

SIX CLASSES OF NONLINEAR TWO-DIMENSIONAL SYSTEMS OF DIFFERENCE EQUATIONS WHICH ARE SOLVABLE

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Abstract. We present six classes of nonlinear two-dimensional systems of difference equations which are solvable. Some methods for finding their general solutions are described in detail.

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REFERENCES

- [1] D. ADAMOVIĆ, *Solution to problem 194*, Mat. Vesnik, **23** (1971), 236–242.
- [2] I. BAJO, E. LIZ, *Global behaviour of a second-order nonlinear difference equation*, J. Difference Equ. Appl. **17** (10) (2011) 1471–1486.
- [3] K. BERENHAUT, J. FOLEY, S. STEVIĆ, *Boundedness character of positive solutions of a max difference equation*, J. Difference Equ. Appl. **12** (12) (2006), 1193–1199.
- [4] K. BERENHAUT, S. STEVIĆ, *The behaviour of the positive solutions of the difference equation $x_n = A + (x_{n-2}/x_{n-1})^p$* , J. Difference Equ. Appl. **12** (9) (2006), 909–918.
- [5] L. BERG, *On the asymptotics of nonlinear difference equations*, Z. Anal. Anwendungen **21** (4) (2002), 1061–1074.
- [6] L. BERG, S. STEVIĆ, *On the asymptotics of the difference equation $y_n(1 + y_{n-1} \cdots y_{n-k+1}) = y_{n-k}$* , J. Difference Equ. Appl. **17** (4) (2011), 577–586.
- [7] D. BERNOULLI, *Observationes de seriebus quae formantur ex additione vel subtractione quacunque terminorum se mutuo consequentium, ubi praesertim earundem insignis usus pro inveniendis radicum omnium aequationum algebraicarum ostenditur*, Commentarii Acad. Petropol. III, 1728 (1732), 85–100, (in Latin).
- [8] G. BOOLE, *A Treatise on the Calculus of Finite Differences*, Third Edition, Macmillan and Co., London, 1880.
- [9] L. BRAND, *A sequence defined by a difference equation*, Amer. Math. Monthly **62** (7) (1955), 489–492.
- [10] A. DE MOIVRE, *Miscellanea Analytica de Seriebus et Quadraturis*, J. Tonson & J. Watts, Londini, 1730, (in Latin).
- [11] B. IRIČANIN, S. STEVIĆ, *On some rational difference equations*, Ars Combin. **92** (2009), 67–72.
- [12] C. JORDAN, *Calculus of Finite Differences*, Chelsea Publishing Company, New York, 1965.
- [13] G. L. KARAKOSTAS, *Convergence of a difference equation via the full limiting sequences method*, Differ. Eqs. Dyn. Syst. **1** (4) (1993) 289–294.
- [14] G. KARAKOSTAS, *The forbidden set, solvability and stability of a circular system of complex Riccati type difference equations*, AIMS Mathematics **8** (11) (2023), 28033–28050.
- [15] V. A. KRECHMAR, *A Problem Book in Algebra*, Mir Publishers, Moscow, 1974.
- [16] S. F. LACROIX, *Traité des Différences et des Séries*, J. B. M. Duprat, Paris, 1800, (in French).
- [17] S. F. LACROIX, *An Elementary Treatise on the Differential and Integral Calculus, with an Appendix and Notes by J. Herschel, J. Smith*, Cambridge, 1816.
- [18] J.-L. LAGRANGE, *Sur l'intégration d'une équation différentielle à différences finies, qui contient la théorie des suites récurrentes*, Miscellanea Taurinensia, t. I, (1759), 33–42 (Lagrange OEuvres, I, 23–36, 1867), (in French).

- [19] P. S. LAPLACE, *Recherches sur l'intégration des équations différentielles aux différences finies et sur leur usage dans la théorie des hasards*, Mémoires de l' Académie Royale des Sciences de Paris 1773, t. VII, (1776) (Laplace OEuvres, VIII, 69–197, 1891), (in French).
- [20] H. LEVY, F. LESSMAN, *Finite Difference Equations*, The Macmillan Company, New York, NY, USA, 1961.
- [21] A. A. MARKOFF, *Differenzenrechnung*, Teubner, Leipzig, 1896, (in German).
- [22] L. M. MILNE-THOMSON, *The Calculus of Finite Differences*, MacMillan and Co., London, 1933.
- [23] D. S. MITRINOVIĆ, D. D. ADAMOVIĆ, *Nizovi i Redovi*, Naučna Knjiga, Beograd, Serbia, 1980, (in Serbian).
- [24] D. S. MITRINOVIĆ, J. D. KEČKIĆ, *Metodi Izračunavanja Konačnih Zbirova*, Naučna Knjiga, Beograd, 1984, (in Serbian).
- [25] N. E. NÖRLUND, *Vorlesungen über Differenzenrechnung*, Berlin, Springer, 1924, (in German).
- [26] G. PAPASCHINOPOULOS, C. J. SCHINAS, *On a system of two nonlinear difference equations*, J. Math. Anal. Appl. **219** (2) (1998), 415–426.
- [27] G. PAPASCHINOPOULOS, C. J. SCHINAS, *Invariants for systems of two nonlinear difference equations*, Differ. Equ. Dyn. Syst. **7** (1999), 181–196.
- [28] G. PAPASCHINOPOULOS, C. J. SCHINAS, *Invariants and oscillation for systems of two nonlinear difference equations*, Nonlinear Anal. Theory Methods Appl. **46** (2001), 967–978.
- [29] G. PAPASCHINOPOULOS, C. J. SCHINAS, G. STEFANIDOU, *On a k-order system of Lyness-type difference equations*, Adv. Difference Equ. Vol. 2007, Article ID 31272, (2007), 13 pp.
- [30] G. PAPASCHINOPOULOS, G. STEFANIDOU, *Trichotomy of a system of two difference equations*, J. Math. Anal. Appl. **289** (2004), 216–230.
- [31] G. PAPASCHINOPOULOS, G. STEFANIDOU, *Asymptotic behavior of the solutions of a class of rational difference equations*, Inter. J. Difference Equations **5** (2) (2010), 233–249.
- [32] M. H. RHOUMA, *The Fibonacci sequence modulo π , chaos and some rational recursive equations*, J. Math. Anal. Appl. **310** (2005), 506–517.
- [33] C. SCHINAS, *Invariants for difference equations and systems of difference equations of rational form*, J. Math. Anal. Appl. **216** (1997), 164–179.
- [34] C. SCHINAS, *Invariants for some difference equations*, J. Math. Anal. Appl. **212** (1997), 281–291.
- [35] S. STEVIĆ, *A global convergence results with applications to periodic solutions*, Indian J. Pure Appl. Math. **33** (1) (2002), 45–53.
- [36] S. STEVIĆ, *On the recursive sequence $x_{n+1} = A/\prod_{i=0}^k x_{n-i} + 1/\prod_{j=k+2}^{2(k+1)} x_{n-j}$* , Taiwanese J. Math. **7** (2) (2003), 249–259.
- [37] S. STEVIĆ, *On the recursive sequence $x_{n+1} = \alpha_n + (x_{n-1}/x_n)$ II*, Dyn. Contin. Discrete Impuls. Syst. Ser. A Math. Anal. **10** (6) (2003), 911–916.
- [38] S. STEVIĆ, *Boundedness character of a class of difference equations*, Nonlinear Anal. TMA **70** (2009), 839–848.
- [39] S. STEVIĆ, *Solutions of a max-type system of difference equations*, Appl. Math. Comput. **218** (2012), 9825–9830.
- [40] S. STEVIĆ, *On the system of difference equations $x_n = c_n y_{n-3}/(a_n + b_n y_{n-1} x_{n-2} y_{n-3})$, $y_n = \gamma_n x_{n-3}/(\alpha_n + \beta_n x_{n-1} y_{n-2} x_{n-3})$* , Appl. Math. Comput. **219** (2013), 4755–4764.
- [41] S. STEVIĆ, *Representations of solutions to linear and bilinear difference equations and systems of bilinear difference equations*, Adv. Difference Equ. Vol. 2018, Article No. 474, (2018), 21 pp.
- [42] S. STEVIĆ, J. DIBLIK, B. IRIČANIN, Z. ŠMARD, *On a third-order system of difference equations with variable coefficients*, Abstr. Appl. Anal. Vol. 2012, Article ID 508523, (2012), 22 pp.
- [43] S. STEVIĆ, J. DIBLIK, B. IRIČANIN, Z. ŠMARD, *On a solvable system of rational difference equations*, J. Difference Equ. Appl. **20** (5–6) (2014), 811–825.
- [44] S. STEVIĆ, J. DIBLIK, B. IRIČANIN, Z. ŠMARD, *Solvability of nonlinear difference equations of fourth order*, Electron. J. Differential Equations Vol. 2014, Article No. 264, (2014), 14 pp.
- [45] S. STEVIĆ, B. IRIČANIN, Z. ŠMARD, *On a product-type system of difference equations of second order solvable in closed form*, J. Inequal. Appl. Vol. 2015, Article No. 327, (2015), 15 pp.
- [46] S. STEVIĆ, B. IRIČANIN, Z. ŠMARD, *Solvability of a close to symmetric system of difference equations*, Electron. J. Differential Equations Vol. 2016, Article No. 159, (2016), 13 pp.
- [47] S. STEVIĆ, B. IRIČANIN, Z. ŠMARD, *On a symmetric bilinear system of difference equations*, Appl. Math. Lett. **89** (2019), 15–21.

- [48] D. T. TOLLU, Y. YAZLIK, N. TASKARA, *On fourteen solvable systems of difference equations*, Appl. Math. Comput. **233** (2014), 310–319.
- [49] N. N. VOROBIEV, *Fibonacci Numbers*, Birkhäuser, Basel, 2002.