

## APPROXIMATION OF PERIODIC FUNCTIONS BY ZYGMUND MEANS IN ORLICZ SPACES

SADULLA Z. JAFAROV

**Abstract.** In the present work we investigate the approximation of the functions by Zygmund means in the Orlicz spaces  $L_M(\mathbb{T})$  in the terms of the best approximation  $E_n(f)_M$  and modulus of smoothness  $\omega_k(\cdot, f)_M$ .

**Mathematics subject classification (2010):** 41A10, 41A25, 42A10, 42B25, 46E30.

**Keywords and phrases:** reflexive Orlicz spaces; best approximation; trigonometric polynomials;  $k$ -th modulus of smoothness; Zygmund means of order  $k$ .

### REFERENCES

- [1] R. AKGUN, D.M. ISRAFILOV, *Approximation by interpolating polynomials in Smirnov-Orlicz class*, J. Korean Math. Soc. **43**, 2 (2006), 413–424.
- [2] R. AKGUN, D. M. ISRAFILOV, *Approximation and moduli of fractional orders in Smirnov-Orlicz classes*, Glas. Mat. Ser. III **43** (63), 1 (2008), 121–136.
- [3] R. AKGUN, D. M. ISRAFILOV, *Simultaneous and converse approximation theorems in weighted Orlicz spaces*, Bull. Belg. Math. Soc. Simon Stevin **17** (2010), 13–28.
- [4] R. AKGUN, *Improved converse theorems and fractional moduli of smoothness in Orlicz spaces*, Bull. Malays. Math. Sci. Soc., (2) **36** (2013), 49–62.
- [5] S. P. BAIBORODOV, *Approximation of functions by Vallée-Poussin sums*, Mat. Zametki, **27**, 1 (1980), 33–48 (in Russian).
- [6] A. BOTTCHER AND YU. I. KARLOVICH, *Carleson curves, Muckenhoupt weights and Toeplitz operators*, Birkhauser - Verlag, (1997).
- [7] D. W. BOYDS, *Indices for the Orlicz spaces*, Pacific J. Math. **38**, 2 (1971), 315–323.
- [8] V. G. GAVRILYUK, *Linear methods of summing Fourier series and best approximation*, Ukr. Math. J. **15**, 4 (1963), 412–417.
- [9] A. GUVEN, D. M. ISRAFILOV, *Polynomial approximation in Smirnov- Orlicz classes*, Comput. Meth. Funct. Th. **2**, 2 (2002), 509–517.
- [10] A. GUVEN, D. M. ISRAFILOV, *Approximation by means of Fourier trigonometric series in weighted Orlicz spaces*, Adv. Stud. Contemp. Math. (Kyungshang), **19**, 2 (2009), 283–295.
- [11] N. A. IL'YASOV, *Approximation of periodic functions by Zygmund means*, Mat. Zametki, **39**, 3 (1986), 367–382 (in Russian).
- [12] N. A. IL'YASOV, *On the order of approximation in the uniform metric by Fejér-Zygmund means in the classes  $E_p[\varepsilon]$* , Mat. Zametki, **69**, 5 (2001), 679–687 (in Russian).
- [13] D. M. ISRAFILOV, R. AKGUN, *Approximation in weighted Smirnov-Orlicz classes*, J. Math. Kyoto Univ. (JMKYAZ) **46**, 4 (2006), 755–770.
- [14] D. M. ISRAFILOV, A. GUVEN, *Approximation by trigonometric polynomials in weighted Orlicz spaces*, Studia Math. **174**, 2 (2006), 147–168.
- [15] S. Z. JAFAROV, *Approximation by rational functions in Smirnov-Orlicz classes*, J. Math. Anal. Appl. **379** (2011), 870–877.
- [16] S. Z. JAFAROV, *The inverse theorem of approximation of the function in Smirnov-Orlicz classes*, Math. Inequal. Appl. **12**, 4 (2012), 835–844.
- [17] S. Z. JAFAROV, J. I. MAMEDKHANOV, *On approximation by trigonometric polynomials in Orlicz spaces*, Georgian Math. J. **19**, 4 (2012), 687–695.

- [18] S. Z. JAFAROV, *Approximation by Fejér sums of Fourier trigonometric series in weighted Orlicz spaces*, Hacet. J. Math. Stat. **42**, 3 (2013), 259–268.
- [19] S. Z. JAFAROV, *Linear methods for summing Fourier series and approximation in weighted Lebesgue with variable exponents*, Ukrainian Math. J. **66**, 10 (2015) 1509–1518.
- [20] S. M. NIKOLSKI, *On linear methods of summation of Fourier series*, Akad. Nauk SSSR ser. Math. **12** (1948), 259–278 (in Russian).
- [21] M. A. KRASNOSELSKI, YA. B. RUTICKII, *Convex Functions and Orlicz Spaces*, P. Norrdhoff Ltd., Groningen, 1961.
- [22] V. M. KOKILASHVILI, *On analytic functions of Smirnov-Orlicz classes*, Studia Math. **31** (1968), 43–59.
- [23] V. M. KOKILASHVILI, *On approximation of periodic functions*, Trudy Tbiliss. Mat. Inst. im. Razmadze Akad. Nauk Gruzin. SSR **34** (1968), 51–81 (in Russian).
- [24] V. M. KOKILASHVILI, S. G. SAMKO, *Operators of harmonic analysis in weighted spaces with non-standard growth*, J. Math. Anal. Appl. **352** (2009), 15–34.
- [25] V. M. KOKILASHVILI, TS. TSANAVA, *On the norm estimate of deviation by linear summability means and an extension of the Bernstein inequality*, Proc. A. Razmadze Math Inst. **154** (2010), 144–146.
- [26] V. M. KOKILASHVILI, TS. TSANAVA, *Approximation by linear summability means in weighted variable exponent Lebesgue spaces*, Proc. A. Razmadze Math. Inst. **154** (2010), 147–150.
- [27] A. YU. KARLOVICH, *Algebras of Singular integral operators with piecewise continuous coefficients on reflexive Orlicz spaces*, Math. Nachr. **179** (1996), 187–222.
- [28] W. MATUSZEWSKA, W. ORLICZ, *On certain properties of  $\phi$ -functions*, Bull. Acad. Polon. Sci., Ser. Math. Astron. et Phys. **8** (1960), 439–443.
- [29] L. MALIGRANDA, *Indices and interpolation*, Dissertation Math. **234** (1985).
- [30] LE.YU. OVSI, A. S. SERDYUK, *Approximation of continuous periodic functions by de la Vallée-Poussin sums*, Zb. Pr. Inst. Mat. NAN Ukr. **8**, 1 (2011), 151–161 (in Russian).
- [31] V. G. PONOMARENKO, *Approximation of periodic functions in an Orlicz space*, Sibirsk. Mat. J. **6** (1966), 1338–1346 (in Russian).
- [32] A.-R. K. RAMAZANOV, *On approximation by polynomials and rational functions in Orlicz spaces*, Anal. Math. **10** (1984), 117–132.
- [33] R. RYAN, *Conjugate functions in Orlicz spaces*, Pacific J. Math. **13** (1963), 1371–1377.
- [34] M. M. RAO, Z. D. REN, *Theory of Orlicz spaces*, Marcel Dekker, New York, 1991.
- [35] K. RUNOVSKI, *On Jackson type inequality in Orlicz classes*, Rev. Mat. Complut. **14** (2001), 395–404.
- [36] S. B. STECHKIN, *The approximation of periodic functions by Fejér sums*, Trudy Math. Inst. Steklov, G2 (1961), 522–523 (in Russian).
- [37] S. B. STECHKIN, *Approximation of functions by Vallée- Poussin sums*, Mat. Zametki **27**, 1 (1980), 33–48 (in Russian).
- [38] A.S. SERDYUK, LE. YU. OVSI, A. P. MUSIENKO, *Approximation of classes of analytic functions by de la Vallée-Poussin sums in uniform metric*, Rend. Mat. Appl., Ser. VII **32** (2012), 1–15.
- [39] M. F. TIMAN, *Some linear summation processes for Fourier series and best approximation*, Dokl. Akad. Nauk SSSR **145** (1962), 741–743.
- [40] M. F. TIMAN, *Best approximation of a function and linear methods of summing Fourier series*, Izv. Akad. Nauk SSSR Ser: Math. **29** (1965), 587–604 (in Russian).
- [41] M. F. TIMAN, *The approximation of continuous periodic functions by linear operators which are constructed on the basis of their Fourier series*, Dokl. Akad. Nauk SSSR **181** (1968), 1339–1342 (in Russian).
- [42] G. WU, *On approximation by polynomials in Orlicz spaces*, Approx. Theory Appl. **7**, 3 (1991), 97–110.
- [43] A. A. ZAKHAROV, *Bound on deviations of continuous periodic functions from their de la Vallée-Poussin sums*, Mat. Zametki, **3**, 1 (1968), 77–84 (in Russian).