

BOUNDARY VALUE PROBLEM FOR HYBRID GENERALIZED HILFER FRACTIONAL DIFFERENTIAL EQUATIONS

ABDELKrim SALIM, BASHIR AHMAD*, MOUFFAK BENCHOHRA
AND JAMAL EDDINE LAZREG

Abstract. This manuscript is concerned with the existence of solutions for a class of boundary value problems for nonlinear fractional hybrid differential equations involving generalized Hilfer fractional derivative. The main result is based on a fixed point theorem due to Dhage, which is illustrated with examples.

Mathematics subject classification (2020): 34A08, 26A33, 34B15.

Keywords and phrases: Generalized Hilfer fractional derivative, boundary value problem, existence, hybrid fractional differential equations, fixed point.

REFERENCES

- [1] S. ABVAS, M. BENCHOHRA, J. R. GRAEF, J. HENDERSON, *Implicit Differential and Integral Equations: Existence and stability*, Walter de Gruyter, London, 2018.
- [2] S. ABVAS, M. BENCHOHRA, J. E. LAZREG, A. ALSAEDI, Y. ZHOU, *Existence and Ulam stability for fractional differential equations of Hilfer-Hadamard type*, Adv. Difference Equ. (2017), Paper No. 180, 14 pp.
- [3] S. ABVAS, M. BENCHOHRA, J. E. LAZREG, G. N'GUÉRÉKATA, *Hilfer and Hadamard functional random fractional differential inclusions*, Cubo **19** (2017), 17–38.
- [4] S. ABVAS, M. BENCHOHRA, J. E. LAZREG, Y. ZHOU, *A survey on Hadamard and Hilfer fractional differential equations: analysis and stability*, Chaos Solitons Fractals **102** (2017), 47–71.
- [5] S. ABVAS, M. BENCHOHRA, G. M. N'GUÉRÉKATA, *Topics in Fractional Differential Equations*, Springer-Verlag, New York, 2012.
- [6] S. ABVAS, M. BENCHOHRA, G. M. N'GUÉRÉKATA, *Advanced Fractional Differential and Integral Equations*, Nova Science Publishers, New York, 2014.
- [7] B. AHMAD, A. ALSAEDI, S. K. NTOUYAS, J. TARIBOON, *Hadamard-type Fractional Differential Equations, Inclusions and Inequalities*, Springer, Cham, 2017.
- [8] B. AHMAD, S. K. NTOUYAS, *Fractional differential inclusions with fractional separated boundary conditions*, Fract. Calc. Appl. Anal. **15** (2012), 362–382.
- [9] B. AHMAD, S. K. NTOUYAS, *Initial value problems for hybrid Hadamard fractional differential equations*, Electron. J. Differential Equations (2014), no. 161, 8 pp.
- [10] R. ALMEIDA, A. B. MALINOWSKA, T. ODZIJEWICZ, *Fractional differential equations with dependence on the Caputo-Katugampola derivative*, J. Comput. Nonlinear Dynam **11** (2016), 1–11.
- [11] D. BALEANU, Z. B. GÜVENÇ, J. A. T. MACHADO, *New Trends in Nanotechnology and Fractional Calculus Applications*, Springer, New York, 2010.
- [12] Z. BAITCHE, K. GUERBATI, M. BENCHOHRA, Y. ZHOU, *Boundary value problems for hybrid Caputo fractional differential equations*, Mathematics (2019), 7, 282.
- [13] M. BENCHOHRA, S. BOURIAH, J. J. NIETO, *Terminal value problem for differential equations with Hilfer-Katugampola fractional derivative*, Symmetry, (2019), 11, 672.
- [14] M. BENCHOHRA, J. E. LAZREG, *Existence and Ulam stability for nonlinear implicit fractional differential equations with Hadamard derivative*, Stud. Univ. Babes-Bolyai Math. **62** (2017), 27–38.
- [15] C. DERBAZI, H. HAMMOUCHE, M. BENCHOHRA, Y. ZHOU, *Fractional hybrid differential equations with three-point boundary hybrid conditions*, Adv Difference Equ. (2019), Paper No. 125, 11 pp.

- [16] B. C. DHAGE, *On a fixed point theorem in Banach algebras with applications*, Appl. Math. Lett. **18** (2005), 273–280.
- [17] K. HILAL, A. KAJOUNI, *Boundary value problems for hybrid differential equations with fractional order*, Adv. Difference Equ. (2015), 2015:183, 19 pp.
- [18] U. KATUGAMPOLA, *A new approach to a generalized fractional integral*, Appl. Math. Comput. **218** (2011), 860–865.
- [19] D. S. OLIVEIRA, E. CAPELAS DE OLIVEIRA, *Hilfer–Katugampola fractional derivatives*, Comput. Appl. Math. **37** (2018), 3672–3690.
- [20] A. SALIM, M. BENCHOHRA, E. KARAPINAR, J. E. LAZREG, *Existence and Ulam stability for impulsive generalized Hilfer-type fractional differential equations*, Adv. Difference Equ. **2020**, Paper No. 601, 21 pp.
- [21] A. SALIM, M. BENCHOHRA, J. E. LAZREG, J. HENDERSON, *Nonlinear implicit generalised Hilfer-type fractional differential equations with non-instantaneous impulses in Banach spaces*, Adv. Theory Nonl. Anal. Appl. **4** (2020), 332–348.
- [22] A. SALIM, M. BENCHOHRA, J. R. GRAEF, J. E. LAZREG, *Boundary value problem for fractional generalised Hilfer-type fractional derivative with non-instantaneous impulses*, Fractal Fract. (2021), 5 (1): 1.
- [23] Y. ZHAO, S. SUN, Z. HAN, Q. LI, *Theory of fractional hybrid differential equations*, Comput. Math. Appl. **62** (2011), 1312–1324.