CIRCUIT DESIGN FOR MULTIPLE-ORDER SYSTEM WITH FRACTIONAL POWER USING SINGULARITY FUNCTION APPROACH

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ABSTRACT

A fractional slope on the log-log bode plot has been observed in characterizing a certain type of physical phenomena and has been called the fractal system or the fractional power pole.

This thesis present the analysis and synthesis of multiple fractal system with fractal dimension $0 < m_i < 1$. Multiple fractal system consists of numbers of fractional power pole. A singularity function method is used to approximate the fractional-order function. This method represents the structure of pole-zero pairs on the real axis. The function is then synthesized to circuit form and simulated using PSPICE for its frequency and unit-step responses. The simulation results are presented and compared with the responses from the approximated function that were plotted using MATHCAD.

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CHAPTER 1

1. INTRODUCTION

Numerous studies have been made about the fractal system ever since the phenomena of 1/f noise spectrum was first introduced by Van Der Zeil back in 1950 [1]. The concept of fractals provides a precise description and a mathematical model for many of complex structures found in nature.

Fractional power pole has been suggested for representation of fractal system in frequency domain. A fractal system or the fractional power pole generally represented as follows:

$$H(s) = \frac{1}{s^m} \quad (1)$$

where $s = j\omega$ is the complex frequency and m is a positive fractional number and can also be called the fractal dimension. A single fractal system can be modeled in the frequency domain by the transfer function of a single-fractional power pole as follows:

$$H(s) = \frac{1}{\left(1+\frac{s}{P_T}\right)^m} \quad (2)$$

where $1/P_T$ is the relaxation time constant and $0 < m < 1$. This type of