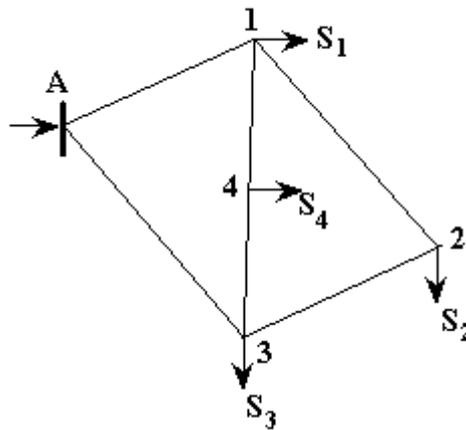


Figure 3.1

#### 3.3 Preparation and content of the work

- a) To study the necessary theoretical material.
- b) In accordance with a variant of initial data in table 3.1 to determine the parameters of the network sections.
- c) to create a scheme for replacing meshed system .
- d) to determine the distribution of active and reactive power through the sections and to find the voltage levels of the load units in the normal mode.
- f) to determine the distribution of active and reactive power and voltage levels of the nodes in the load in the post-emergency mode.

#### 3.4 Procedure of work

- 3.4.1 Enter the prepared calculated data in a computer memory.
- 3.4.2 Make calculations the normal mode hard-closed network. Get the results of the calculation, and write them on a computer screen.
- 3.4.3 Make calculations disaster mode (turns off the most downloaded head-section).
- 3.4.4 The calculation results are applied to the network diagram. Analyze the results and draw conclusions.

Table 3.1- The initial data to do the work

№ variant	U <sub>n</sub> kV	length of the sections km						load power, MBA			
		A-1	1-2	2-3	1-4	4-3	A-3	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>
1	220	50	60	40	35	45	40	40+j20	35+j15	45+j20	30+j18
2	220	45	55	60	50	40	35	50+j25	45+j20	50+j20	30+j10
3	110	25	30	20	25	15	20	25+j10	15+j8	20+j12	25+j15
4	110	20	25	15	20	25	20	15+j7	20+j10	25+j12	15+j6
5	110	20	15	25	18	14	23	25+j12	20+j8	25+j10	15+j10
6	110	30	22	25	20	25	18	20+j10	25+j12	18+j10	20+j8
7	220	60	55	45	50	40	35	60+j35	50+j30	45+j20	55+j25
8	220	55	60	50	55	45	40	65+j40	60+j30	55+j30	45+j 25

NOTE Take the condition that the wire sections in all parts of the network. For options with Un = 110 kV take-section AC 120/19 for options with Un = 220 kV take-section AC 240/32.

## 4 Laboratory work № 4 Regulation of voltage in electrical networks

### 4.1 Objective

The paper considers the requirements for mode of voltage in electrical networks. The analysis of technical performance network using a variety of means for voltage regulation.

### 4.2 The scheme of investigated transmission

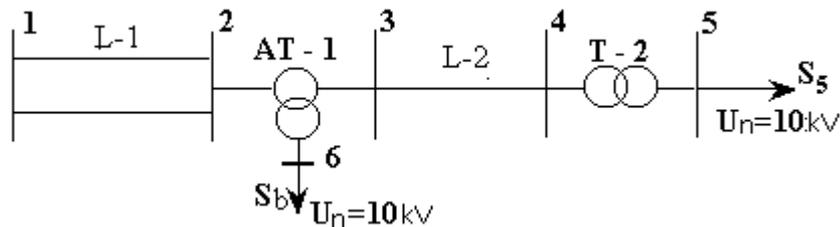


Figure 4.1

Parameters lines and transformers, load capacities are given by the teacher.

### 4.3 Preparation and content of the work

- to study the necessary theoretical material.
- in accordance with an embodiment of initial data in table 4.1 to determine the parameters of lines and transformers.
- to create a scheme for the replacement of power transmission.
- without applying means of regulation to determine the voltage and power in corresponding points in the network of maximum and post emergency mode. Determine the loss in active power at lines and transformers.
- change the transformation ratio of transformer obtain the desired or close to them the voltage on the buses 10 kV substation.
- change the transformation ratio of transformers and at install capacitor banks, obtain the desired voltage on the buses 10 kV.

### 4.4 Procedure of work

- Enter the calculated data into the design data in a computer memory.
- Calculate the maximum and minimum modes without the use of a voltage regulation means. Get the results of the calculation, and write them on a computer screen.
- Carry out the calculation mode by changing the transformation ratio of transformers.
- Carry out the calculation mode by changing the transformation ratio of transformers and install capacitor banks. At the same time to consider two cases:
  - Installed in the capacitor banks node 6
  - The capacitor banks nodes are set to 5 and 6

4.5 Analyze the results and draw conclusions about the impact of different methods of voltage regulation by the amount of active power losses in the electric network elements.

Table 4.1- The initial data to do the work.

№ variant	L-1	L km	number of circuits	L-2	L km	number of circuits	autotransformer AT - 1	transformer T -2	number of transformer	load MBA	
	mark wires			mark wires						S <sub>5</sub>	S <sub>6</sub>
1	AC 300/39	50	2	AC 70/1	10	2	*ATDCTN-	*TRDN-40000/110	2	60+j35	50+j25
2	AC 240/32	50	2	AC 120/1	15	1	200000/220	* TRDN -40000	1		
3	AC 300/39	40	2	AC 95/10	20	2	--«---«---«--	* TRDN -25000	2	30+j20	40+j20
4	AC 240/32	65	2	AC 150/2	8	1	-----	* TRDN - 63000	1	40+j18	48+j23
5	AC 300/39	55	2	AC 120/1	12	2	-----	* TRDN - 63000	2	50+j25	45+j25
6	AC 240/32	45	2	AC 70/1	22	2	-----	* TRDN - 25000	1	100+j60	55+j30
7	AC 240/32	35	2	AC 95/10	25	2	-----	* TRDN - 25000	2	20+J12	35+j20
8	AC 300/39	45	2	AC 150/24	0	1		TRDN – 63000	1	35+j20	50+j30
										45+j 25	40+j20

\*three-phase transformer winding split LV oil and blow with the natural circulation of oil natural cooling nonflammable liquid dielectric

\* auto-transformer oil with blown and forced circulation of oil three-winding transformer with a tap changer

## Appendix A

Calculation of operating modes of the selected network options using the RASTR program.

The complex of programs Rastr is intended for calculation and analysis of steady-state modes of electrical systems on the PC of IBM PC and compatible with it. Rastr allows for calculation, equivalence and weighting of the mode, provides the possibility of screen input and correction of initial data, quick disconnection of nodes and branches of the circuit, has the possibility of regionalizing the network, and provides a graphical representation of the circuit or its individual fragments along with almost any calculated and initial parameters.

### A.1 Running Rastr with the restoration of the working file.

### A.2 Main Menu

After downloading Rastr you get to the main menu of the complex, which displays the main commands. To navigate the menu, use:

a) cursor keys, <ENTER> to enter for the selected command, <ESC> to exit.  
b) function keys - pressing the Alt key at the same time as the selected color with the letter of the horizontal menu results in getting into this menu, wherever you are. Pressing the highlighted letter of the vertical menu leads to the beginning of the execution of this command (use keys on which are written Russian (!) letters regardless of the Cyrillic alphabet and the register). For example: ALT D / B / U - will lead to hit the table "nodes" from anywhere in the program. The F1-F10 keys are used to execute commands that are not in the menu, help on them is the last line of the screen, and help on the keys Alt F1-F10 can be obtained by pressing the Alt key.

c) mouse - uses a two-button mouse with an inverted cursor (the place marked with a color), moving the mouse cursor and pressing the left mouse button causes the program cursor to move to the specified location, a quick double-click of the left key ("click") leads to the execution of the selected command (similarly ENTER), pressing the left key in the last line of the screen results in the corresponding command (depending on the Alt key pressed). The right mouse button is used as the Esc key.

Working with the mouse has its own features in the on-screen editor and the output of the results.

The first line of the screen contains error messages and warnings, if any. Information about the current file has the form:

<Kod> - <v> - <text> (Y / N),

Where kod is the name of the module that issued the message;

V - message type

W - warning;

E is an error;

F is a fatal error.

When messages appear that end with (Y / N), you must enter Y if you agree, or any other key otherwise.

In all cases, the program has a context-sensitive help system, to activate it, you must press F1, and you must press F1 again to display the table of contents of the hint.

When executing some commands from you, you need to enter additional information (file name, directory, etc.), in all cases you can control the input using the arrow keys, and

Ins - insert a space,

Del - delete the character above the cursor,

Bs - delete the character before the cursor,

Ctrl ^ Bs - delete all text,

Home - the cursor to the beginning,

End - the cursor to the end.

### **1) Function keys of the main menu:**

F1 - HELP, again - the HELP table of contents,

F2 - Save a mode file,

F3 - Load a mode file,

F4 - Change the current disc,

F5 - Change the current directory,

F6 - Change video mode - allows you to switch the standard video mode (25 lines of the screen) to EGA mode (43 lines), VGA (50 lines) and back.

F7 - Enter the name of the current circuit,

F8 - Enter a password to restrict access to files,

F9 - Set the attributes for the current schema (after changing the attributes it must be saved), the attributes are significant only when working with the password. Attribute "Read" - all users with a different password can not write this file.

"Hide" - the file is not available for users with a different password.

"Normal" - is available for reading and writing to all users.

Setting attributes does not affect the DOC attributes of the files.

F10 - Finish the work of Rastr.

ALT F10 - display the extended protocol.

When executing the F2, F3 commands, the file name is entered without an extension in accordance with the MS DOS rules (one to eight characters). The name can contain wildcards (the characters \*?), In this case, the screen displays information about the regime files corresponding to the selected mask and contained in the working directory. Using the cursor keys, you can select the desired one and load (ENTER) or delete (Del).

The characteristics of the downloaded file are displayed in the first line of the screen and contain the following information: file name, schema name, number of nodes, branches, districts, size in kilobytes, date and time of creation.

To save the downloaded (working) file in the working directory, you must press F2 and rename, if necessary.

Advanced protocol (Alt F10) is available from anywhere in the program and contains detailed information about the results of the execution of commands.

### **A.3 The Data command**

It provides various operations with the original data.

#### **A.3.1 The "Enter / Cor" subcommand**

Produces screen input, correction, display of initial data.

After entering this subcommand, you need to select the type of the object of interest "Sites", "Branches", "Regions", "Polynomials" and press ENTER, and you get into the corresponding table.

TAB is the next column;

Shift TAB - previous column;

PGDN - sheet forward;

PGUP - sheet back;

Ctrl PGUP - the beginning of the table;

Ctrl PGDN - the end of the table.

In tables, the left mouse button is used to move the cursor to the desired position, a long press of the left button in one of the edges of the screen cause the screen to move up, down, left, right, depending on the position of the mouse cursor. The action of the right button can be set in accordance with the menu (Alt F7).

#### **A.3.2 Function keys:**

F2 - switch mode correction / view, in the view mode all correction tools are blocked;

F3 - go to the column attributes menu, in this menu you can use the Ins switch to change the visibility of any field on the screen, and Del allows you to lock any column of the screen. ENTER - to change the width of the column and the accuracy of displaying numbers in it; Esc - exit from the menu; allows you to lock any column of the screen. ENTER - to change the width of the column and the accuracy of displaying numbers in it; Esc - exit from the menu;

F4 - search for a node or branch;

F5 - assign / cancel the base node;

F6 - enable / disable the selected node or branch;

F7 - mark / uncheck the line / line;

F8 - insert an empty string;

F9 - duplicate the line;

F10 - exit the table;

**Alt F1** - group setting of parameters of nodes and branches, the marker should be set to the column whose elements are supposed to be adjusted. The input line should look like:

**<Selection> = [character] <value>**,

Commas separate where the sample is numbers and / or ranges of node numbers, numbers, and ranges are dashes.

Sign + - add to the previous value of the parameter;

\* - multiply the previous value of the parameter;

/ - split the previous value of the parameter.

\ - reverse division (divided by the previous value of the parameter);

If there is no sign, the parameter is set to the job.

Examples: 10, 20,100-200, 56 = 100 - the parameters in the nodes 10, 20, 56 and in the range from 100 to 200 are set equal to 100.

10, 20,100-200 = \* 1.2 parameters in nodes are multiplied by 1.2.

When working with a branch, in order for a branch to fall into the correction area, it is sufficient that one of the nodes that connect it gets in the sample.

**Alt F2** - Group switching or marking of nodes and branches – pre- switching menu appears (similar to Alt F5), in which it is necessary to select the required switching, then sample the menu in which to set the required sample.

**Alt F3** – Setting desired colors for the text editor. When setting colors, it is desirable that all possible combinations of colors (trip, mark, basic) are on the screen, colors are saved along with the file;

**Alt F5** - The switching menu allows you to perform complex switching of nodes and branches.

For the nodes are permissible: disconnection of the earth shunts, switching off the generation and load, switching off the control limits Q (the node becomes the reactive power balancer), switching off the node with all suitable lines, and any combination of trips.

For branches it is possible to: disconnect the branch at the beginning, at the end, completely turn off the branch.

**Alt F7** - print the current table. Only visible columns are displayed (menu F3), according to the specified maximum printing width (specified when configuring);

**Alt F8** - delete the row of the table;

**Alt F9** - set the function for the right mouse button, a menu appears in which you can select one of the functions: search, on / off, mark / unmark, insert a line;

**Alt F10** - display the extended protocol;

**Esc** - Exit to the previous menu.

### **A.3.3 Data format**

#### **1) "Nodes"**

Area - the number of the district to which the node belongs [1-255];

Number - node number [1-255];

N is the number of the statistical characteristic [0-32000];

0-not specified 1, 2 - standard (protection in the program);

the user in the table «Polynomials» sets 3-32000 -;

Name - the name of the node [0-12 characters];

$U_{nom}$  - rated voltage or voltage module;

$P_{load}$ ,  $Q_{load}$  - load power;

$P_{gen}$ ,  $Q_{gen}$  - generation power;

$Q_{\min}$ ,  $Q_{\max}$  - the limits of reactive power generation, the node is fixed  
 Module if  $Q_{\min} < Q_{\max}$ ;  
 $G_{\text{shunt}}$ ,  $B_{\text{shunt}}$  - the conductance of the shunt to the ground ( $\mu\text{Sim}$ );  
 $V$ ,  $\Delta$  - module and voltage angle (it makes sense to change only for basic nodes);  
 $X_g$  - generator resistance (reserved for future use).

## 2) "Branches"

$N_{\text{begin}}$ ,  $N_{\text{end}}$  - the number of nodes that bound the line;  
 $N_p$  is the number of the parallel;  
 $R$ ,  $X$  - resistance;  
 $GB$ -conductivity ( $\mu\text{Sim}$ ), for the transmission line - the total conductance of the shunts of the U-shaped circuit ( $B < 0$ ), for the transformer-the conductivity of the shunt of the L-shaped circuit ( $B < 0$ );  
 $K_T \setminus r$ ,  $K_T \setminus i$  - is the real and imaginary component of the transformation coefficient;  
 The resistance of the branch must be reduced to the voltage  $U_{\text{begin}}$ , and the ratio of the transformation is defined as the ratio  $U_{\text{end}} / U_{\text{begin}}$   
 When you specify a branch with zero resistance, it is perceived as a switch.

## 3) "Districts"

Number - number of the area;  
 Name - name "0-12 characters";  
 $dP_{\text{load}}$ ,  $dQ_{\text{load}}$ ,  $dP_g$  - the coefficients on which the corresponding capacities of the area are multiplied (the outgoing data does not change, the calculation and results are performed taking these coefficients into account)

## 4) "Polynomials"

$CXN$  - number of circuits;  
 $P_0$ ,  $P_1$ ,  $P_2$ ,  $P_3$  are the coefficients of the polynomial of the active load power;  
 $Q_0$ ,  $Q_1$ ,  $Q_2$ ,  $Q_3$  are the coefficients of the reactive load power polynomial;  
 Polynomial coefficients can be set up to the fourth degree.

The polynomials of standard  $CXN$  are:

$N=1,2$	$P_0=0,83$	$P_1=0,3$	$P_2=0,47$
$N=1$	$Q_0=3,7$	$Q_1=7$	$Q_2=4,3$ at $0,815 < U/U_{\text{nom}} < 1,2$
$N=2$	$Q_0=4,9$	$Q_1=10,1$	$Q_2=6,2$ at $0,815 < U/U_{\text{nom}} < 1,2$
$N=1,2$	$Q_0=1,49$		at $U/U_{\text{nom}} > 1,2$
$N=1$	$Q_0=0,721$	$Q_1=0,158$	at $U/U_{\text{nom}} < 0,815$
$N=2$	$Q_0=0,657$	$Q_1=0,158$	at $U/U_{\text{nom}} < 0,815$

### A.3.4 The "Control" subcommand

It checks the schema for the presence of nodes without links, links without nodes, nodes that are not related to the database. All such objects are disabled. The conformity of the transformation coefficients to the nominal voltages of the nodes is also monitored.

If necessary, the control is automatically performed when performing calculations. Information about the results of the control is entered in the extended protocol, available at any time by pressing Alt10.

## **A.4 The Results Team**

### **A.4.1 The "Nodes" subcommand**

When viewing the table, you can use the keys PGUP, PGDN; to scroll the table forward and backward through the pages, arrows to move through one node. All connections of the node are always displayed on the screen (if they do not fit on the screen, the site is not shown in its entirety). To go directly to the site of interest, you need to dial its number and press ENTER (the node number is displayed on the first line of the screen), if the node with such number is not there, the transfer will not occur. To go to the beginning of the table, you must press Ctrl ^ PGUP, to go to the end - Ctrl ^ PGDN. When specifying number of the region in the field "Area" only nodes which are a part of the area are displayed, intersystem lines are displayed in other color, the node is viewed only in the specified area. To enter the viewing mode, you must delete the area number and press ENTER.

To view only the marked nodes, press F9, press again - the whole scheme;

The right mouse button is used to quickly jump from one node to another, pressing it on a line containing the node number (even if it is a line) will lead to the appearance of a node with links on the screen.

#### **1) Printing functions**

**F7** - print information about one node (node with the number specified in the first line of the screen).

**F8** - selective printing. After pressing F8, the list of nodes of the selective print is requested commas and the ranges separate (the node numbers by dashes). To execute the command after entering the list, it is necessary to press ENTER, and to refuse execution - Esc. The entered list is saved in the future work; it can be adjusted using standard keys. It should be borne in mind that this list coincides with the list of nodes used for weighting the regime.

#### **2) Additional functions**

**F3** - transition to the table Areas;

**F4** - go to the Loss table;

### **A.4.2 The "Losses" subcommand**

It is intended for derivation of the structural analysis of losses of active and reactive power in a given area or throughout the network.

To print the table - **F8**.

Additional functions: **F2** - go to the Nodes table;

**F3**- go to the District table.

## Bibliography

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