Mathematical models of the subsystems with distributed parameters for the transient simulation of electric circuits by diakoptic methods

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Abstract **The ways of using mathematical models of subsystems with distributed parameters for the transient simulation of complex heterogeneous electrical circuits are proposed. Mathematical model of this subsystem is formed as a separate subcircuit at each matching step or as a single discrete nonlinear macromodel throughout the integration. The effectiveness of the approach is confirmed by examples of simulation of such circuits.**

Keywords **heterogeneous electrical circuits, diakoptic methods, subcircuit.**

I. INTRODUCTION

The presence of nonlinear components of electrical circuits with distributed parameters defines certain features of diakoptic algorithms for simulation of dynamic modes of complex heterogeneous circuits. In particular, there is a need for a special calculation algorithms that take into account the characteristic properties of each type of subsystem for the partitioning method of separate subcircuit. Therefore it is advisable to do the informed choice of the method of numerical solution of ordinary differential equations or partial differential equations, which are used for the analysis of subcircuits with lumped and distributed parameters, respectively. The automatic choice of integration step of each subsystem is important procedure in the partitioning method of integration defined dynamic changes of internal variables. In this regard, one important issue is assessment dynamics of the process or transience of transients in subcircuit with distributed parameters. This work is a continuation of research carried out in [1, 2].].

II. FEATURES OF ELECTRICAL PROBLEMS WITH COMPONENTS WITH DISTRIBUTED PARAMETERS

Stationarity of partial differential equations is the main factor that determines the computing algorithm for constructing further procedures. In this case, the condition of subcircuit with distributed parameters depends on boundary conditions, and the dynamics of its behaviour is determined by external actions. In particular this includes the problem of electrostatics and magnetostatics. For stationary partial differential equations is sufficient to apply the sampling procedure for spatial coordinates by the method of finite differences, where the temporal component is defined as external matching with other subcircuit. That is, at each step of matching sources due time change manifests itself by changing boundary conditions subcircuit with distributed parameters. It is clear that there is no feedback influence of processes in subcircuit with distributed parameters on the integration step.

Sampling spatial coordinates for nonstationary problems leads to the transformation of partial differential equations taking into account temporal changes in the subcircuit with distributed parameters, of course, through a discretization step of time coordinate. In particular, the integration of hyperbolic equations is carried out on a uniform grid. This feature leads to the next. It is known, the separate matching step of subcircuits solutions, i.e. step coordination of external variables of the particular subcircuits for the partitioning method generally correlated with integration step of subcircuit and, of course, is determined by the maximum possible integration step of separate subcircuit. Increase of matching step size leads to a decrease in the accuracy of calculations and may lead to an unstable computing process. However, its smallest value of step size depends not only on the stability conditions of applied integration methods, as well as technological error that arises from the restriction of digit capacity, i.e. the smallest value of floating-point, which can be used in a computer system. However time step is constant on a uniform grid of subsystem with distributed parameters. This fact imposes additional, not always beneficial constraints that affect the value of matching step. For example, this step should be a multiple of discretization step. Otherwise there is a need for interpolation of external variables on the time points of matching of subcircuit solutions. It is obvious that the circumstances which lead additional errors in the results of calculations are undesirable and optional.

III. CONCLUSION

These features significantly influence the choice of algorithm for constructing a mathematical model of subcircuit with distributed parameters, and hence the structure of the software for transient simulation of complex heterogeneous electrical circuits by diakoptic methods..

IV. REFERENCES (SELECTION)

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