
BIBLIOGRAPHY

- [1] Hongmei Zhang, Fawang Liu, Ian Turner, and Qianqian Yang. Numerical solution of the time fractional Black–Scholes model governing European options. *Computers & Mathematics with Applications*, 71(9):1772–1783, 2016.
- [2] R H De Staelen and A S Hendy. Numerically pricing double barrier options in a time-fractional Black-Scholes model. *Computer and Mathematics with Application*, 74(6):1166–1175, 2017.
- [3] Alpesh Kumar, Akanksha Bhardwaj, and Shruti Dubey. A local meshless method to approximate the time-fractional telegraph equation. *Engineering with Computers*, pages 1–16, 2020.
- [4] K.S. Miller and Bertram Ross. *An introduction to the fractional calculus and fractional differential equations*. John Wiley & Sons, Inc, 1993.
- [5] S.F. Lacroix. *Traite du calcul differentiel et du calcul integral*. 2nd ed. Courcier, Paris, 1819.
- [6] J.B.J. Fourier. *Theorie analytique da la chaleur*. Oeuvres de Fourier, Vol 1, Firmin Didot, Paris p.508., 1822.

-
- [7] Keith Oldham and Jerome Spanier. *The fractional calculus theory and applications of differentiation and integration to arbitrary order*. Elsevier, 1974.
- [8] Keith B Oldham. Fractional differential equations in electrochemistry. *Advances in Engineering Software*, 41(1):9–12, 2010.
- [9] Igor Podlubny. *Fractional Differential Equations*. Academic Press, San Diego, 1999.
- [10] Anatolii Aleksandrovich Kilbas, Hari Mohan Srivastava, and Juan J Trujillo. *Theory and Applications of Fractional Differential Equations*, volume 204. Elsevier Science Limited, 2006.
- [11] Peter J Torvik and Ronald L Bagley. On the appearance of the fractional derivative in the behavior of real materials. *Journal of Applied Mechanics*, 51(2):294–298, 1984.
- [12] Varun Joshi, Ram Bilas Pachori, and Antony Vijesh. Classification of ictal and seizure-free EEG signals using fractional linear prediction. *Biomedical Signal Processing and Control*, 9:1–5, 2014.
- [13] Ralf Matzler and Joseph Klafter. The random walk’s guide to anomalous diffusion: a fractional dynamics approach. *Physics Reports*, 339(1):1–77, 2000.
- [14] Haitao Qi and Mingyu Xu. Stokes’ first problem for a viscoelastic fluid with the generalized Oldroyd-B model. *Acta Mechanica Sinica*, 23(5):463–469, 2007.
- [15] Nader Engheta. Fractional curl operator in electromagnetics. *Microwave and Optical Technology Letters*, 17(2):86–91, 1998.
- [16] Richard L Magin. Fractional calculus models of complex dynamics in biological tissues. *Computers & Mathematics with Applications*, 59(5):1586–1593, 2010.

-
- [17] V Srivastava and KN Rai. A multi-term fractional diffusion equation for oxygen delivery through a capillary to tissues. *Mathematical and Computer Modelling*, 51(5-6):616–624, 2010.
- [18] BM Vinagre, I Podlubny, A Hernandez, and V Feliu. Some approximations of fractional order operators used in control theory and applications. *Fractional Calculus and Applied Analysis*, 3(3):231–248, 2000.
- [19] Wei Lin. Global existence theory and chaos control of fractional differential equations. *Journal of Mathematical Analysis and Applications*, 332(1):709–726, 2007.
- [20] Vaibhav Mehandiratta, Mani Mehra, and Gunter Leugering. Existence and uniqueness results for a nonlinear Caputo fractional boundary value problem on a star graph. *Journal of Mathematical Analysis and Applications*, 477:1243–1264, 2019.
- [21] Vasily E Tarasov and George M Zaslavsky. Fractional dynamics of systems with long-range space interaction and temporal memory. *Physica A: Statistical Mechanics and its Applications*, 383(2):291–308, 2007.
- [22] Albert CJ Luo and Valentin Afraimovich. *Long-range Interactions, Stochasticity and Fractional Dynamics: Dedicated to George M. Zaslavsky (1935–2008)*. Springer Science & Business Media, 2011.
- [23] Ludwig Boltzmann. Zur theorie der elastischen nachwirkung. *Annalen der Physik*, 241(11):430–432, 1878.
- [24] L Boltzmann. Theory of elastic aftereffect [zur theorie der elastischen Nachwirkung]. *Cambridge University Press: Cambridge, UK*, 1:616–644, 2012.

-
- [25] HongGuang Sun, Yong Zhang, Dumitru Baleanu, Wen Chen, and YangQuan Chen. A new collection of real world applications of fractional calculus in science and engineering. *Communications in Nonlinear Science and Numerical Simulation*, 64:213–231, 2018.
- [26] S Shen, Fawang Liu, V Anh, and Ian Turner. The fundamental solution and numerical solution of the Riesz fractional advection-dispersion equation. *IMA Journal of Applied Mathematics*, 73(6):850–872, 2008.
- [27] Fawang Liu, V Anh, and Ian Turner. Numerical solution of the space fractional Fokker–Planck equation. *Journal of Computational and Applied Mathematics*, 166(1):209–219, 2004.
- [28] Mark M. Meerschaert and Charles Tadjeran. Finite difference approximations fractional advection-dispersion flow equations. *Journal of Computational and Applied Mathematics*, 172(2):65–77, 2004.
- [29] David A. Benson, Stephan W. Wheatcraft, and Mark M Meerschaert. Application of a fractional advection-dispersion equation. *Water Resources Research*, 36(6):1403–1412, 2000.
- [30] David A. Benson, Stephan W. Wheatcraft, and Mark M Meerschaert. The fractional-order governing equation of levy motion. *Water Resources Research*, 36(6):1413–1423, 2000.
- [31] Fanhai Zeng, Changpin Li, Fawang Liu, and Ian Turner. New applications of fractional variational principles. *Reports on Mathematical Physics*, 61(2):199–206, 2008.

-
- [32] Eqad M Rabei, Ibrahim M Rawashdeh, Muslih Sami, and Dumitru Baleanu. Hamilton—Jacobi formulation for systems in terms of Riesz’s fractional derivatives. *International Journal of Theoretical Physics*, 50:1569–1576, 2011.
- [33] Alexander I. Saichev and George M. Zaslavsky. Fractional kinetic equations: solutions and applications. *Chaos*, 7(4):753–764, 1997.
- [34] George M. Zaslavsky. Chaos, fractional kinetics, and anomalous transport. *Physics Reports*, 371(6):461–580, 2002.
- [35] Kuldeep Singh Patel and Mani Mehra. Fourth order compact scheme for space fractional advection–diffusion reaction equations with variable coefficients. *Journal of Computational and Applied Mathematics*, 380(112963):1–15, 2020.
- [36] Anatoly A Alikhnov, Murat Beshtokov, and Mani Mehra. The Crank–Nicholson type compact difference scheme for a loaded time-fractional Hal–laire’s equation. *arXiv:1903.04228*, 2019.
- [37] Changpin Li and Fanhai Zeng. *Numerical methods for fractional calculus*. Chapman and Hall/CRC, 2015.
- [38] Anatoly A Alikhanov. A new difference scheme for the time fractional diffusion equation. *Journal of Computational Physics*, 280:424–438, 2015.
- [39] Lijuan Su, Wenqia Wang, and Qiuyan Xu. Finite difference methods for fractional dispersion equations. *Applied Mathematics and Computation*, 216(11):3329–3334, 2010.
- [40] Zhizhong Sun and Xiaonan Wu. A fully discrete difference scheme for a diffusion-wave system. *Applied Numerical Mathematics*, 56(2):193–209, 2006.

-
- [41] Fanhai Zeng, Changpin Li, Fawang Liu, and Ian Turner. The use of finite difference/element approaches for solving the time-fractional subdiffusion equation. *SIAM Journal on Scientific Computing*, 35(6):A2976–A3000, 2013.
- [42] Yumin Lin and Chuanju Xu. Finite difference/spectral approximations for the time-fractional diffusion equation. *Journal of Computational Physics*, 225(2):1533–1552, 2007.
- [43] Xianjuan Li and Chuanju Xu. A space-time spectral method for the time fractional diffusion equation. *SIAM Journal on Numerical Analysis*, 47(3):2108–2131, 2009.
- [44] Shahrokh Esmaeili and M Shamsi. A pseudo-spectral scheme for the approximate solution of a family of fractional differential equations. *Communications in Nonlinear Science and Numerical Simulation*, 16(9):3646–3654, 2011.
- [45] Shahrokh Esmaeili, Mostafa Shamsi, and Yury Luchko. Numerical solution of fractional differential equations with a collocation method based on Müntz polynomials. *Computers & Mathematics with Applications*, 62(3):918–929, 2011.
- [46] Abhishek Kumar Singh and Mani Mehra. Uncertainty quantification in fractional stochastic integro-differential equations using Legendre wavelet collocation method. In *Computational Science – ICCS 2020*, pages 58–71. Springer International Publishing, 2020.
- [47] Soleiman Hosseinpour, Alireza Nazemi, and Emran Tohidi. Müntz–Legendre spectral collocation method for solving delay fractional optimal control problems. *Journal of Computational and Applied Mathematics*, 351:344–363, 2019.

-
- [48] Weihua Deng. Finite element method for the space and time fractional Fokker–Planck equation. *SIAM Journal on Numerical Analysis*, 47(1):204–226, 2008.
- [49] Yingjun Jiang and Jingtang Ma. High-order finite element methods for time-fractional partial differential equations. *Journal of Computational and Applied Mathematics*, 235(11):3285–3290, 2011.
- [50] Neville J Ford, Jingyu Xiao, and Yubin Yan. A finite element method for time fractional partial differential equations. *Fractional Calculus and Applied Analysis*, 14(3):454–474, 2011.
- [51] Qianqian Yang, Ian Turner, Timothy Moroney, and Fawang Liu. A finite volume scheme with preconditioned Lanczos method for two-dimensional space-fractional reaction–diffusion equations. *Applied Mathematical Modelling*, 38(15-16):3755–3762, 2014.
- [52] Fawang Liu, Pinghui Zhuang, Ian Turner, Kevin Burrage, and Vo Anh. A new fractional finite volume method for solving the fractional diffusion equation. *Applied Mathematical Modelling*, 38(15-16):3871–3878, 2014.
- [53] Abbas Saadatmandi and Mehdi Dehghan. A new operational matrix for solving fractional-order differential equations. *Computers & Mathematics with Applications*, 59(3):1326–1336, 2010.
- [54] Abbas Saadatmandi and Mehdi Dehghan. A tau approach for solution of the space fractional diffusion equation. *Applied Mathematical Modelling*, 62(3):1135–1142, 2011.
- [55] Fischer Black and Myron Scholes. The pricing of options and corporate liabilities. *Journal of Political Economy*, 81(3):637–654, 1973.

-
- [56] Robert D Merton. Theory of rational option pricing. *Bell Journal of Economics and Management Science*, 4(1):141–183, 1973.
- [57] Zvi Bodie and Alex Kane. *Investments*. McGraw-Hill/Irwin, New York, 2008.
- [58] Mark M. Meerschaert and Alla Sikorskii. *Stochastic Models for Fractional Calculus*. De Gruyter, Berlin, Boston, 01 Jan. 2012.
- [59] Peter Carr and Liuren Wu. The finite moment log stable process and option pricing. *The Journal of Finance*, 2(58):597–626, 2003.
- [60] Diego del Castillo-Negrete and Alvaro Cartea. Fractional diffusion models of option prices in markets with jumps. *Physica A: Statistical Mechanics and its Applications*, 374:749–763, 2006.
- [61] W Wyss. The fractional Black–Scholes equation. *Fractional Calculus and Applied Analysis*, 3(1):51–61, 2000.
- [62] Alvaro Cartea. Derivatives pricing with marked point processes using tick-by-tick data. *Quantitative Finance*, 13:111–123, 2013.
- [63] Guy Jumarie. Stock exchange fractional dynamics defined as fractional exponential growth driven by (usual) Gaussian white noise. Application to fractional Black–Scholes equations. *Insurance: Mathematics and Economics*, 42:271–287, 2008.
- [64] Guy Jumarie. Derivation and solutions of some fractional Black–Scholes equations in coarse-grained space and time. Application to Merton’s optimal portfolio. *Computers & Mathematics with Applications*, 59:1142–1164, 2008.
- [65] Jin-Rong Liang, Jun Wang, Wen-Jun Zhang, Wei-Yuan Qui, and Fu-Yao Ren. Option pricing of a bi-fractional Black–Merton-Scholes model with the Hurst exponent H in $[\frac{1}{2}, 1]$. *Applied Mathematics Letters*, 23:859–863, 2010.

-
- [66] Yasin Fadaei, Zareen A Khan, and Ali Akgül. A greedy algorithm for partition of unity collocation method in pricing American options. *Mathematical Methods in the Applied Sciences*, 42:5595–5606, 2019.
- [67] L Morgado and M Rebelo. *Black-Scholes equation with distributed order in time*, in *:Progress in Industrial Mathematics at ECMI 2018*. Springer, Amsterdam, 2019.
- [68] Yashveer Kumar and Vineet Kumar Singh. Computational approach based on wavelets for financial mathematical model governed by distributed order fractional differential equation. *Mathematics and Computers in Simulation*, 190:531–569, 2021.
- [69] Zhengguang Liu, Aijie Cheng, and Xiaoli Li. A novel finite difference discrete scheme for the time fractional diffusion-wave equation. *Applied Numerical Mathematics*, 134:17–30, 2018.
- [70] Bangti Jin, Raytcho Lazarov, and Zhi Zhou. Two fully discrete schemes for fractional diffusion and diffusion-wave equations with nonsmooth data. *SIAM journal on scientific computing*, 38(1):A146–A170, 2016.
- [71] Milos Illic, Fawang Liu, Ian Turner, and V. Anh. Numerical approximation of a fractional-in-space diffusion equation, I. *Fractional Calculus and Applied Analysis*, 8(3):323–341, 2005.
- [72] Qianqian Yang, Fawang Liu, and Ian Turner. Numerical methods for fractional partial differential equations with Riesz space fractional derivatives. *Applied Mathematical Modelling*, 34(3):200–218, 2010.

-
- [73] Tan Wenchang, Pan Wenxiao, and Xu Mingyu. A note on unsteady flows of a viscoelastic fluid with the fractional Maxwell model between two parallel plates. *International Journal of Non-Linear Mechanics*, 38(5):645–650, 2003.
- [74] Nicole Heymans and J C Bauwens. Fractal rheological models and fractional differential equations for viscoelastic behavior. *Rheologica acta*, 33(3):210–219, 1994.
- [75] Guy Barles and Halil Mete Soner. Option pricing with transaction costs and a nonlinear Black-Scholes equation. *Finance and Stochastics*, 2(4):369–397, 1998.
- [76] Houde Han and Xiaonan Wu. A fast numerical method for the Black-Scholes equation of American Options. *SIAM Journal on Numerical Analysis*, 41(6):2081–2095, 2003.
- [77] Martin Bohner and Yao Zheng. On analytical solutions of the Black-Scholes equation. *Applied Mathematics Letters*, 22(3):309–313, 2009.
- [78] Min Shao and Chrysostomos L Nikias. Signal processing with fractional lower order moments: stable processes and their applications. *Proceedings of the IEEE*, 81(7):986–1010, 1993.
- [79] Zhengjun Liu, She Li, Wei Liu, Yanhua Wang, and Shutian Liu. Image encryption algorithm by using fractional Fourier transform and pixel scrambling operation based on double random phase encoding. *Optics and Lasers in Engineering*, 51(1):8–14, 2013.
- [80] Naveen Kumar Nishchal, Joby Joseph, and Kehar Singh. Securing information using fractional Fourier transform in digital holography. *Optics communications*, 235(4-6):253–259, 2004.

-
- [81] Rodolfo Martin, Jose J Quintana, Alejandro Ramos, and Ignacio De La Nuez. Modeling of electrochemical double layer capacitors by means of fractional impedance. *Journal of Computational and Nonlinear Dynamics*, 3(2):021303, 2008.
- [82] A M A El-Sayed, S Z Rida, and A A M Arafa. Exact solutions of fractional-order biological population model. *Communications in Theoretical Physics*, 52(6):992, 2009.
- [83] BM Vinagre and V Feliu. Modeling and control of dynamic system using fractional calculus: Application to electrochemical processes and flexible structures. In *Proc. 41st IEEE Conf. Decision and Control, Las Vegas, NV*, pages 214–239, 2002.
- [84] Vasily E Tarasov. Fractional integro-differential equations for electromagnetic waves in dielectric media. *Theoretical and Mathematical Physics*, 158(3):355–359, 2009.
- [85] Muhammad Zubair, Muhammad Junaid Mughal, and Qaisar Abbas Naqvi. Differential electromagnetic equations in fractional space. In *Electromagnetic Fields and Waves in Fractional Dimensional Space*, pages 7–16. Springer, 2012.
- [86] Cem Celik and Melda Duman. Crank–Nicolson method for the fractional diffusion equation with the Riesz fractional derivative. *Journal of Computational Physics*, 231:1743–1750, 2012.
- [87] Yu-xin Zhang and Heng-fei Ding. New numerical methods for the Riesz space fractional partial differential equations. *Computer and Mathematics with Application*, 63:1135–1146, 2012.

-
- [88] Z. B. Yuan, Y. F. Nie, F Liu, I Turner, G. Y. Zhang, and Y. T. Gu. An advanced numerical modeling for Riesz space fractional advection-dispersion equations by a meshfree approach. *Applied Mathematical Modelling*, 40:7816–7829, 2016.
- [89] Fahimeh Saberi Zafarghandi and Maryam Mohammadi. Numerical approximations for the Riesz space fractional advection-dispersion equations via radial basis functions. *Applied Numerical Mathematics*, 144:59–82, 2019.
- [90] S Chen, Fawang Liu, Ian Turner, and V Anh. A fast numerical method for two-dimensional Riesz space fractional diffusion equations on a convex bounded region. *Applied Numerical Mathematics*, 134:66–80, 2018.
- [91] Bela J. Szekeres and Ferenc Izsak. Finite difference approximation of space-fractional diffusion problems: The matrix transformation method. *Computer and Mathematics with Application*, 73(1):15–36, 2017.
- [92] Hengfei Ding, Changpin Li, and Yang Quan Chen. High-order algorithms for Riesz derivative and their applications. *Abstract and Applied Analysis*, 2014(653797):1–17, 2014.
- [93] Asma Ali Elbeleze, Adam Kilicman, and Bachok M Taib. Homotopy perturbation method for fractional Black–Scholes European option pricing equations using Sumudu transform. *Mathematical Problems in Engineering*, 1(524852):1–7, 2013.
- [94] Sunil Kumar, Devendra Kumar, and Jagdev Singh. Numerical computation of fractional Black–Scholes equation arising in financial market. *Egyptian Journal of Basic and Applied Sciences*, 1:177–183, 2014.

-
- [95] Wenting Chen, Xiang Xu, and Song-Ping Zhu. Analytically pricing double barrier options based on a time-fractional Black-Scholes equation. *Computers & Mathematics with Applications*, 69:1407–1419, 2015.
- [96] Zhongdi Cen, Jian Huang, Aimin Xu, and Anbo Le. Numerical approximation of a time-fractional Black-Scholes equation. *Computers & Mathematics with Applications*, 75(8):2874–2887, 2018.
- [97] Ahmad Golbabai and Omid Nikan. Numerical analysis of time fractional Black-Scholes European option pricing model arising in financial market. *Computational and Applied Mathematics*, 38(173):1–24, 2019.
- [98] Fazlollah Soleymani and Ali Akgül. Improved numerical solution of multi-asset option pricing problem: A localized RBF-FD approach. *Chaos, Solitons and Fractals*, 119:298–309, 2019.
- [99] Fazlollah Soleymani and Ali Akgül. European option valuation under the bates pide in finance: A numerical implementation of the gaussian scheme. *Discrete & Continuous Dynamical Systems-S*, 13:889–909, 2020.
- [100] Pradip Roul and V.M.K. Prasad Goura. A compact finite difference scheme for fractional Black-Scholes option pricing model. *Applied Numerical Mathematics*, 166:40–60, 2021.
- [101] Xingyu An, Fawang Liu, Minling Zheng, Vo V Anh, and Ian W Turner. A space-time spectral method for time-fractional Black-Scholes equation. *Applied Numerical Mathematics*, 165:152–166, 2021.
- [102] Guang-hua Gao, Zhi-zhong Sun, and Hong-wei Zhang. A new fractional numerical differentiation formula to approximate the Caputo fractional derivative and its application. *Journal of Computational Physics*, 259:33–50, 2014.

-
- [103] Hefeng Li, Jianxiong Cao, and Changpin Li. High-order approximation to Caputo derivatives and caputo-type advection–diffusion equations (iii). *Journal of computational and Applied mathematics*, 299:159–175, 2016.
- [104] Shidong Jiang, Jiwei Zhang, Qian Zhang, and Zhimin Zhang. Fast evaluation of the Caputo fractional derivative and its applications to fractional diffusion equations. *Communications in Computational Physics*, 21:650–678, 2017.
- [105] Yonggui Yan, Zhi-Zhong Sun, and Jiwei Zhang. Fast evaluation of the Caputo fractional derivative and its applications to fractional diffusion equations: A second-order scheme. *Communications in Computational Physics*, 22:1028–1048, 2017.
- [106] R Mokhtari and F Mostajeran. A high order formula to approximate the Caputo fractional derivative. *Communications on Applied Mathematics and Computation*, 2:1–29, 2020.
- [107] Anatoly A. Alikhanov and Chengming Huang. A high-order L2 type difference scheme for the time-fractional diffusion equation. *Applied Mathematics and Computation*, 411:126545, 2021.
- [108] V.E. Lynch, B.A. Carreras, D. del Castillo-Negrete, K.M. Ferreira-Mejias, and H.R. Hicks. Numerical methods for the solution of partial differential equations of fractional order. *Journal of Computational Physics*, 192(2):406–421, 2003.
- [109] Ruilian Du, W R Cao, and Zhi-Zhong Sun. A compact difference scheme for the fractional diffusion-wave equation. *Applied Mathematical Modelling*, 34:2998–3007, 2010.

-
- [110] J. Y. Yang, J. F. Huang, D. M. Liang, and Y. F. Tang. Numerical solution of fractional diffusion-wave equation based on fractional multistep method. *Applied Mathematical Modelling*, 38:3652–3661, 2014.
- [111] Hong Sun, Zhi-Zhong Sun, and G.-H Gao. Some temporal second order difference schemes for fractional wave equations. *Numerical Methods for Partial Differential Equation*, 32:970–1001, 2016.
- [112] Hong Sun, Xuan Zhao, and Zhi-Zhong Sun. The temporal second order difference schemes based on the interpolation approximation for the time multi-term fractional wave equation. *Journal of Scientific Computing*, 78:467–498, 2019.
- [113] Ruilian Du, Yubin Yan, and Zongqi Liang. A high-order scheme to approximate the Caputo fractional derivative and its application to solve the fractional diffusion wave equation. *Journal of Computational Physics*, 376:1312–1330, 2019.
- [114] Jinye Shen, Changpin Li, and Z Z Sun. An H2N2 interpolation for Caputo derivative with order in (1, 2) and its application to time-fractional wave equations in more than one space dimension. *Journal of Scientific Computing*, 83:1–29, 2020.
- [115] Hengfei Ding. The development of higher-order numerical differential formulas of Caputo derivative and their applications (i). *Computers & Mathematics with Applications*, 84:203–223, 2021.
- [116] Shaher Momani. Analytic and approximate solutions of the space-and time-fractional telegraph equations. *Applied Mathematics and Computation*, 170(2):1126–1134, 2005.

-
- [117] Jinhua Chen, Fawang Liu, and Vo Anh. Analytical solution for the time-fractional telegraph equation by the method of separating variables. *Journal of Mathematical Analysis and Applications*, 338(2):1364–1377, 2008.
- [118] Subir Das, K Vishal, PK Gupta, and A Yildirim. An approximate analytical solution of time-fractional telegraph equation. *Applied Mathematics and Computation*, 217(18):7405–7411, 2011.
- [119] Wei Jiang and Yingzhen Lin. Representation of exact solution for the time-fractional telegraph equation in the reproducing kernel space. *Communications in Nonlinear Science and Numerical Simulation*, 16(9):3639–3645, 2011.
- [120] Changpin Li and Jianxiong Cao. A finite difference method for time-fractional telegraph equation. In *Proceedings of 2012 IEEE/ASME 8th IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications*, pages 314–318. IEEE, 2012.
- [121] S Chen, X Jiang, Fawang Liu, and Ian Turner. High order unconditionally stable difference schemes for the Riesz space-fractional telegraph equation. *Journal of Computational and Applied Mathematics*, 278:119–129, 2015.
- [122] Elyas Shivanian, Saeid Abbasbandy, Mohammed S Alhuthali, and Hamed H Alsulami. Local integration of 2-d fractional telegraph equation via moving least squares approximation. *Engineering Analysis with Boundary Elements*, 56:98–105, 2015.
- [123] Vahid Reza Hosseini, Elyas Shivanian, and Wen Chen. Local integration of 2-d fractional telegraph equation via local radial point interpolant approximation. *The European Physical Journal Plus*, 130(2):1–21, 2015.

-
- [124] Ying Wang and Liquan Mei. Generalized finite difference/spectral Galerkin approximations for the time-fractional telegraph equation. *Advances in Difference Equations*, 2017(1):1–16, 2017.
- [125] Yuxiang Liang, Zhongsheng Yao, and Zhibo Wang. Fast high order difference schemes for the time fractional telegraph equation. *Numerical Methods for Partial Differential Equations*, 36(1):154–172, 2020.
- [126] Tayyaba Akram, Muhammad Abbas, Azhar Iqbal, Dumitru Baleanu, and Jihad H Asad. Novel numerical approach based on modified extended cubic B-spline functions for solving non-linear time-fractional telegraph equation. *Symmetry*, 12(7):1154, 2020.
- [127] Mohammed Al-Smadi, Omar Abu Arqub, and Mohamed Gaith. Numerical simulation of telegraph and Cattaneo fractional-type models using adaptive reproducing kernel framework. *Mathematical Methods in the Applied Sciences*, 44(10):8472–8489, 2021.
- [128] Mostafa MA Khater, Kottakkaran Sooppy Nisar, and Mohamed S Mohamed. Numerical investigation for the fractional nonlinear space-time telegraph equation via the trigonometric Quintic B-spline scheme. *Mathematical Methods in the Applied Sciences*, 44(6):4598–4606, 2021.
- [129] Omid Nikan, Zakieh Avazzadeh, and JA Tenreiro Machado. Numerical approximation of the nonlinear time-fractional telegraph equation arising in neutron transport. *Communications in Nonlinear Science and Numerical Simulation*, 99:105755, 2021.
- [130] Yuanlu Li and Ning Sun. Numerical solution of fractional differential equations using the generalized block pulse operational matrix. *Computers & Mathematics with Applications*, 62(3):1046–1054, 2011.

-
- [131] Youssri H Youssri. A new operational matrix of Caputo fractional derivatives of Fermat polynomials: an application for solving the Bagley-Torvik equation. *Advances in Difference Equations*, 2017(1):1–17, 2017.
- [132] Waleed M Abd-Elhameed and Youssri H Youssri. A novel operational matrix of Caputo fractional derivatives of Fibonacci polynomials: spectral solutions of fractional differential equations. *Entropy*, 18(10):345, 2016.
- [133] E H Doha, A H. Bhrawy, and S S Ezz-Eldien. A new jacobi operational matrix: an application for solving fractional differential equations. *Applied Mathematical Modelling*, 36(10):4931–4943, 2012.
- [134] Mehdi Dehghan, Jalil Manafian, and Abbas Saadatmandi. The solution of the linear fractional partial differential equations using the homotopy analysis method. *Zeitschrift für Naturforschung-A*, 65(11):935, 2010.
- [135] Amit K Singh, Vineet K Singh, and Om P Singh. The Bernstein operational matrix of integration. *Applied Mathematical Sciences*, 3(49):2427–2436, 2009.
- [136] Frank Stenger. Kronecker product extensions of linear operators. *SIAM Journal on Numerical Analysis*, 5(2):422–435, 1968.
- [137] Rajesh K Pandey, Narayan Kumar, Abhinav Bhardwaj, and Goutam Dutta. Solution of Lane–Emden type equations using Legendre operational matrix of differentiation. *Applied Mathematics and Computation*, 218(14):7629–7637, 2012.
- [138] A Sami Bataineh, AK Alomari, and Ishak Hashim. Approximate solutions of singular two-point BVPs using Legendre operational matrix of differentiation. *Journal of Applied Mathematics*, 2013, 2013.

- [139] Chahn Yong Jung, Zeqing Liu, Arif Rafiq, Faisal Ali, and Shin Min Kang. Solution of second order linear and nonlinear ordinary differential equations using Legendre operational matrix of differentiation. *International Journal of Pure and Applied Mathematics*, 93(2):285–295, 2014.
- [140] Rajesh K Pandey and Narayan Kumar. Solution of Lane–Emden type equations using Bernstein operational matrix of differentiation. *New Astronomy*, 17(3):303–308, 2012.
- [141] PN Paraskevopoulos, PG Sklavounos, and G Ch Georgiou. The operational matrix of integration for Bessel functions. *Journal of the Franklin Institute*, 327(2):329–341, 1990.
- [142] F Toutounian, Emran Tohidi, and A Kiliçman. Fourier operational matrices of differentiation and transmission: introduction and applications. In *Abstract and Applied Analysis*, volume 2013. Hindawi, 2013.
- [143] PN Paraskevopoulos, PD Sparis, and SG Mouroutsos. The Fourier series operational matrix of integration. *International Journal of Systems Science*, 16(2):171–176, 1985.
- [144] Mohsen Razzaghi and S Yousefi. The Legendre wavelets operational matrix of integration. *International Journal of Systems Science*, 32(4):495–502, 2001.
- [145] Ferhad Khellat and SA Yousefi. The linear Legendre mother wavelets operational matrix of integration and its application. *Journal of the Franklin Institute*, 343(2):181–190, 2006.
- [146] Emran Tohidi, Kh Erfani, Mortaza Gachpazan, and Stanford Shateyi. A new Tau method for solving nonlinear Lane–Emden type equations via Bernoulli

- operational matrix of differentiation. *Journal of Applied Mathematics*, 2013, 2013.
- [147] EH Doha, WM Abd-Elhameed, and YH Youssri. Second kind Chebyshev operational matrix algorithm for solving differential equations of Lane–Emden type. *New Astronomy*, 23:113–117, 2013.
- [148] Esmail Babolian and F Fattahzadeh. Numerical solution of differential equations by using Chebyshev wavelet operational matrix of integration. *Applied Mathematics and computation*, 188(1):417–426, 2007.
- [149] M Tavassoli Kajani, A Hadi Vencheh, and M Ghasemi. The Chebyshev wavelets operational matrix of integration and product operation matrix. *International Journal of Computer Mathematics*, 86(7):1118–1125, 2009.
- [150] Jin-Sheng Guf and Wei-Sun Jiang. The Haar wavelets operational matrix of integration. *International Journal of Systems Science*, 27(7):623–628, 1996.
- [151] Harold V Henderson, Friedrich Pukelsheim, and Shayle R Searle. On the history of the Kronecker product. *Linear and Multilinear Algebra*, 14(2):113–120, 1983.
- [152] Randall J. LeVeque. *Finite Difference Methods for Ordinary and Partial Differential Equations*. Society for Industrial and Applied Mathematics, 2007.
- [153] Richard Hamming. *Numerical methods for scientists and engineers*. Courier Corporation, 2012.
- [154] Mehdi Dehghan. Finite difference procedures for solving a problem arising in modeling and design of certain optoelectronic devices. *Mathematics and Computers in Simulation*, 71(1):16–30, 2006.

-
- [155] Alfonso Bueno Orovio, David Kay, and Kevin Burrage. Fourier spectral methods for fractional-in-space reaction-diffusion equations. *BIT Numerical mathematics*, 54(4):937–954, 2014.
- [156] E H Doha, A H. Bhrawy, and S S Ezz-Eldien. A Chebyshev spectral method based on operational matrix for initial and boundary value problems of fractional order. *Computers & Mathematics with Applications*, 62(5):2364–2373, 2011.
- [157] E H Doha, A H. Bhrawy, and S S Ezz-Eldien. Efficient Chebyshev spectral methods for solving multi-term fractional orders differential equations. *Applied Mathematical Modelling*, 35(12):5662–5672, 2011.
- [158] Emran Tohidi and Hassan Saberi Nik. A Bessel collocation method for solving fractional optimal control problems. *Applied Mathematical Modelling*, 39(2):455–465, 2015.
- [159] J Donea, S Giuliani, H Laval, and L Quartapelle. Finite element solution of the unsteady Navier-Stokes equations by a fractional step method. *Computer Methods in Applied Mechanics and Engineering*, 30(1):53–73, 1982.
- [160] André Schmidt and Lothar Gaul. Finite element formulation of viscoelastic constitutive equations using fractional time derivatives. *Nonlinear Dynamics*, 29(1-4):37–55, 2002.
- [161] Bangti Jin, Raytcho Lazarov, and Zhi Zhou. Error estimates for a semidiscrete finite element method for fractional order parabolic equations. *SIAM Journal on Numerical Analysis*, 51(1):445–466, 2013.
- [162] Vineet Kumar Singh and Eugene B Postnikov. Operational matrix approach for solution of integro-differential equations arising in theory of anomalous

- relaxation processes in vicinity of singular point. *Applied Mathematical Modelling*, 37(10-11):6609–6616, 2013.
- [163] Stephan V Joubert and Johanna C Greef. Can cas be trusted? *The Buf-felspoort TIME 2008 Peer reviewed Conference Proceedings*, pages 119–128, 2008.
- [164] P Zhuang, Fawang Liu, V Anh, and Ian Turner. Numerical methods for the variable-order fractional advection-diffusion equation with a nonlinear source term. *SIAM Journal on Numerical Analysis*, 47(3):1760–1781, 2009.
- [165] Harendra Singh and Chandra Shekhar Singh. A reliable method based on second kind Chebyshev polynomial for the fractional model of Bloch equation. *Alexandria Engineering Journal*, 57:1425–1432, 2018.
- [166] Rahul Kumar Maurya, Vinita Devi, Nikhil Srivastava, and Vineet Kumar Singh. An efficient and stable Lagrangian matrix approach to Abel integral and integro-differential equations. *Applied Mathematics and Computation*, 374(125005):1–30, 2020.
- [167] Om Prakash Singh, Vineet Kumar Singh, and Rajesh Kumar Pandey. A stable numerical inversion of Abel’s integral equation using almost Bernstein operational matrix. *Journal of Quantitative Spectroscopy and Radiative Transfer*, 111:245–252, 2010.
- [168] Mehdi Dehghan, Jalil Manafian, and Abbas Saadatmandi. Solving nonlinear fractional partial differential equations using the homotopy analysis method. *Numerical Methods for Partial Differential Equations: An International Journal*, 26(2):448–479, 2010.

- [169] Mehdi Dehghan, Mansour Safarpour, and Mostafa Abbaszadeh. Two high-order numerical algorithms for solving the multi-term time fractional diffusion-wave equations. *Journal of Computational and Applied Mathematics*, 290:174–195, 2015.
- [170] Nikhil Srivastava, Aman Singh, Yashveer Kumar, and Vineet Kumar Singh. Efficient numerical algorithms for Riesz-space fractional partial differential equations based on finite difference/operational matrix. *Applied Numerical Mathematics*, 161(8):244–274, 2021.
- [171] Yashveer Kumar, Somveer Singh, Nikhil Srivastava, Aman Singh, and Vineet Kumar Singh. Wavelet approximation scheme for distributed order fractional differential equations. *Computers & Mathematics with Applications*, 80(8):1985–2017, 2020.
- [172] Farshid Mirzaee and Nasrin Samadyar. Combination of finite difference method and meshless method based on radial basis functions to solve fractional stochastic advection–diffusion equations. *Engineering with Computers*, pages 1–14, 2019.
- [173] Nikhil Srivastava, Aman Singh, and Vineet Kumar Singh. Computational algorithm for financial mathematical model based on European option. *Mathematical Sciences*, 2022.
- [174] Vahid Reza Hosseini, Wen Chen, and Zakieh Avazzadeh. Numerical solution of fractional telegraph equation by using radial basis functions. *Engineering Analysis with Boundary Elements*, 38:31–39, 2014.
- [175] Nikhil Srivastava and Vineet Kumar Singh. L3 approximation of Caputo derivative and its application to time-fractional wave equation-(1). *Mathematics and Computers in Simulation*, 205(3):532–557, 2023.

List of Publications

Research paper published in peer-reviewed journals:

- [1] **Nikhil Srivastava** and Vineet Kumar Singh, “L3 approximation for Caputo derivative and its application to time-fractional wave equation-(I)” **Mathematics and Computers in Simulation** (Elsevier) 205 (3): 532-557, 2023.
DOI: <https://doi.org/10.1016/j.matcom.2022.10.003>.
- [2] Yashveer Kumar, **Nikhil Srivastava**, Aman Singh, Vineet Kumar Singh, “Wavelets Based Computational Algorithms for Multidimensional Distributed Order Fractional Differential Equations with Nonlinear Source Term” **Computers & Mathematics with Application** (Elsevier), 132, 73-103, 2023.
DOI: <https://doi.org/10.1016/j.camwa.2022.12.001>.
- [3] **Nikhil Srivastava**, Aman Singh, Vineet Kumar Singh, “Computational algorithm for financial mathematical model based on European option”, Accepted in **Mathematical Sciences** (Springer), (May 2022).
DOI: <https://doi.org/10.1007/s40096-022-00474-0>.
- [4] Aman Singh, **Nikhil Srivastava**, Somveer Singh, Vineet Kumar Singh, “Computational technique for multi-dimensional non-linear weakly singular fractional integro-differential equation”, **Chinese Journal of Physics** (Elsevier), 80, 305-333, 2022.
DOI: <https://doi.org/10.1016/j.cjph.2022.04.015>.
- [5] **Nikhil Srivastava**, Aman Singh, Yashveer Kumar, Vineet Kumar Singh. Efficient numerical algorithms for Riesz-space fractional partial differential

- equations based on finite difference/operational matrix. **Applied Numerical Mathematics** (Elsevier), 161 (3): 244-274, 2021.
DOI: <https://doi.org/10.1016/j.apnum.2020.10.032>.
- [6] Yashveer Kumar, Somveer Singh, **Nikhil Srivastava**, Aman Singh, Vineet Kumar Singh, “Wavelet approximation scheme for distributed order fractional differential equations”, **Computers & Mathematics with Application** (Elsevier), 80, 1985-2017, 2020.
DOI: <https://doi.org/10.1016/j.camwa.2020.08.016>.
- [7] Rahul Kumar Maurya, Vinita Devi, **Nikhil Srivastava**, Vineet Kumar Singh, An efficient and stable Lagrangian matrix approach to Abel integral and integro-differential equations, **Applied Mathematics and Computation** (Elsevier), 374, 125005, 2020.
DOI: <https://doi.org/10.1016/j.amc.2019.125005>.
-

Research paper communicated in peer-reviewed journals:

- [1] Aman Singh, **Nikhil Srivastava**, Yashveer Kumar, Vineet Kumar Singh, “Computational approach for two dimensional fractional integro differential equations” (revision submitted) **International Journal of Computer Mathematics** (Taylor & Francis).
- [2] **Nikhil Srivastava**, Yashveer Kumar and Vineet Kumar Singh, “A new difference scheme for time-fractional telegraph equation” Communicated.
- [3] Priyanka Rajput, **Nikhil Srivastava**, Vineet Kumar Singh, “Higher order numerical algorithm for the variable order sub-diffusion equation” Communicated.

- [4] Priyanka Rajput, **Nikhil Srivastava**, Vineet Kumar Singh, “A high order numerical method for the variable order time-fractional reaction-diffusion equation” Communicated.
-