

ON SOLVABILITY OF SOME NONLINEAR FRACTIONAL INTERVAL INTEGRAL EQUATIONS

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Abstract. In this paper, firstly we deal with solvability of a first kind nonlinear interval integral equation of fractional order. Then we present a theorem giving sufficient conditions for existence of solution of a second kind nonlinear interval integral equation of fractional order in the space of continuous interval-valued functions on the interval $[a, b]$ by using Banach fixed point theorem. We give also some examples satisfying the conditions of our main theorems.

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REFERENCES

- [1] S. ARSHAD AND V. LUPULESCU, *On the fractional differential equations with uncertainty*, Nonlinear Anal. **74**, (2011), 3685–3693.
- [2] J.P. AUBIN AND H. FRANKOWSKA, *Set-Valued Analysis*, Birkhauser, Boston, 1980.
- [3] R.J. AUmann, *Integrals of set-valued functions*, J. Math. Anal. Appl. **12**, (1965), 1–12.
- [4] S. CHANDRASEKHAR, *Radiative Transfer*, Oxford Univ. Press, London, 1950.
- [5] G. GRIPENBERG, *On some epidemic models*, Quart. Appl. Math. **39**, (1981), 317–327.
- [6] F. HIAI, H. UMEGAKI, *Integrals, conditional expectations and martingales of multivalued functions*, J. Multivar. Anal. **7**, (1977), 149–182.
- [7] E. KREYSZIG, *Introductory Functional Analysis with Applications*, John Wiley-Sons Inc., New York (1989).
- [8] V. LAKSHMIKANTHAM, T. GNANA BHASKAR AND J. VASUNDHARA DEVI, *Theory of set differential equations in metric spaces*, Cambridge Scientific Publ., Florida, 2006.
- [9] V. LUPULESCU, *Fractional calculus for interval-valued functions*, Fuzzy Sets and Systems **265**, (2015), 63–85.
- [10] V. LUPULESCU AND N.V. HOA, *Interval Abel Integral Equations*, Soft Comput. doi:10.1007/s00500-015-1980-2, (2016).
- [11] M.T. MALINOWSKI, *Interval differential equations with a second type Hukuhara derivative*, Appl. Math. Lett. **24**, (2011), 2118–2123.
- [12] S. MARKOV, *Calculus for interval functions of a real variables*, Computing **22**, (1979), 325–337.
- [13] R.E. MOORE, R.B. KEARFOTT AND M.J. CLOUD, *Introduction to Interval Analysis*, SIAM, Philadelphia, 2009.
- [14] S. SALAHSHOUR AND M. KHAN, *Exact solutions of nonlinear interval Volterra integral equations*, Int. J. Ind. Math. **4**, Article ID: IJIM-00291, (2012).
- [15] S.G. SAMKO, A.A. KILBAS, O.I. MARICHEV, *Fractional integrals and derivatives: theory and applications*, Gordon and Breach Science Publishers, Switzerland, 1993.
- [16] Y. SHEN, *The Cauchy type problem for interval-valued fractional differential equations with the Riemann-Liouville gH-fractional derivative*, Adv. Difference Equ. doi:10.1186/s13662-016-0827-1, (2016).
- [17] L. STEFANINI, *A generalization of Hukuhara difference and division for interval and fuzzy arithmetic*, Fuzzy Sets and Systems **161**, (2010), 1564–1584.

- [18] L. STEFANINI AND B. BEDE, *Generalized Hukuhara differentiability of interval valued functions and interval differential equations*, Nonlinear Anal. **71**, (2009), 1311–1328.