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# A Problem of Stability of Parametrical System of Two Coupled Circuits with External Conductive Connection

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**Abstract**—Stability provision problem is very important in radio electronics. Each unstable amplifier self-excites and causes damage to radio equipment. Unstability of parametrical oscillating circuits is specified by physical nature of their functioning. Self-exciting appears where temporal variable reactance is present. Two coupled circuits are widely spread in practice. The simplest ones are systems with conductive connection, but nevertheless they are more complicated than parametric oscillating circuit. In this paper a problem of such system stability provision is considered. Analysis is carried out based on Lyapunov's stability theory.

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Usual systems of two coupled circuits are widely applied in radio-communication and other technical fields of application. The theory of such systems is more complicated than oscillating circuit one. If we compare parametrical systems with usual, we can see that first systems are more complicated and varied. In particular, systems with positive elements are always asymptotically stable according to Lyapunov's theory, i.e. their natural process tends to zero as times goes by, moreover, if dissipation is present, it tends to zero according exponential law, i.e. so fast than this natural process can hardly be detected in practice. In analogous parametrical systems this natural process tends often to infinity, but not to zero. This undesirable cases can be detected theoretically and eliminated at development stage. For this purpose Lyapunov's theory application is suitable.

Self- excitation is eliminated, as a rule, experimentally, that is expensive, moreover, it does not allow to discover self-excitation cause. At that, if self-excitation is eliminated experimentally, it can appear at different time point. In this case it is necessary to discover theoretically using, fundamental statements of Lyapunov's stability theory. In this paper we try to provide stability my means of specified not simple example. Selected for analysis system is often used in practice, proposed method of Lyapunov's stability theory application can be naturally generalized for the other parametrical circuits.

Analyzed system of two coupled circuits with external conductive connection is represented in Fig. 1. We suppose circuit elements (capacities, inductances, active resistances and conductivities) are always positive, their temporal changes are described by arbitrary functions with only one restriction: the first time derivative of reactance functions must be existent. For energy sources are shown: two current sources $j_1$ and $j_2$, and two voltage sources $\varepsilon_1$, $\varepsilon_2$ with their sequential internal resistances $R^{(1)}$, $R^{(2)}$. It is supposed heat waste is uniformly distributed in the system, in spite of its different nature. Usually it is taken into account by concentrated resistances and conductivities application, but this approach is approximate, it is more exact, the less is heat waste. In parametrical circuits this waste is greater, than in analogous circuits with constant elements. In considered system heat waste, as usual, is taken into account in form of concentrated active resistances and conductivities, they are separated for capacities and inductances. Several energy sources are considered with purpose to consider as much particular cases, as it possible. Voltages $\varepsilon_1$, $\varepsilon_2$ and feed currents $j_1$, $j_2$ are undefined.

Mathematic equation of the system can be different dependently on functions that are defined as determinant, at that we obtained approximately equivalent equations.

As determinant functions we select charges $q_1$ and $q_2$ of capacitors $C_1$ and $C_2$ and magnetic fluxes $\Phi_1$, $\Phi_2$, connected with inductances $L_1$ and $L_2$. Mathematic equation obtaining for represented in Fig. 1 system is enough intricate problem. It is nessesary to apply Kirchhoff laws, where all currents and voltages are