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Some General Operational Method in Quasi Harmonic Non-linear Circuit Analysis and its Application to Mutual Synchronization of Two Oscillators

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One of the most interesting aspects of non-linear electrical system is the wide variety of periodic behavior which may exhibit. It is well-known that operational methods have been applied to analyze the steady state response of linear time invariant systems for many years. But it is impossible to apply such methods to non-linear systems which can not be applied the principle of supper-position. Therefore, we must usually analyze non-linear circuits by solving non-linear differential equations which describe the circuits.

However, in many cases the behavior of a non-linear circuit is "quasi harmonic" in nature; that is, currents or voltages in the circuit are approximately supposed to be sinusoidal ones. Under such a condition it is often possible to obtain reasonable approximations to circuit behavior by using something like operational treatments. These methods consist in equivalent linearization, hnd we can easily get the steady state behavior of non-linear circuits. On the other hand, when multiplicity of the steady states which characterizes non-linear systems is exhibited, these methods can not give us any information of which the steady states actually exist, that is, of which the states are stable.

The purpose of the former part of this paper is to show some general operational treatment of almost sinusoidal non-linear electrical circuits, that provides us not only their steady state behaviors by using their circuit equations with equivalent linearized impedance or admittance but also the stability conditions of them from the same circuit equations.

The problem of mutual synchronization of two coupled oscillators is of great significance because of its interesting behavior and its wide applications. In the usual treatments of synchronization, only the action of an external source to the oscillator is considered but the reaction of the oscillator to the source is disregarded. However, when two oscillators with nearly equal power and frequency are coupled each other, the situations become different and the mutual action and reaction exert important influence on the synchronized states. Hence the problem is a particular case of self-oscillations with two degrees of freedom.

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The later part of the paper shows some investigation of the effects of two oscillators coupled each other by means of a capacitor or a resister concerning their frequency, phase and amplitude characteristics in the synchronized zones using the operational treatment above mentioned.