

THE C-N-STAR, S-STAR AND C-MINUS PARTIAL ORDERS

QIULI LING, XUE HUA, HONGXING WANG* AND SHUANGZHE LIU

Abstract. In this paper, we derive several characterizations of the s-star partial order in terms of the core-nilpotent decomposition, and establish the conditions under which the s-star partial order implies the C-N-star partial order. By applying the core-EP decomposition, we introduce a new partial order, the c-minus partial order, which generalizes the core-minus partial order. Additionally, we provide several characterizations and properties of the c-minus partial order.

Mathematics subject classification (2020): 15A09, 06A06, 15A24.

Keywords and phrases: C-N-star partial order, s-star partial order, c-minus partial order, core-EP decomposition, core-nilpotent decomposition.

REFERENCES

- [1] O. M. BAKSALARY, *Solvability of a system of linear equations—an approach based on the generalized inverses determined by the Penrose equations*, Physica Scripta, 2024, **99**: 085250.
- [2] O. M. BAKSALARY, G. TRENKLER, *Core inverse of matrices*, Linear and Multilinear Algebra, 2010, **58** (6): 681–697.
- [3] O. M. BAKSALARY, G. TRENKLER, *A partial ordering approach to characterize properties of a pair of orthogonal projectors*, Indian Journal of Pure and Applied Mathematics, 2021, **52**: 323–334.
- [4] G. DOLINAR, B. KUZMA, J. MAROVT, D. MOSIĆ, *A note on star partial order preservers on the set of all variance-covariance matrices*, Mathematica Slovaca, 2023, **73** (1): 263–273.
- [5] G. DOLINAR, B. KUZMA, J. MAROVT, D. MOSIĆ, *On G-Drazin partial order in rings*, Acta Mathematica Hungarica, 2024, **173** (1): 176–192.
- [6] M. P. DRAZIN, *Natural structures on semigroups with involution*, Bulletin of the American Mathematical Society, 1978, **84** (1): 139–141.
- [7] D. E. FERREYRA, S. B. MALIK, *Some new results on the core partial order*, Linear and Multilinear Algebra, 2022, **70** (18): 3449–3465.
- [8] J. GAO, H. WANG, X. LIU, *Dual minus partial order*, 2024, arXiv: 2407.06453.
- [9] J. GAO, H. WANG, Z. LIU, *The CPO-inverse and its partial orders*, Linear and Multilinear Algebra, 2025, **73** (3): 427–460.
- [10] Y. GAO, J. CHEN, *Characterizations of *-DMP matrices over rings*, Turkish Journal of Mathematics, 2018, **42** (3): 786–796.
- [11] R. E. HARTWIG, *How to partially order regular elements*, Math. Japon, 1980, **25** (1): 1–13.
- [12] J. HAUGE, A. MARKIEWICZ, *On partial orderings on the set of rectangular matrices*, Linear Algebra and its Applications, 1995, **219**: 187–193.
- [13] A. HERRERO, N. THOME, *Sharp partial order and linear autonomous systems*, Applied Mathematics and Computation, 2020, **366**: 124736.
- [14] S. B. MALIK, L. RUEDA, N. THOME, *The class of m-EP and m-normal matrices*, Linear and Multilinear Algebra, 2016, **64** (11): 2119–2132.
- [15] K. MANJUNATHA PRASAD, K. S. MOHANA, *Core-EP inverse*, Linear and Multilinear Algebra, 2014, **62** (6): 792–802.
- [16] J. MAROVT, *On partial orders in proper *-rings*, Revista De La Union Matematica Argentina, 2018, **59** (1): 193–204.
- [17] J. MAROVT, *Orders in rings based on the corenilpotent decomposition*, Linear and Multilinear Algebra, 2018, **66** (4): 803–820.

- [18] J. MAROVT, D. MOSIĆ, I. CREMER, *On some generalized inverses and partial orders in $*$ -rings*, Journal of Algebra and Its Applications, 2023, **22** (12): 2350256.
- [19] S. K. MITRA, *On group inverses and the sharp order*, Linear Algebra and its Applications, 1987, **92** (1): 17–37.
- [20] S. K. MITRA, P. BHIMASANKARAM, S. B. MALIK, *Matrix Partial Orders, Shorted Operators and Applications*, World Scientific, Singapore, 2010.
- [21] S. K. MITRA, R. E. HARTWIG, *Partial orders based on outer inverses*, Linear Algebra and its Applications, 1992, **176**: 3–20.
- [22] D. MOSIĆ, P. S. STANIMIROVIĆ, I. I. KYRCHEI, *Index-MP and MP-index matrices*, Journal of Mathematical Analysis and Applications, 2024, **533** (2): 128004.
- [23] P. PATRICIO, R. PUYSTJENS, *Drazin-Moore-Penrose invertibility in rings*, Linear Algebra and its Applications, 2004, **389**: 159–173.
- [24] M. H. PEARL, *On generalized inverses of matrices*, Mathematical Proceedings of the Cambridge Philosophical Society, 1966, **62** (4): 673–677.
- [25] R. PENROSE, *A generalized inverse for matrices*, Mathematical Proceedings of the Cambridge Philosophical Society, 1955, **51** (3): 406–413.
- [26] D. S. PURUSHOTHAMA, *Secondary Partial Ordering of Neutrosophic Fuzzy Matrices*, International Journal of Neutrosophic Science, 2024, **24** (4): 411–419.
- [27] Y. TIAN, H. WANG, *Characterizations of EP matrices and weighted-EP matrices*, Linear Algebra and its Applications, 2011, **434** (5): 1295–1318.
- [28] G. WANG, Y. WEI, S. QIAO, *Generalized Inverses: Theory and Computations*, Springer, Singapore, 2018.
- [29] H. WANG, *Core-EP decomposition and its applications*, Linear Algebra and its Applications, 2016, **508** (1): 289–300.
- [30] H. WANG, X. LIU, *Partial orders based on core-nilpotent decomposition*, Linear Algebra and its Applications, 2016, **488**: 235–248.
- [31] H. WANG, X. LIU, *The weak group matrix*, Aequationes Mathematicae, 2019, **93** (6): 1261–1273.
- [32] H. WANG, P. HUANG, *Characterizations and properties of dual matrix star orders*, Communications on Applied Mathematics and Computation, 2025, **7**: 179–202.
- [33] H. WANG, T. JIANG, *Properties and characterizations of dual sharp orders*, Journal of Computational and Applied Mathematics, 2023, **433**: 115321.
- [34] H. WANG, T. JIANG, Q. LING, Y. WEI, *Dual core-nilpotent decomposition and dual binary relation*, Linear Algebra and its Applications, 2024, **684**: 127–157.
- [35] Y. ZHANG, Z. JIANG, *A new partial order based on core partial order and star partial order*, Journal of Mathematical Inequalities, 2023, **17** (2): 555–567.