Applications of Coincidence Degree Theory to Fractional Boundary Value Problems and Non-Autonomous Ecological ODE Models

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Abstract

This talk highlights coincidence degree theory as a powerful tool in nonlinear analysis, proving existence results in both fractional boundary value problems and non-autonomous ecological dynamical systems. We first consider higher-order Riemann–Liouville fractional differential equations subject to Riemann–Stieltjes integral boundary conditions at resonance. The main idea is to transform the nonlinear problem into a semilinear operator equation of the form $Lx = Fx$, where L is a linear Fredholm operator of index zero and F is a nonlinear operator. By constructing appropriate operators and verifying the conditions of Mawhin's coincidence degree theory, we establish existence results for various classes of fractional boundary value problems (problems involving Caputo, Hadamard, and Katugampola derivatives). Related Publications [1, 2, 4].

Using the same analytical methodology, we also study non-autonomous ecological ODE models. In particular, we present recent results on allelopathic phytoplankton systems and bioeconomic fishery models with periodic coefficients. By carefully defining suitable function spaces, norms, and operator settings, we derive sufficient conditions for the existence of positive periodic solutions. Related Publications [3].

References

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[3] Satyam Narayan Srivastava, Alexander Domoshnitsky, Seshadev Padhi, Rana D. Parshad, and John R. Graef. Existence of periodic solution of a non-autonomous allelopathic phytoplankton model with fear effect. *Electronic Research Archive*, 34(2):723–737, 2026.

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