

WEAKLY PICARD OPERATORS: EQUIVALENT DEFINITIONS, APPLICATIONS AND OPEN PROBLEMS

IOAN A. RUS, ADRIAN PETRUȘEL and MARCEL ADRIAN ȘERBAN

Department of Applied Mathematics

Babeș-Bolyai University

Cluj-Napoca 400084, Romania

E-mail: iarus@math.ubbcluj.ro

petrusel@math.ubbcluj.ro

mserban@math.ubbcluj.ro

Abstract. The purpose of this paper is to present several characterizations for the concept of weakly Picard operator in K-metric spaces. Some new characterizations and applications, as well as, several open questions are also discussed.

Key Words and Phrases: Fixed point, L-space, (weakly) Picard operator, K-metric, Caristi operator, Schröder's pair, invariant subset, maximal element, progressive operator.

2000 Mathematics Subject Classification: 47H10, 54H25, 06A06, 54E35, 54E70, 54A20.

REFERENCES

- [1] O. Agratini and I. A. Rus, *Iterates of a class of discrete linear operators via contraction principle*, Comment. Math. Univ. Carolin., **44**(2003), 555-563.
- [2] O. Agratini, I. A. Rus, *Iterates of some bivariate approximation process via weakly Picard operators*, Nonlinear Anal. Forum, **8**(2003), 159-168.
- [3] V. G. Angelov, *A converse to a contraction mapping theorem in uniform spaces*, Nonlinear Anal., **12**(1988), 989-996.
- [4] V. G. Angelov, *A reuniformization for contractive mappings in uniform spaces*, Math. Nachr., **127**(1986), 211-221.
- [5] J. Appell, A. Carbone, P.P. Zabrejko, *Kantorovich majorants for nonlinear operators and applications to Uryson integral equations*, Rend. Mat. Appl., **12**(1992), 675-688.
- [6] I. N. Baker, *Permutable power series and regular iteration*, J. Austral. Math. Soc., **2**1961/1962 265-294.
- [7] C. Bessaga, *On the converse of the Banach fixed point principle*, Colloq. Math., **7**(1959), 41-43.

- [8] A. Brøndsted, *Fixed points and partial orders*, Proc. Amer. Math. Soc., **60**(1976), 365-366.
- [9] A. Brøndsted, *On a lemma of Bishop and Phelps*, Pacific J. Math., **55**(1974), 335-341.
- [10] F. E. Browder, *On a theorem of Caristi and Kirk*, Fixed point theory and its applications (Proc. Sem. Dalhousie Univ., Halifax, 1975), 23-27.
- [11] J. Caristi, *Fixed point theorems for mappings satisfying inwardness conditions*, Trans. Amer. Math. Soc., **215**(1976), 241-251.
- [12] L. Collatz, *Functional Analysis and Numerical Mathematics*, Acad. Press, New York, 1966.
- [13] E. De Pascale, G. Marino and P. Pietromala, *The use of the E-metric spaces in the search for fixed points*, Le Matematiche, **48**(1993), 367-376, 1993.
- [14] K. Deimling, *Nonlinear Functional Analysis*, Springer-Verlag, Berlin, 1980.
- [15] J. Eisenfeld, V. Lakshmikantham, *Remarks on nonlinear contraction and comparison principle in abstract cones*, J. Math. Anal Appl., **61**(1977), 116-121.
- [16] M. Fréchet, *Les espaces abstraits*, Gauthier-Villars, Paris, 1928.
- [17] B. Fuchssteiner, *Iteration and fixed-points*, Pacific J. Math., **68**(1977), 73-80.
- [18] O. Hadžić, E. Pap and V. Radu, *Generalized contraction mapping principles in probabilistic metric spaces*, Acta Math. Hungar., **101**(2003), 131-138.
- [19] O. Hadžić and E. Pap, *Fixed Point Theory in Probabilistic Metric Spaces*, Kluwer Acad. Publ., Dordrecht, 2001.
- [20] T. L. Hicks and B. E. Rhoades, *A Banach type fixed point theorem*, Math. Japonica, **24**(1979), 327-330.
- [21] P. Hitzler and A. K. Seda, *A "converse" of the Banach contraction mapping theorem*, Proceedings S.C.A.M. 2001.
- [22] T. T. Hsieh, K. K. Tan, *Periodic points and contractive mappings*, Canad. Math. Bull., **17**(1974), 209-211.
- [23] A. Iwanik, L. Janos, F. A. Smith, *Compactification of a set which is mapped to itself*, Proceedings of the Ninth Prague Topological Symposium (2001), 165-169 (electronic), Topol. Atlas, North Bay, ON, 2002.
- [24] J. Jachymski, *Equivalence of some contractivity properties over metrical structures*, Proc. Amer. Math. Soc., **125**(1997), 2327-2335.
- [25] J. Jachymski, *A short proof of the converse to the contraction principle and some related results*, Topol. Methods in Nonlinear Anal., **15**(2000), 179-186.
- [26] J. Jachymski, *Converses to fixed point theorems of Zermelo and Caristi*, Nonlinear Analysis, **52**(2003), 1455-1463.
- [27] L. Janos, *A converse of Banach's contraction theorem*, Proc. Amer. Math. Soc., **18**(1967), 287-289.
- [28] L. Janos, *The Banach contraction mapping principle and cohomology*, Comment. Math. Univ. Caroline, **41**(2000), 605-610.
- [29] L. Janos, *Punti fissi di tipo contrattivi*, Univ. degli Studi di Firenze, 1971.

- [30] W. A. Kirk, L. M. Saliga, *The Brézis-Browder order principle and extensions of Caristi's theorem*, *Nonlinear Anal.*, **47**(2001), 2765-2778.
- [31] W. A. Kirk, L. M. Saliga, *Some results on existence and approximation in metric fixed point theory*, *J. Comput. Applied Math.*, **113**(2000), 141-152.
- [32] W. A. Kirk, B. Sims (editors), *Handbook of metric fixed point theory*, Kluwer Acad. Publ., Dordrecht, 2001.
- [33] M. A. Krasnoselskii, *Positive Solutions of Operator Equations*, Noordhoff, Leyden, 1964.
- [34] M. Kuczma, *Functional Equations in a Single Variable*, Monografie Matematyczne, Tom 46, P. W. N. Warsaw, 1968.
- [35] S. Leader, *Uniformly contractive fixed points in compact metric spaces*, *Proc. Amer. Math. Soc.*, **86**(1982), 153-158.
- [36] Z. Liu, *Order completeness and stationary points*, *Rostock Math. Kolloq.*, **50**(1997), 85-88.
- [37] P. R. Meyers, *A converse to Banach's theorem*, *J. Res. Nat. Bur. Stand.*, **71B**(1967), 73-76.
- [38] V. I. Opoizev, *The converses of the contraction theorem* (Russian), *Usp. Math. Nauk.*, **21**(1976), 169-198.
- [39] A. Petruşel, *Multivalued weakly Picard operators and applications*, *Scientiae Mathematicae Japonicae*, **59**(2004), 167-202.
- [40] A. Petruşel, I. A. Rus, *Multivalued weakly Picard and multivalued Picard operators*, *Proceedings of the International Conference on Fixed Point Theory*, Yokohama Publ., 2004, 207-226.
- [41] V. Radu, *Equicontinuous iterates of t -norms and applications to random normed and fuzzy Menger spaces*, *Iteration Theory*, *Grazer Math. Ber.*, **346**(2004), 323-350.
- [42] I. Rosenholtz, *Evidence of a conspiracy among fixed point theorems*, *Proc. Amer. Math. Soc.*, **53**(1975), 213-218.
- [43] I. A. Rus, *Weakly Picard mappings*, *Comment. Math. Univ. Carolinae*, **34**(1993), 769-773.
- [44] I. A. Rus, *Generalized contractions and applications*, Cluj Univ. Press, 2001.
- [45] I. A. Rus, *Picard operators and applications*, *Scientiae Mathematicae Japonicae*, **58**(2003), 191-219.
- [46] I. A. Rus, *Iterates of Bernstein operators, via contraction principle*, *J. Math. Anal. Appl.*, **292**(2004), 259-261.
- [47] I. A. Rus, *Some equivalent conditions in the metrical fixed point theory*, *Mathematica*, **23**(1981), 213-218.
- [48] I. A. Rus, A. Petruşel, G. Petruşel, *Fixed Point Theory 1950-2000 : Romanian contributions*, House of the Book of Science, Cluj-Napoca, 2002.
- [49] B. Schweizer, H. Sherwood and R. M. Tardiff, *Contractions on probabilistic metric spaces: Examples and counterexamples*, *Stochastica*, **12**(1998), 5-17.
- [50] M. Turinici, *Pseudometric versions of the Caristi-Kirk fixed point theorem*, *Fixed Point Theory*, **5**(2004), 147-161.

- [51] M. Turinici, *Fixed point results on abstract ordered sets*, *Matematiche*, **49**(1994), 25-34.
- [52] M. Turinici, *A maximality principle on ordered metric spaces*, *Rev. Colombiana Mat.*, **16**(1982), 115-123.
- [53] J. S. Wong, *Generalizations of the converse of the contraction mapping principle*, *Canad. J. Math.*, **18**(1966), 1095-1104.
- [54] P. P. Zabreiko, *K-metric and K-normed linear spaces: survey*, *Collect. Math.*, **48**(1997), 825-859.

Received 14.04.2005; Revised 30.10.2005.