The fractional Green's function by Babenko's approach

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Abstract: The goal of the current work is to derive the fractional Green's function for the first time in the distributional space $\mathcal{D}'(R^+)$ for the following fractional-order differential equation with constant coefficients

$$a_n u^{(\beta_n)}(x) + a_{n-1} u^{(\beta_{n-1})}(x) + \cdots + a_1 u^{(\beta_1)}(x) + a_0 u^{(\beta_0)}(x) = g(x).$$

Our new technique is based on Babenko's approach, without using any integral transforms, such as the Laplace transform, and the Mittag-Leffler functions. The results obtained are not only simpler but also more generalized than classical ones as they deal with distributions in Schwartz's sense. Furthermore, we provide several interesting applications of solving the fractional differential and integral equations by showing the convergence of double series based on gamma functions.