- wide use of computation procedures for parameters of single branches of the equivalent circuit or by power and square of branch current or on the basis of solving the difference equation for the circuit *RL* or *RC*, along with the computation procedures on the basis of the Ohm's law.

The possibilities of the sampled electric engineering device allow determining parameters and characteristics of the controlled circuits of the known configuration [6].

Conclusion

1. To work with the arrays of instantaneous currents and voltages, obtained by the digital recorders of electric signals, the specialized mathematical apparatus – the sampled electrical engineering was developed. It allows determining in operating mode determining the parameters of electric modes and elements of electric systems.
2. The three-stage procedure of diagnosing operating condition of the RF power engineering proposed by the authors was described. It allows passing from the system of planned-prophylactic repairs to the ones according to real operating conditions of electric equipment.
3. Working capacity of the formulas and procedures of the sampled electric engineering at determination of parameters of electric modes and equivalent circuits of electric system elements was shown.

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DETERMINING THE EQUIVALENT CIRCUIT PARAMETERS OF TRANSMISSION LINES, REACTORS, POWER RESISTORS AND CAPACITOR BANKS BY THE ARRAYS OF INSTANTANEOUS CURRENTS AND VOLTAGES

Dzhumik D.V.

Tomsk Polytechnic University
E-mail: dzhumik@tpu.ru

The possibility of defining parameter of electric system static elements by the arrays of instantaneous currents and voltages for various problems of electric power engineering has been shown. The procedures of determining the parameter of the reverse Г-type equivalent circuit of a line are considered. The procedures of determining the equivalent circuit parameter of linear current-limiting reactor/resistor and computation results are introduced.

Definition of the equivalent circuit parameters of the electric system elements is the important and topical aim for power engineering of Russian Federation. It is obvious, that at management of a controlled object and diagnosis of its operating conditions, it is necessary to have rather complete and reliable information on the equivalent circuit (EC) parameters. However, in practice, the equivalent circuit parameters of the electric system elements are determined, as a rule, from the reference or published data. It is known that the values of the EC parameters undergo significant changes and depend considerably on a majority of factors at electrical equipment operation.

In connection with the ubiquitous introduction of the up-to-date measuring systems and meters using digital techniques of processing and providing information, the apparatus of the sampled electrical engineering [1], allows, comparatively simply, in the best way possible, solving a number of problems of determining the equivalent circuit parameters of electrical power engineering objects by the arrays of instantaneous values (AIV). The «technique» of obtaining the EC parameters at the «input» and «output» of transmission line (TL) is shown in Fig. 1. It should be noted, as well, that the instantaneous values of voltage and current signals are measured at the beginning and at the end of the line and the arrays are transmitted from the end of the line to its beginning by fiber-optic, satellite or high-frequency communication channel (CC) [2].

The principle equivalent circuits of TL are introduced in Fig. 2. As an example, let us consider the definition of parameters of the reverse G-type EC of TL.

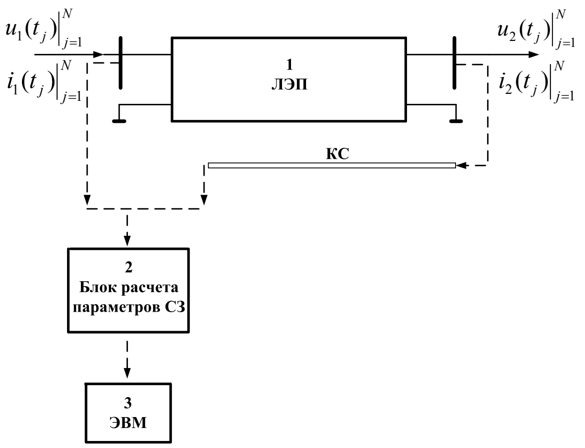

Fig. 1. *Obtaining the equivalent circuit parameters of TL*

Блок расчета параметров СЗ – The assembly of calculating the EC parameters; ЭВМ – Computer; ЛЭП – TL; КС – CC

By the arrays of counts of instantaneous current and voltage at the beginning $u_1(t_j)|_{j=1}^N$, $i_1(t_j)|_{j=1}^N$ and at the end $u_2(t_j)|_{j=1}^N$, $i_2(t_j)|_{j=1}^N$ of transmission line obtained at the same instants of time $t_j = t_1, t_2, ..., t_N$ with the increment $\Delta t = T/N$, where T is the period of current (voltage) signal and N is the numbed of counts on a period, using the possibilities of the sampled electrical engineering [1, 3], we determine voltage drop on longitudinal resistance of the equivalent circuit and current in crosscut branch:

$$\Delta u_{12}(t_j)\Big|_{j=1}^N = u_1(t_j)\Big|_{j=1}^N - u_2(t_j)\Big|_{j=1}^N;$$

$$i_0(t_j)\Big|_{j=1}^N = i_1(t_j)\Big|_{j=1}^N - i_2(t_j)\Big|_{j=1}^N.$$

Then, we determine the effective values of currents I_1, I_0, active ΔP_{12}, ΔP_0 and reactive ΔQ_{12}, ΔQ_0, capacity loss in longitudinal and crosscut branches by proper procedures:

$$I_1 = \left[\frac{1}{N}\sum_{j=1}^{N} i_1^2(t_j)\Big|_{j=1}^N\right]^{0,5}; \ \Delta P_{12} = \frac{1}{N}\sum_{j=1}^{N}[\Delta u_{12}(t_j)\cdot i_1(t_j)]\Big|_{j=1}^N;$$

$$\Delta Q_{12} = \frac{1}{4\pi}\sum_{j=1}^{N}[\Delta u_{12}(t_j) - \Delta u_{12}(t_{j+1})]\cdot[i_1(t_j) + i_1(t_{j+1})]\Big|_{j=1}^N;$$

$$I_0 = \left[\frac{1}{N}\sum_{j=1}^{N} i_0^2(t_j)\Big|_{j=1}^N\right]^{0,5}; \ \Delta P_0 = \frac{1}{N}\sum_{j=1}^{N}[u_2(t_j)\cdot i_0(t_j)]\Big|_{j=1}^N;$$

$$\Delta Q_0 = \frac{1}{4\pi}\sum_{j=1}^{N}[u_2(t_j) - u_2(t_{j+1})]\cdot[i_0(t_j) + i_0(t_{j+1})]\Big|_{j=1}^N.$$

By capacities and effective values of currents the parameters of the EC branches may be determined:

$$R_1 = \frac{\Delta P_{12}}{I_1^2}; \ X_1 = \frac{\Delta Q_{12}}{I_1^2}; \ R_0 = \frac{\Delta P_0}{I_0^2}; \ X_0 = \frac{\Delta Q_0}{I_0^2}.$$

Using the similar procedures the parameters of the straight line of Г-, Т- and П-type equivalent circuit of transmission line may be determined [4–7].

Then, let us consider the first and the second methods of determining the parameters of EES elements by example of linear current-limiting reactor/resistor.

The first method of determining the parameters of linear current-limiting reactor/resistor (Fig. 3).

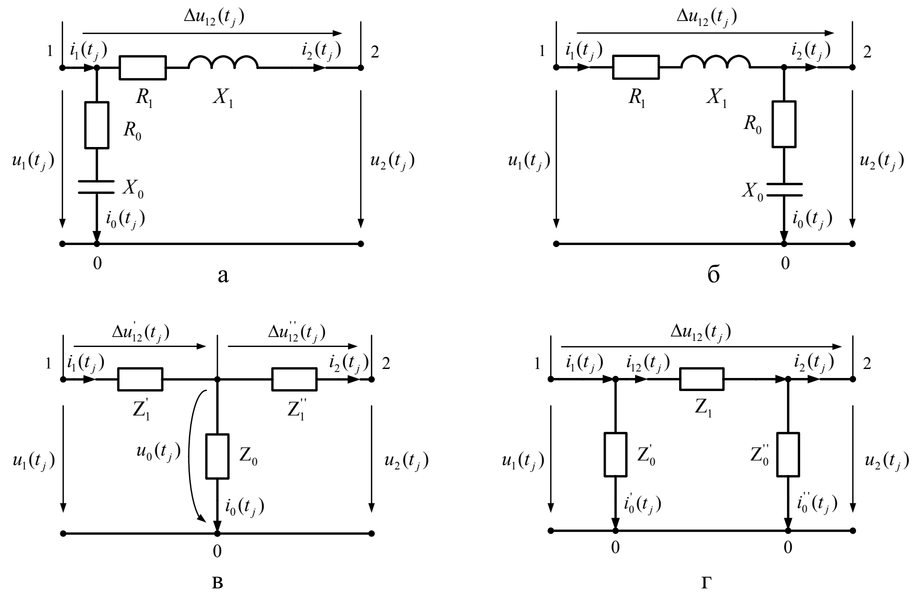

Fig. 2. *The equivalent circuits of transmission lines: а) straight Г-type; б) reverse Г-type; в) Т-type; г) П-type*

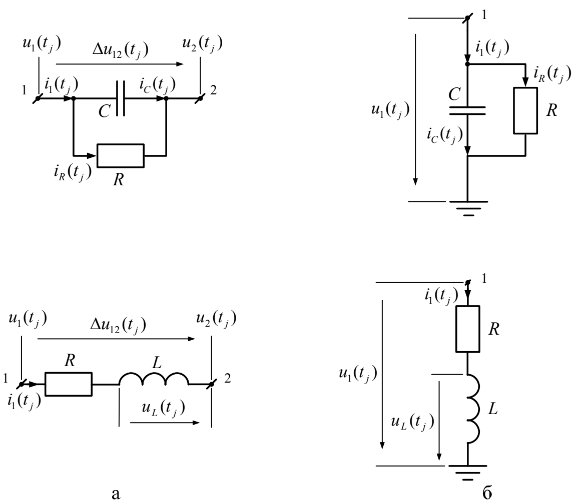

Fig. 3. *The equivalent circuit of a capacitor bank and reactor/resistor at switching on: a) longitudinal; б) crosscut*

Voltage drop on resistances of the equivalent circuit is determined by the arrays of counts of instantaneous currents and voltages $u_1(t_j)|_{j=1}^{N}$, $i_1(t_j)|_{j=1}^{N}$, $u_2(t_j)|_{j=1}^{N}$ of reactor/resistor obtained at the same instant times $t_j=t_1,t_2,...,t_N$, with increment $\Delta t=T/N$:

$$\Delta u_{12}(t_j)\Big|_{j=1}^{N} = u_1(t_j)\Big|_{j=1}^{N} - u_2(t_j)\Big|_{j=1}^{N}.$$

Then, the effective current value, active and reactive capacity loss are determined by proper procedures:

$$I_1 = \left[\frac{1}{N}\sum_{j=1}^{N} i_1^2(t_j)\Big|_{j=1}^{N}\right]^{0,5}, \Delta P_1 = \frac{1}{N}\sum_{j=1}^{N}[\Delta u_{12}(t_j)\cdot i_1(t_j)]\Big|_{j=1}^{N},$$

$$\Delta Q_1 = \frac{1}{4\pi}\sum_{j=1}^{N}[\Delta u_{12}(t_j) - \Delta u_{12}(t_{j+1})]\cdot[i_1(t_j) + i_1(t_{j+1})]\Big|_{j=1}^{N}.$$

Then active and reactive resistance of linear current-limiting reactor/resistor is found out:

$$R = \frac{\Delta P_1}{I_1^2}, \quad X = \frac{\Delta Q_1}{I_1^2}.$$

Let us consider **the second method** of determining the parameters of linear current-limiting reactor/resistor. By the arrays of counts of instantaneous current and voltage of reactor/resistor, the voltage drop on the equivalent circuit resistances is determined. It includes voltage drops on active resistance and inductance of linear current-limiting reactor/resistor:

$$U_R(t_j) = R\cdot i_1(t_j); \quad U_L(t_j) = L\cdot i_1'(t_j).$$

It should be noted that it is impossible to determine «directly» these components of voltage drop. Besides, solving this task the problem of determining current derivative occurred. The comparative analysis of five-point and three-point differentiation formulas after smoothing [8] showed certain advantages of the first formula. It was used in procedures of determining voltage on inductance and rated derivative $i'_P(t_j)$:

$$U_L(t_j) = \Delta U_{12}(t_{j+1}) - \frac{\Delta U_{12}\cdot i_1(t_{j+1})}{i_1(t_j)};$$

$$i_1'(t_{j+1}) = \frac{1}{12\cdot\Delta t}[(i_1(t_{j-1}) - i_1(t_{j+3})) - 8\cdot(i_1(t_j) - i_1(t_{j+2}))];$$

$$i_1'(t_j) = \frac{1}{12\cdot\Delta t}[(i_1(t_{j-2}) - i_1(t_{j+2})) - 8\cdot(i_1(t_{j-1}) - i_1(t_{j+1}))];$$

$$i_P'(t_j) = i_1'(t_{j+1}) - \frac{i_1'(t_j)\cdot i_1(t_{j+1})}{i_1(t_j)}.$$

Then the inductance and active resistance of reactor/resistor are determined:

$$L_i = \frac{U_L(t_j)}{i_P'(t_j)}; \quad R_i = \frac{\Delta U_{12}(t_j) - L_i\cdot i_1'(t_j)}{i_1(t_j)}.$$

The results of calculations of values of current-limiting reactor parameters RB-10-400-0,35У3 and power resistor ShS-300 at N=64 are given in the Table as an example.

Table. *The results of calculations of current-limiting reactor parameters RB-10-400-0,35У3 and resistor ShS-300 the published are given in brackets*

Electric circuit element	*R*, Ohm	*X*, Ohm	Relative error of calculation, %	
			R	*X*
Definition of parameters by power				
Current-limiting reactor RB-10-400-0,35У3	0,01 (0,01)	0,349439 (0,35)	0	0,160
Resistor ShS-300	150,0002 (150)	0,376391 (0,377)	0,0001	0,162
Definition of parameters by differential (difference) equation				
Current-limiting reactor RB -10-400-0,35У3	0,01 (0,01)	0,35 (0,35)	0	0
Resistor ShS -300	150,0002 (150)	0,377 (0,377)	0,0001	0

It is seen from the Table that the parameters of linear current-limiting reactor/resistor obtained by the proposed methods are close to the certified values. The most accurate values of parameters of linear current-limiting reactor/resistor at the same quantity of counts at current (voltage) signal cycle may be obtained using the second method. However, the most informative one is the first method of determining the parameters of linear current-limiting reactor/resistor as it allows determining additionally the parameters of electric mode (integral characteristics – active and reactive capacity loss, effective current value).

Similar procedures may be used as well at definition of the equivalent circuit parameters of a capacitor bank and transmission lines [1, 9].

Conclusion

1. The working capacity of the proposed procedures for determining the parameters of the equivalent circuits of transmission lines, reactors, resistors, and capacitor banks by the arrays of instantaneous currents and voltages is shown.
2. The possibility of obtaining information for diagnosing the electrical power engineering object comparing the parameters of its equivalent circuit in operating mode with the similar parameters at the known good object is shown by concrete example.
3. Introduction of the developed procedures of determining the equivalent circuit parameters of energy object requires only insignificant complication of software of electric signal recorders already set in EES.

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NOISINESS OF THE VIDEO AMPLIFIER MADE BY THE CASCODE CIRCUIT WITH DYNAMIC LOAD

V.N. Maslennikov

Tomsk university of control systems and radio electronics
E-mail: vnmas@mail.tusur.ru

Relative influence of active elements on noises of video amplifier cascode circuit at resistive loading and at use of an active element as the cascade dynamic load has been considered. The conclusion is drawn that in both cases the second transistor of the cascode circuit contributes insignificantly into amplifier noises in comparison with the first one. The contribution of active element noises of dynamic load exceeds considerably the contribution of traditional resistive loading of the cascade and doubles practically in capacity the noises conditioned by the first active element.

Cascode circuit (cascode) was proposed, in due time, in video amplifiers on vacuum electron valves for decreasing the influence of transfer capacitance and increasing amplifier stability connected with it. It represents an amplifying stage where two triodes are connected in series instead of one. The first one is with a common cathode and another is a grounded-grid one. Owing to the fact that the cathode circuit of the second valve is the load of the first one in anode, the signal voltage, as it is known, is only inverted (at similar amplifying elements) and, therefore, the transfer capacitance is only doubled in composition of aggregate equivalent input capacitance of the amplifier while in a general circuit with common cathode it increases in (K_u+1) times where K_u is the voltage gain of the first triode.

The cascode circuit is widely used in transistor circuits – both bipolar and field-effect ones [1, 2].

In video amplifiers of TV cameras made on vacuum pickup tubes which are still irreplaceable in some conditions, in input stages the field-effect transistors with a control *p-n*-junction are applied as the best ones by noisiness and radiation resistance.

Each time at constructing the unique camera video amplifiers, the question on the influence of the second transistor (a common-gate one) on noises occurs; and applying another transistor as the cascade dynamic load the question on its noise contribution occurs. The information for concrete situations may be found in scientific sources but there is no a cogent fundamental answer for a common case: in spite of the apparent simplicity of a research circuit the analysis is not simple at all.

The aim of the given work is to estimate the relative influence of amplifying elements on the amplifier noises. Therefore, the other amplifier noise sources are not considered.

The first cascade of the video amplifier is often performed by the cascode circuit. Such circuit operation for the case of its performance from the signal current