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2024 3rd International Conference on Control, Instrumentation, Energy & Communication (CIEC)

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FPA-based Approximation and Realization of Analog Fractional-Order Integrator

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This paper presents the approximation of the analog fractional-order integrator, commonly referred to as the $s^{-\alpha}$ operator, where $\alpha \in (0, 1)$, using a metaheuristic optimization strategy. The minimization of the frequency response error of the biquadratic approximant with respect to the targeted model is carried out using Flower Pollination Algorithm (FPA). Five different models are suggested by varying a tuning parameter in the cost function which controls the degree of effort individually expended by FPA on minimizing the magnitude and the phase errors. Comparisons with the current literature justify the improved approximation accuracy of the proposed designs. Circuit implementation for the FPA-based half-order integrator is validated using PSPICE.

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☰ Contents**I. Introduction**

Fractional Calculus (FC) is a branch of mathematics which generalizes the integration and differentiation operations to encompass non-integers also [1]. It is well-established in the literature that FC, in comparison to the classical calculus, provides a more accurate modeling of real-life systems in diverse domains [2]–[4]. A well-known definition of the fractional-order derivative is provided by Caputo, as defined in (1).

$${}^C D_t^\alpha f(t) = \frac{1}{\Gamma(n-\alpha)} \int_a^t \frac{f^{(n)}(\tau)}{(t-\tau)^{\alpha+1-n}} d\tau \quad (1)$$

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