# ON THE ZEROS OF POLYNOMIALS AND RELATED REGULAR FUNCTIONS OF A QUATERNIONIC VARIABLE 

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#### Abstract

In this paper, we establish a ring-shaped region containing all the zeros of a unilateral polynomial with quaternionic coefficients located on only one side of the powers of the quaternionic variable. We shall also obtain zero-free regions for the related subclass of regular power series.


Mathematics subject classification (2020): 30E10, 30G35, 16K20.
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## REFERENCES

[1] A. AZIZ AND Q. G. Mohammad, On the zeros of a certain class of polynomials and related analytic functions, J. Math. Anal. Appl., 75 (1980), 495-502.
[2] A. CaUChy, Exercises de mathématique, In Oeuvres 9 (1829), 122.
[3] N. Carney, R. Gardner, R. Keaton A. Powers, The Eneström-Kakeya theorem for polynomials of a quaternionic variable, J. Approx. Theory, 250 (2020), (Art. 105325), pp. 1-10.
[4] L. Coroianu and S. G. Gal, On the inequalities of Turán, Bernstein and Erdös-Lax in quaternionic setting, RACSAM, 115 (2021), Art. 187, 1-20.
[5] C. G. Cullen, An integral theorem for analytic intrinsic functions on quaternions, Duke Math. J., 32 (1965), 139-148.
[6] S. G. GaL And I. SABADINI, On Bernstein and Erdös-Lax inequalities for quaternionic polynomials, C. R. Acad. Sci. Paris Ser. I, 353 (2015), 5-9.
[7] R. B. Gardner and M. A. Taylor, Generalization of an Eneström-Kakeya type theorem to the quaternions, Armenian J. Math., 14 (2022), 1-8.
[8] G. Gentili and D. C. Struppa, On the multiplicity of zeros of polynomials with quaternionic coefficients, Milan J. Math., 76 (2008), 15-25.
[9] G. Gentili and D. C. Struppa, A new theory of regular function of a quaternionic variable, Adv. Math., 216 (2007), 279-301.
[10] G. Gentili and C. Stoppato, Zeros of regular function and polynomials of a quaternionic variable, Michigan Math. J., 56 (2008), 655-667.
[11] A. Hussain, A note on Eneström-Kakeya Theorem for quaternionic polynomials, Korean J. Math., 30 (2022), 503-512.
[12] D. JANOVSKÁ AND G. OpFER, A note on the computation of all zeros of simple quaternionic polynomials, SIAM J. Numer. Anal., 48 (2010), 244-256.
[13] D. JANOVSKÁ AND G. Opfer, The classification and the computation of the zeros of quaternionic, two-sided polynomials, Numer. Math., 115 (2010), 81-100.
[14] T. T. Lam, A First Course in Noncommutative Rings, Springer, New York, 1991.
[15] M. Marden, Geometry of Polynomials, Math. Surveys, no. 3, Amer. Math. Soc., Providence, R.I., 1966.
[16] G. V. Milovanović and A. Mir, Zeros of one class of quaternionic polynomials, Filomat, 36 (2022), 6655-6667.
[17] G. V. Milovanović and A. Mir, On the zero bounds of polynomials and regular functions of $a$ quaternionic variable, Appl. Anal. Discrete Math. 17 (2023), 216-231.
[18] G. V. Milovanović, A. Mir and A. Ahmad, On the zeros of a quaternionic polynomial with restricted coefficients, Linear Algebra Appl., 653 (2022), 231-245.
[19] G. V. Milovanović and Th. M. Rassias, Inequalities for polynomial zeros (Th. M. Rassias ed.), Surveys on Classical Inequalities, Kluwer Academics, Netherlands, 2000, pp. 165-202.
[20] G. V. Milovanović, D. S. Mitrinović and Th. M. Rassias, Topics in Polynomials: Extremal Problems, Inequalities, Zeros, World Scientific, Singapore, 1994.
[21] A. MIR, On the zeros of a quaternionic polynomial: an extension of the Eneström-Kakeya theorem, Czechoslovak Math. J. 73 (148) (2023), 649-662.
[22] A. Mir, Estimation of bounds for the zeros of polynomials and regular functions with quaternionic coefficients, Rev. R. Acad. Cienc. Exactas Fís. Nat. Ser. A Mat. RACSAM 118 (1) (2024), Paper No. $1,14 \mathrm{pp}$.
[23] Q. G. Mohammad, On the zeros of polynomials, Amer. Math. Monthly, 72 (1965), 631-633.

