

A method for one port and two-port RC circuit synthesis

F. CONSTANTINESCU, M. NITESCU, AL. G. GHEORGHE, C.V. MARIN

Department of Electrical Engineering
Politehnica University

Splaiul Independentei 313, Bucharest, 060042
ROMANIA

Abstract: A new method for the synthesis of RC one ports and two-ports is proposed in this paper. A new model of the human body, computed using this method, is developed. This model proves to be more accurate than the classical Cole model. The proposed synthesis method can be used to compute reduced order models (ROM), preserving the circuit passivity, unlike most known ROM computation methods.

Key-Words: Synthesis of RC circuits, pole/zero, RC model of human body, reduced order models

1. Introduction

The common approach to circuit synthesis is to start from a given set of frequency characteristics, to approximate them with realizable rational functions (ratios of polynomials of the Laplace variable s), and to use a synthesis method for finding a circuit which corresponds to the above circuit functions [1].

A new approach to this problem, based on pole/zero placement of RC circuits, is presented in this paper. A new method for RC admittance synthesis is given in Section 2. Section 3 outlines a new method for the synthesis of RC two-ports. A new circuit model for body cell mass prediction, illustrating the new synthesis method, is described in Section 4.

2. Synthesis of a RC admittance

The poles and zeros of a RC admittance $Y_{RC}(s)$ alternate on the negative real axis, the closest to the origin being a zero. The shape of the curve $|Y_{RC}(j\omega)|$ vs. ω is defined by the location of the poles and zeros. Sweeping the ω axis starting from the origin we remark that the occurrence of a zero is associated with a slope change of 20 dB/decade and the occurrence of a pole is associated with a slope change of -20 dB/decade [2]. This is because the characteristic $|Y_{RC}(j\omega)|$ has asymptotes whose slopes are 20 dB/decade , 0 , -20 dB/decade , 0 a.s.o. Characteristic approximation by asymptotes has the maximum error of 3dB at the asymptote intersection (Fig.1).

A natural way to approximate $|Y_{RC}(j\omega)|$ is to

consider fewer asymptotes with the same slopes as the original ones.

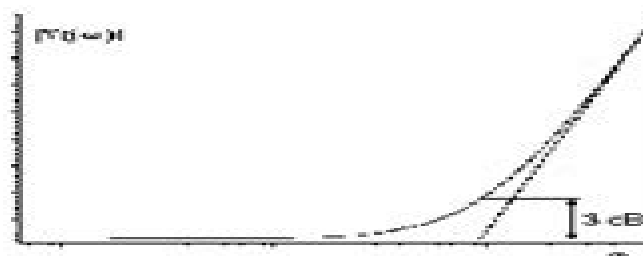


Fig. 1. The frequency characteristic of a RC admittance and its asymptotes

The complexity of the synthesized circuit depends on the relative error ϵ with respect to the original characteristic. Obviously a greater ϵ leads to a simpler circuit. Our algorithm for synthesis of a RC admittance has the following steps:

1. computation of the first zero z_1
2. computation of the other poles and zeros
3. computation of the circuit parameters

The frequency range of interest is $[\omega_{\min}, \omega_{\max}]$. z_1 is set to $\omega_{\min}$. Sweeping the frequency axis with a step $\Delta\omega_{\min}$ the error between the asymptote of 20 dB/decade and the given characteristic is checked. The first pole p_1 is placed to the last value before that corresponding to an error of 2ϵ or greater. If this error occurs after the first step $\Delta\omega_{\min}$ then p_1 is placed very close to z_1 . The first asymptote is

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