

SOME NEW MULTIDIMENSIONAL HARDY-TYPE INEQUALITIES WITH GENERAL KERNELS ON TIME SCALES

E. AWWAD* AND A. I. SAIED

Abstract. This paper contains some new multidimensional Hardy-type inequalities with general kernels on time scales. Our results (when $\mathbb{T} = \mathbb{R}$) give the inequalities proved by Oguntuase and Durojaye.

Mathematics subject classification (2020): 26D10, 26D15, 34N05, 42B25, 42C10, 47B38.

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REFERENCES

- [1] R. P. AGARWAL, D. O'REGAN, S. H. SAKER, *Dynamic Inequalities on Time Scales*, Springer Cham Heidelberg New York Dordrecht London, 2014.
- [2] R. P. AGARWAL, D. O'REGAN, S. H. SAKER, *Hardy Type Inequalities on Time Scales*, Springer, 2016.
- [3] R. BIBI, M. BOHNER, J. PEČARIĆ, S. VAROŠANEC, *Minkowski and Beckenbach-Dresher inequalities and functionals on time scales*, J. Math. Inequal. **7** (2013), no. 3, 299–312.
- [4] M. BOHNER, A. PETERSON, *Dynamic Equations on Time Scales: An Introduction with Applications*, Birkhäuser, Boston, Mass, USA, 2001.
- [5] M. BOHNER, A. PETERSON, *Advances in Dynamic Equations on Time Scales*, Birkhäuser, Boston, 2003.
- [6] A. CIŽMEŠIJA, J. PEČARIĆ, L. E. PERSSON, *On strengthened Hardy and Pólya-Knopp's inequalities*, J. Approx. Theory **125**, (2003), 74–84.
- [7] E. T. COPSON, *Note on series of positive terms*, J. Lond. Math. Soc. **3** (1927), 49–51.
- [8] O. O. FABELURIN, J. A. OGUNTUASE, L. E. PERSSON, *Multidimensional Hardy-type inequalities on time scales with variable exponents*, J. Math. Ineq. **13** (2019), 725–736.
- [9] G. H. HARDY, *Notes on some points in the integral calculus (LXIV)*, Mess. Math. **57** (1928), 12–16.
- [10] G. H. HARDY, J. E. LITTLEWOOD, *Elementary theorems concerning power series with positive coefficients and moment constants of positive functions*, J. Für Math. **157** (1927), 141–158.
- [11] H. P. HEINIG, *Weighted norm inequalities for certain integral operators II*, Proc. Amer. Math. Soc. **95** (1985), no. 3, 387–395.
- [12] H. HEINIG, L. MALIGRANDA, *Weighted inequalities for monotone and concave functions*, Studia Math. **116** (1995), 133–165.
- [13] S. KAIJSER, L. E. PERSSON, A. ÖBERG, *On Carleman and Knopp's inequalities*, J. Approx. Theory **117**, (2002), 140–151.
- [14] S. KAIJSER, L. NIKOLOVA, L. E. PERSSON, A. WEDESTIG, *Hardy type inequalities via convexity*, Math. Inequal. Appl. **8** (2005), no. 3, 403–417.
- [15] K. KNOPP, *Über Reihen mit positiven Gliedern*, J. London. Math. Soc. **3** (1928), 205–311.
- [16] A. KUFNER, L. E. PERSSON, *Weighted Inequalities of Hardy Type*, World Scientific Publishing, 2003.
- [17] A. KUFNER, L. MALIGRANDA, L. E. PERSSON, *The Hardy Inequalities: About its History and Some Related Results*, Vydavateľsk servis, 2007.
- [18] S. LAI, *Weighted norm inequalities for general operators on monotone functions*, Transactions of the American Mathematical Society, **340** (2) (1993), 811–836.
- [19] L. LEINDLER, *Generalization of inequalities of Hardy and Littlewood*, Acta Sci. Math. (Szeged), **31** (1970), 285–297.

- [20] J. A. OGUNTUASE AND P. DUROJAYE, *Some new multidimensional hardy-type inequalities with kernels via convexity*, Publications de l'Institut Mathematique, 93 (107), (2013), 153–164.
- [21] B. OPIC A. KUFNER, *Hardy-Type Inequalities*, Pitman Research Notes in Mathematics Series, Longman Scientific and Technical, Harlow, 1990.
- [22] U. M. ÖZKAN, H. YILDIRIM, *Hardy-Knopp type inequalities on time scales*, Dyn. Syst. Appl. **17** (2008), 477–486.
- [23] U. M. ÖZKAN, H. YILDIRIM, *Time scale Hardy-Knopp type integral inequalities*, Communications in Mathematical Analysis, 6 (1), (2009).
- [24] S. H. SAKER, R. R. MAHMOUD, A. PETERSON, *Weighted Hardy-type inequalities on time scales with applications*, Mediter. J. Math. **13** (2015), no. 2, 585–606.
- [25] S. H. SAKER, E. AWWAD AND A. SAIED, *Some new dynamic inequalities involving monotone functions on time scales*, Journal of Function Spaces, 2019, (2019).
- [26] S. H. SAKER, A. I. SAIED AND M. KRNIĆ, *Some New Weighted Dynamic Inequalities for Monotone Functions Involving Kernels*, Mediterranean Journal of Mathematics, 17 (2), (2020), 1–18.
- [27] S. H. SAKER, A. I. SAIED AND M. KRNIĆ, *Some new dynamic Hardy-type inequalities with kernels involving monotone functions*, Revista de la Real Academia de Ciencias Exactas, Físicas y Naturales, Serie A. Matematicas, 114, (2020), 1–16.
- [28] G. J. SINNAMON, WEIGHTED HARDY, *Opial-type inequalities*, J. Math. Anal. Appl. **160** (1991), 434–445.
- [29] V. D. STEPANOV, *Boundedness of linear integral operators on a class of monotone functions*, Siberian Math. J. **32** (1991), 540–542.