Frequency Symbolic Analysis of Linear Periodically Time-Variable Circuits with Many Parametric Elements

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Abstract. **The possibility of application of frequency symbolic method of analysis of linear periodically time-variable (LPTV) circuits with one parametric element to the circuits with many parametric elements is shown.**

Keywords**: linear periodically time-variable (LPTV) circuits, frequency symbolic method (FSM)**.

I. INTRODUCTION

Most of parametric circuits that is used in electronic devices contains one parametric element. Efficiency of functioning of such circuits may be achieved at significant depths of modulation of parameter of parametric element. However, increasing the depth of modulation, in practice, limited or can lead to the emergence unwanted harmonic components in the parameter of parametric element and, consequently in output signal. So sometimes it may be advisable introduction in circle several parametric elements whose parameters vary in a relatively small limits. From the above follows and relevance of the proposed work.

The formation of symbolic parametric transfer function $W(s,t)$ of established mode of LPTV circuit with one parametric element that changes periodically in time with period T by FSM described in detail in [1] and is based on the approximation of the transfer function $W(s,t)$ by trigonometric polynomial of Fourier $\hat{W}(s,t)$ with a certain number of harmonic components k of the frequencies $i\Omega$, where s - complex variable, t - time, $\Omega = 2\pi/T$ - basic frequency changes of parametric element, $i = 0,1,2,\ldots,k$.

II. TECHNIQUE OF ANALYSIS OF CIRCUITS WITH MANY PARAMETRIC ELEMENTS

The paper shows that the parametric transfer function $W(s,t)$ of established mode of circuit with many parametric elements that change periodically in time, should be approximated by trigonometric polynomial of Fourier $\hat{W}(s,t)$ that contains harmonic components with frequencies $i\Omega$ where Ω is equal the greatest common divisor (GCD) values of the basic frequencies for which is vary the parametric elements of circuit, respectively. For example, if in circuit: a) n parametric elements, and they are changing with the basic frequencies $\Omega_1, \Omega_2, \ldots, \Omega_n$, the function $\hat{W}(s,t)$ should decompose in frequency $\Omega = GCD(\Omega_1, \Omega_2, \ldots, \Omega_n)$; b) all elements are parametric, but are changing with one basic frequency Ω, then the function $\hat{W}(s,t)$ should be decompose in frequency $\Omega = GCD(\Omega, \Omega, \ldots)$; c) $GCD(\Omega_1, \Omega_2, \ldots, \Omega_n)$ does not exist, so such circuit has no established mode, and therefore can not be analyzed by FSM. Thus, the difficulty of task is determined not by the number of parametric elements in the circuit but the number of different basic frequencies their changes. In another FSM of analysis of LPTV circuits with many parametric elements with proper choice of values k of no additional changes are not provide.

The paper considers example of analysis of established mode of single-circuit parametric amplifier. It is shown that for two parametric elements – capacitance $c(t)$ and inductance $L(t)$ with depths of modulation m_c, m_L, respectively, can be ensured the same amplification of signal as in parametric amplifiers with the one parametric element $c(t) = c_0[1 + m\cos(\Omega t + \varphi)]$ and a constant inductance L, provided $m_c, m_L < m$.

III. CONCLUSION

Presented in the work examples which are convince in correctness of application of the FSM to the analysis of LPTV circuits with many parametric elements.

1) Accuracy of calculations by FSM for determined by the number of harmonic components k which included in approximation of the transfer function, and growing with increasing the this number.

2) Difficulty of analysis of of LPTV circuit by FSM is determined not by a number of parametric elements in the circuit, but the number of different basic frequencies of change of their parameters.

3) If the basic frequencies of changes of parametric elements of circuit have no common divisor (except one), such circuit has no a established mode and can not be analyzed by FSM.

4) The results of presented computer experiments are with single-circuit parametric amplifier supporting the possibility of reducing the depth modulation of parametric element with an increase in their number in the circuit.

IV. REFERENCES

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