Tempered Ψ-Fractional Calculus:
Integral Inequalities and Their Applications

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Abstract

The notion of the tempered Ψ-Hilfer fractional integral was recently introduced to establish a connection between the tempered Riemann–Liouville fractional integral and Ψ-Riemann–Liouville fractional integral. By modifying the classic integral inequalities using a desingularization method for integrals with weakly singular kernels, new nonlinear integral inequalities with the tempered Ψ-Hilfer fractional integrals are derived. Results for differential equations involving the tempered Ψ-Caputo fractional derivative, such as Ψ-exponential stability, nonexistence of blow-up solutions, and the existence of a unique solution, are derived with the aid of these inequalities.

References

[1] H. M. Fahad, A. Fernandez, M. ur Rehman, M. Siddiqi, Tempered and Hadamard-type fractional calculus with respect to functions, *Mediterr. J. Math.* **18**(2021), No. 4, Art. No. 143, 28 pages.

[2] M. Medveď, E. Brestovanská, Differential equations with tempered Ψ-Caputo fractional derivative, *Math. Model. Anal.* **26**(2021), No. 4, 631–650.

[3] M. Medveď, M. Pospíšil, E. Brestovanská, Nonlinear integral inequalities involving tempered Ψ-Hilfer fractional integral and fractional equations with tempered Ψ-Caputo fractional derivative, *Fractal Fract.* **7**(2023), No. 8, Art. No. 611, 1–17.

[4] M. Medveď, M. Pospíšil, E. Brestovanská, A new nonlinear integral inequality with tempered Ψ-Hilfer fractional integral and its application to a class of tempered Ψ-Caputo fractional equations, *Axioms* **13**(2024), No. 5, Art. No. 301, 16 pages.

[5] M. Medveď, M. Pospíšil, E. Brestovanská, Nonlinear integral inequalities involving Ψ-Hilfer fractional integrals and iterated fractional integrals, with applications to Ψ-Caputo fractional differential equations, *Electron. J. Qual. Theory Differ. Equ.*, (2025), No. 30, 1–24.

[6] M. Pospíšil, L. Pospíšilová Škripková, Existence results for differential equations with tempered Ψ-Caputo fractional derivatives, *Axioms* **13**(2024), No. 10, Art. No. 680, 16 pages.