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TO THE QUESTION OF CALCULATION OF TRANSIENTS IN NONLINEAR ELECTRIC CIRCUITS BY A DIFFERENTIAL HARMONIC METHOD

The possibility of application of differential harmonical method (DGM) for the numerical calculation of transients in nonlinear electric circuits with periodic electromotive force is probed in this article. In the past this method was developed by the author of this article for the numerical analysis of periodic processes in nonlinear electric circuits and devices.

Essence of method is replacement of variables: the instantaneous variables (currents, voltages, magnetic fluxes etc.) are replaced other variables – the amplitudes of harmonics of the Fourier series, which are the functions of time in transients. Thus every scalar instantaneous variable is answered by a vector, named the vector of amplitudes, the components of which are amplitudes of harmonics of dependences on time of scalar instantaneous variables.

At such replacement of variables there is a transition from differential equations for instantaneous variables to differential equations for vectors of amplitudes. These equations are named differential DGM-equations. DGM-equations that describe processes in nonlinear electric circuits are nonlinear. The amplitudes of the harmonics of all variables (elements of vector amplitudes of these variables) for all orders of harmonics are taken into account in the calculation are interrelated. To take account of this relationship suggested use of matrix differential harmonic parameters.

The values of the matrix of differential harmonic parameters and the values of the vectors of the amplitudes of all the dependent variables are calculated at each step in the numerical integration of nonlinear DGM-equations using the values of vectors of the amplitudes of the independent variables. For implementation of these operations in the programs of calculations of transients it is possible to use algorithms and procedures which can be found in the monograph the author of this article«Nonlinear oscillations: numerical polyharmonic simulation» (2008, bibliographic information can be found in the list of the quoted literature).

Applicability DGM-method to the calculation of transients in electrical circuits is illustrated on example of the R-L-C circuit, which have a nonlinear inductance with the magnetization curve in the form of analytical approximations or table.

Calculations have shown that in transients of this circuit dependences on the time of the amplitudes of harmonics are more calm and "quieter" than dependences on the time instantaneous variables. Therefore numerical integration of DGM-equations can be made with greater lenght of steps, than when differential equations for instantaneous variables are integrated with the same relative error. This feature is useful at a necessity the numerical calculation of transients real-time, and also when exists a problem of inflexibility of differential equations is for instantaneous variables.