Forecast Criteria of Calculation Stability for Heterogeneous Electrical Systems

Serhiy Rendzinyak, Vasyl Korud

Abstract - **Problem of numerical stability is fairly complicated enough. Presence of components with lumped and distributed parameters has imposed their own features on numerical stability. Computer experiments have confirmed an expediency of relative change usage of matching currents for electrical circuits with long lines.**

Keywords - **diakoptic, multirate method, subcircuit, transient simulation, long line.**

I. INTRODUCTION

The problem of numerical stability of waveform relaxation methods is rather complicated and there are no clear recommendations concerning the criteria of stability even for linear systems. Analytical criteria of difference methods have not received practical usage because in most cases the electrical circuits are nonlinear and the step of integration constantly varies [1]. In [2] the problem how to define the stability criteria for the separate subsystems which can be described by the same equation was formulated. But if non-homogeneous electric circuit should be analyzed such approach usage in ineffective. The presence of component with different type parameters leads to the special features of calculation process stability. It can be explained by fact that every type of equations should be integrated by separate methods which should be matched. If each method is absolutely stable then the process of calculation using diakoptic methods is unstable. Therefore it is necessary to define such criteria which will help us to foresee the stability or instability of calculation process.

II. THEORETICAL BASES

Let us consider a computation of transient process of heterogeneous electrical circuit (Fig. 1) by diakoptic method.

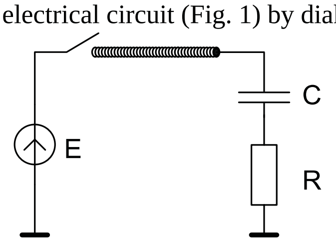

Fig. 1. Scheme of heterogeneous electrical circuit

There are three separate components: two linear subsystems and one subsystem with distributed parameters (Fig. 2) for the diakoptic method implementation. Subsystem with distributed parameters can be described using hyperbolic equations.

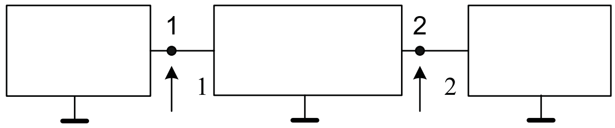

Fig. 2. Partitioning scheme to separated subsystems

It is know that using diakoptic methods the matching of such subsystems which are integrated by their methods is carried out in points 1 and 2 using fictitious sources: for example, in the Fig. 3 such separation is shown in the point 2.

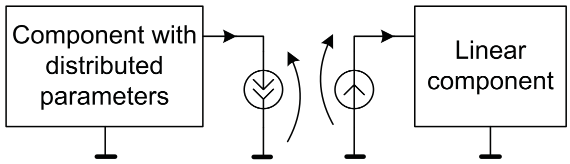

Fig. 3. The circuit for separate subsystems matching.

If for linear components the stability of computation process is clearly defined by the integration step and the equation stiffness then for subsystem with distributed parameters it is necessary to take into account dimension of the grid which is used for the difference equations formation. Stability of these models is defined by steps in time and coordinates that defines stability of such component calculation [3]. This condition of stability is defined as $\frac{\tau}{h^p} = \text{const} \le C$ where h is an integration step in time coordinate; τ – is an integration step in geometry coordinate; C, p – are given constants with value that does not depend on h and τ.

This condition of numerical stability demands simultaneous variation of the steps of integration by coordinates.

It is evident that stability of calculation process using dikoptic methods is connected with values of increments Δu_J, Δu_E, Δi_J, Δi_E on integration steps of separate subcircuits and in points of correction (or, in other words in matching points) – see Fig. 4. These increments depend on the integration step of separate subsystems and on the step of correction $T_k - T_{k-1}$. On this step an increment, for example, for currents of the sources, is defined by features of subsystems in the moment of correction of their parameters – it is a level mismatch of subsystems solution. From other side, these increments are not connected; therefore they can't define some restrictions.

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