

Preface

It is known that many dynamic systems in our world can be better described by differential equations of a non-integer-order, i.e., they behave like non-integer-order (fractional-order) systems. Such systems can be found not only in electronics and signal processing, but also in thermodynamics, biology, chemistry, medicine, mechanics, control theory, nanotechnologies, finances, etc. Thus, fractional-order systems are an emerging area of multidisciplinary research labeled even as the “twenty-first century systems.” Electronic engineers are very interested in applying the concept of fractional calculus. It is motivated mainly by the interdisciplinary nature of this research and possibility to obtain qualitatively new circuit solutions that can provide characteristics not available at integer-order systems. For example, the capability for stepless control of the slope of frequency characteristics in fractional-order filters in comparison with the corresponding integer-order filters is an attractive feature. Fractional-order impedance circuits are also very promising in modeling electrical properties of biological materials, tissues, or cells. Oscillators of fractional-order provide possibility of obtaining higher oscillation frequencies compared to the integer-order counterparts with the same values of passive element parameters offering arbitrary phase shift between output signals.

This book deals with the design and realization of analog fractional-order circuits, which offer the following benefits: (i) capability for on-chip implementation, (ii) capability for low-voltage operation, and (iii) electronic adjustment of their characteristics. Applications of fractional-order circuits, including: a preprocessing stage suitable for the implementation of the Pan-Tompkins algorithm for detecting the QRS complexes of an electrocardiogram (ECG), a fully tunable implementation of the Cole-Cole model used for the modeling of biological tissues, and a simple non-impedance based measuring technique for super-capacitors. A part of the material presented in this book, originates from the work done by Georgia

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Rio Patras, Greece
Rio Patras, Greece
Sharjah, UAE
Cairo, Egypt

Georgia Tsirimokou
Costas Psychalinos
Ahmed Elwakil

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Applications in Medicine and Biology

Tsirimokou, G.; Psychalinos, C.; Elwakil, A.

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