

SOME BIVARIATE DURRMEYER OPERATORS BASED ON q -INTEGERS

DAN BĂRBOSU, CARMEN VIOLETA MURARU AND ANA-MARIA ACU

Abstract. In the present paper we introduce a q -analogue of the bivariate Durrmeyer operators. A convergence theorem for these operators is established and the rate of convergence in terms of modulus of continuity is determined. Also, a Voronovskaja type theorem has been investigated for these operators.

Mathematics subject classification (2010): 41A10, 41A36.

Keywords and phrases: Positive linear operator, q -integers, q -Durrmeyer operator, q -beta function, modulus of continuity, K -functional.

REFERENCES

- [1] T. ACAR, A. ARAL, *On Pointwise Convergence of q -Bernstein Operators and Their q -Derivatives*, Numerical Functional Analysis and Optimization, **36** (3), 2015, 287–304.
- [2] A. M. ACU, C. MURARU, V. RADU, F. SOFONEA, *Some approximation properties of a Durrmeyer variant of q -Bernstein-Schurer operators*, Mathematical Methods in the Applied Sciences, DOI: 10.1002/mma.3949.
- [3] A. M. ACU, *Stancu-Schurer-Kantorovich operators based on q -integers*, Applied Mathematics and Computation, **259** (2015), 896–907.
- [4] O. AGRATINI, *On certain q -analogues of the Bernstein operators*, Carpathian J. Math., **24** (3), 2008, 281–286.
- [5] A. ARAL, V. GUPTA, R. P. AGARWAL, *Applications of q Calculus in Operator Theory*, Springer 2013, XII, 262 p.
- [6] D. BARBOSU, *Some generalized bivariate Bernstein operators*, Math. Notes, Miskolc, **1** (1), 2000, 3–10.
- [7] D. BARBOSU, *Polynomial approximation by means of Schurer-Stancu type operators*, Ed. Univ. de Nord, Baia Mare, 2006, ISBN (10) 973-8138-81-5, (13) 978-973-8133-81-5.
- [8] M. M. DERRIENNICK, *Sur l'approximation des fonctions intégrables sur $[0, 1]$ par des polynômes de Bernstein modifiés*, J. Approx. Theory, **31**, 1981, 325–343.
- [9] P. L. BUTZER, H. BERENS, *Semi-groups of operators and approximation*, Springer, New York, 1967, 318 pp.
- [10] M. M. DERRIENNICK, *Modified Bernstein polynomials and Jacobi polynomials in q -calculus*, Rend. Circ. Mat. Palermo, Serie II (Suppl. 76), 2005, 269–290.
- [11] J. L. DURRMAYER, *Une formule d'inversion de la transformée de Laplace: Application à la théorie des moments*, These de 3-e cycle, Faculté des Sciences de l'Université de Paris, 1967.
- [12] V. GUPTA, *Some approximation properties of q -Durrmeyer operators*, Appl. Math. Comput., **197**, 2008, 172–178.
- [13] V. GUPTA AND Z. FINTA, *On certain q -Durrmeyer type operators*, Appl. Math. Comput., **209**, 2009, 415–420.
- [14] A. LUPAS, *A q -analogue of the Bernstein operator*, University of Cluj-Napoca, Seminar on Numerical Analysis and Statistical Calculus, Preprint **9**, 1987, 85–92.
- [15] C. V. MURARU AND A. M. ACU, *Some approximation properties of q -Durrmeyer-Schurer operators*, Scient. Stud. res., Series Math. and Inf., **23** (1), 2013, 77–84.
- [16] G. M. PHILLIPS, *Bernstein polynomials based on the q -integers*, Ann. Numer. Math., **4**, 1997, 511–518.

- [17] G. M. PHILLIPS, *Interpolation and Approximation by Polynomials*, CMS Books in Math., **14**, Springer, 2003.
- [18] O. SHISHA, P. MOND, *The degree of convergence of linear positive operators*, Proc. Nat. Acad. Sci. USA **60**, 1968, 1196–1200.
- [19] D. F. SOFONEA, *Some new properties in q -calculus*, General Mathematics, **16** (1), 2008, 47–54.
- [20] D. F. SOFONEA, *On a sequence of linear and positive operators*, Result. Math., **53**, 2009, 435–444.
- [21] J. THOMAE, *Beitrage zur Theorie durch die Heinische Reihe*, J. Reine Angew. Math., **70**, 1869, 258–281.
- [22] V. J. VOLKOV, *On the convergence of linear positive operators in the space of continuous functions of two variables* (Russian), Dokl. akad. Nauk. SSSR (N. S.), **115**, 1957, 17–19.