CARPATHIAN J. MATH. 33 (2017), No. 1, 35 - 42
Online version available at http://carpathian.ubm.ro
Print Edition: ISSN 1584 - 2851 Online Edition: ISSN 1843 - 4401

On the Voronovskaja-type formula for the Bleimann, Butzer and Hahn bivariate operators

DAN BĂRBOSU and DAN MICLĂUŞ

ABSTRACT.

In this paper we present two new alternative ways for the proof of Voronovskaja-type formula of the Bleimann, Butzer and Hahn bivariate operators, using the close connection between the recalled operators and Bernstein bivariate operators, respectively Stancu bivariate operators.

REFERENCES

[1] Abel, U., *On the asymptotic approximation with operators of Bleimann, Butzer and Hahn*, Indag. Math., **7** (1996), No. 1, 1–9
[2] Abel, U., *On the asymptotic approximation with bivariate operators of Bleimann, Butzer and Hahn*, J. Approx. Theory, **97** (1999), No. 3, 181–198
[3] Abel, U. and Ivan, M., *Some identities for the operator of Bleimann, Butzer and Hahn involving divided differences*, Calcolo, **36** (1999), 143–160
[4] Abel, U. and Ivan, M., *On Bleimann, Butzer and Hahn operators on exponential functions*, Bull. Austral. Math. Soc., **75** (2007), 409–415
[5] Abel, U. and Ivan, M., *An answer to Hermann's conjecture on Bleimann-Butzer-Hahn operators*, J. Approx. Theory, **160** (2009), 304–310
[6] Adell, J. A., Badia, F. G. and De la Cal, J., *On the iterates of some Bernstein-type operators*, J. Math. Anal. Appl., **209** (1997), 529–541
[7] Agratini, O., *Approximation properties of a generalization of Bleimann, Butzer and Hahn operators*, Math. Pannonica, **9** (1998), No. 2, 165–171
[8] Altin, A., Dogru, O. and Özarslan, M. A., *Korovkin type approximation properties of bivariate Bleimann, Butzer and Hahn operators*, Proceed. of 8-th WSEAS Int. Conf. on Appl. Math., Tenerife, Spain, December 16–18, 2005, 234–238
[9] Bărbosu, D., *Some applications of Shisha-Mond theorem*, Creat. Math. Inform., **23** (2014), No. 2, 141–146
[10] Bărbosu, D., *The Schurer-Stancu approximation formula revisited*, Creat. Math. Inform., **22** (2013), No. 1, 15–18
[11] Bărbosu, D., *Two dimensional devided differences revisited*, Creat. Math. Inform. **17** (2008), No. 1, 1–7
[12] Bărbosu, D., Acu, A. M. and Sofonea, F. D., *The Voronovskaja-type formula for the Bleimann, Butzer and Hahn operators*, Creat. Math. Inform., **23** (2014), No. 2, 137–140
[13] Bărbosu, D. and Pop, O. T., *Bivariate uniform approximation via bivariate Lagrange interpolation polynomials*, Creat. Math. Inform., **23** (2014), No. 1, 7–13
[14] Bărbosu, D. and Pop, O. T., *A cubature formula of Schurer-Stancu type*, Creat. Math. Inform., **18** (2009), No. 2, 103–109
[15] Bernstein, S. N., *Démonstration du théorème de Weierstrass fondée sur le calcul de probabilités*, Commun. Soc. Math. Kharkow, (**2**), **13** (1912-1913), 1-2
[16] Bleimann, G., Butzer, P. L. and Hahn, L., *A Bernstein-type operator approximating continuous functions on the semi-axis*, Nederl. Akad. Wetensch. Indag. Math., **42** (1980), 255–262
[17] Braica, P. I., Pop, O. T. and Bărbosu, D., *Schurer operators of King type*, Creat. Math. Inform., **22** (2013), No. 2, 161–171

Received: 09.11.2015; In revised form: 03.04.2016; Accepted: 04.05.2016
2010 *Mathematics Subject Classification.* 41A10, 41A36, 41A63.
Key words and phrases. *Linear operators, bivariate operators, Bernstein operators, Bleimann, Butzer and Hahn operators, Stancu operators, Voronovskaja-type formula.*
Corresponding author: Dan Micläuş; danmiclausrz@yahoo.com

[18] Hermann, T., On the operator of Bleimann, Butzer and Hahn, in *Proceedings Conference on Approximation theory*, Kecskemét Hungary 1990, (Szabados, J. et al., Eds.), North-Holland Publishing Company, Amsterdam, Colloq. Math. Soc. János Bolyai, **58** (1991), 355–360
[19] Ivan, M., *A note on the Bleimann, Butzer and Hahn operator*, Automat. Comput. Appl. Math., **6** (1997), 11–15
[20] Ivan, M., *Elements of Interpolation Theory*, Mediamira Science Publisher, Cluj-Napoca 2004
[21] Jayasri, C. and Sitaraman, Y., *Direct and inverse theorems for certain Bernstein-type operators*, Indian J. Pure Appl. Math., **16** (1985), No. 12, 1495–1511
[22] Jayasri, C. and Sitaraman, Y., *On a Bernstein-type operator of Bleimann, Butzer and Hahn* , J. Comput. Appl. Math., **47** (1993), No. 2, 267–272
[23] Mercer, A. McD., *A Bernstein-type operator approximating continuous functions on the half-line*, Bull. Calcutta Math. Soc., **81** (1989), 133–137
[24] Miclăuş, D., *On the GBS Bernstein-Stancu's type operators*, Creat. Math. Inform., **22** (2013), No. 1, 73–80
[25] Miclăuş, D. and Braica, P. I., *The generalization of some results for Bernstein and Stancu operators*, Creat. Math. Inform., **20** (2011), No. 2, 147–156
[26] Miclăuş, D. and Pop, O. T., *The Voronovskaja theorem for some linear positive operators defined by infinite sum*, Creat. Math. Inform., **20** (2011), No. 1, 55–61
[27] Pişcoran, L. I., Pop, O. T. and Bărbosu, D., *Bézier type surfaces*, Appl. Math. Inf. Sci., **7** (2013), No. 2, 483–489
[28] Pop, O. T., *The generalization of Voronovskaja's theorem for a class of bivariate operators*, Stud. Univ. Babeş-Bolyai Math., **53** (2008), No. 2, 85–108
[29] Pop, O. T., Bărbosu, D. and Pişcoran, L. I., *Bézier type curves generated by some class of positive linear operators*, Creat. Math. Inform., **19** (2010), No. 2, 191–198
[30] Pop, O. T. and Bărbosu, D., *The Voronovskaja theorem for some Stancu-type operators*, Creat. Math. Inform., **18** (2009), No. 1, 57–64
[31] Stancu, D. D., *The remainder of certain approximation formulas in two variables*, J. Soc. Indust. Appl. Math., Ser. B, Numer. Anal., **1** (1964), 137–163
[32] Stancu, D. D., *On a generalization of the Bernstein polynomials (in Romanian)*, Stud. Univ. Babeş-Bolyai, Ser. Math.-Phys., **14** (1969), 31–45
[33] Totik, V., *Uniform approximation by Bernstein-type operators*, Nederl. Akad. Wetensch. Indag. Math., **46** (1984), 87–93

Department of Mathematics and Computer Science
North University Center at Baia Mare
Technical University of Cluj-Napoca
Victoriei 76, 430122 Baia Mare Romania
E-mail address: barbosudan@yahoo.com
E-mail address: danmiclausrz@yahoo.com