



# ANALYTICAL SOLUTION OF NONLINEAR SPACE-TIME FRACTIONAL FISHER EQUATION BY IMPROVED ADOMIAN DECOMPOSITION METHOD

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## Abstract

This paper aims to improve the Adomian decomposition method for obtaining solution of nonlinear nonhomogeneous space time fractional order partial differential equation by using fractional Taylor series expansion. The efficiency and accuracy of this method are shown by obtaining exact solution of Fisher model with suitable initial condition. With the help of this method, it is possible to investigate nature of solution when we vary order of the fractional derivative. Behavior of the solution of this equation is represented by graphs using Matlab software.

## References

G. Adomian and R. Rach, Inversion of nonlinear stochastic operators, J. Math.

Anal. Appl.91, No. 1(1983) 39-46.

G. Adomian, Convergent series solution of nonlinear equations, J. Comput. Appl.

Math. 1984 Oct 11, No. 2(1984a) 225-30.

G. Adomian, On the convergence region for decomposition solutions, J. Comput. Appl. Math. 11, No. 3(1984b) 379-80.

G. Adomian, Nonlinear stochastic dynamical systems in physical problems, J.

Math. Anal. Appl. 111, No. 1(1985)105-13.

G. Adomian, Decomposition solution for Duffing and Van der Pol oscillators, International Journal of Mathematics and Mathematical Sciences 9, No.4(1986)731-732.

G. Adomian, A Review of decomposition method in applied mathematics, J. Math.

Anal. Appl. 135(1988)501-544.

G. Adomian, Solving Frontier Problems of Physics: the decomposition method,

with a preface by Yves Cherruault, Academic Publishers Group, Dordrecht 1(1994).

G. Adomian and R. Rach, Modified Adomian polynomials, Mathematical and Computer Modeling, 24, No. 11(1996) 39-46.

V. N. Bhadgaonkar and B. R. Sontakke, Exact solution of space-time Fractional partial differential equation by Adomian decomposition method, J. Adv. Math. Compute. Sci. , 36, No. 6, (2021)75-87.

Y. Cherruault, Convergence of Adomian's decomposition method, Math. Comput.

Modeling 14, (1990) 83-86.

Y. Cherruault, G. Adomian, K. Abbaoui, R. Rach, Further remarks on convergence of decomposition method, Int. J. Bio-med. Comput., 38, No.1 (1995) 89-93.

D. B. Dhaigude and V. N. Bhadgaonkar, Analytical solution of nonlinear nonhomogeneous space and time fractional physical models by improved Adomian

decomposition method, Punjab Univ. J. Math., 54, No.2(2022)127-147.

K. Diethelm, The analysis of fractional differential equations: An application oriented exposition using differential operators of Caputo type, Springer Science and Business Media, (2010).

J. S. Duan, R. Rach, D. Baleanu and A. M. Wazwaz, A review of the Adomian decomposition method and its applications to fractional differential equations, Commun. Frac. Calc., 3, No.2 (2012)73-99.

J. S. Duan and R. Rach, New higher-order numerical one-step methods based on

the Adomian and the modified decomposition methods, Appl. Math. Comput., 218, No.6(2011)2810-2828.

J. S. Duan and R. Rach, A new modification of the Adomian decomposition

method for solving boundary value problems for higher order differential equations,

Appl. Math. Comput., 218, No. 8 (2011)4090-4118.

J. S. Duan and R. Rach, Higher-order numeric Wazwaz–El-Sayed modified Adomian decomposition algorithms, Computers and Mathematics with Applications,

, No. 11(2012) 1557-1568.

J. S. Duan, R. Rach and A.M. Wazwaz, Solution of the model of beam type micro- and nano-scale electrostatic actuators by a new modified Adomian decomposition method for nonlinear boundary value problems, International Journal of Nonlinear Mechanics, 49, No. (2013), 1159-169.

J. S. Duan, R. Rach and A. M. Wazwaz, A reliable algorithm for positive solutions of nonlinear boundary value problems by the multistage Adomian decomposition method, Open Engineering 5, No. 1(2014)59-74.

J. S. Duan, R. Rach and A. M. Wazwaz, Simulation of the eigenvalue problem for tapered rotating beams by the modified decomposition method, International Journal for Computational Methods in Engineering Science and Mechanics, (2021)1-10,  
<https://doi.org/10.1080/15502287.2021.1904461>.

M. Edelman, Elbert E. N. Macau and Miguel A. F. Sanjuan, Chaotic, Fractional and Complex Dynamics: New Insights and Perspectives, Springer Int. Publ., (2018).

B. Guo, Xueke Pu and Fenghui Huang, Fractional partial differential equations and their numerical solutions, New Jersey: World Scientific,(2015).

R. Herrmann, Fractional Calculus: An Introduction for Physicists, World Scientific, River Edge, New Jersey, 2nd edition, (2014).

N. Khodabakhshi, S. Mansour Vaezpour and Dumitru Baleanu, Numerical solution of the initial value problem for fractional differential equation by modification of Adomian decomposition method, Frac. Cal. Appl. Anal., 17, No. 2(2014)382–400.

A. A. Kilbas, H. M. Srivastava and J. J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier: Amsterdam, The Netherlands, (2006).

Z. Odibat and N. Shawagfeh, Generalized Taylor's formula, Appl. Math. Comput., 186, No.1(2007) 286–293.

Z. Odibat and S. Momani, A generalized differential transform method for linear partial differential equations of fractional order, Appl. Math. Lett., 21, No.2(2008)194–199.

K. B. Oldham and J. Spanier, The Fractional Calculus, Academic Press, New

York, (1974).

I. Podlubny, Fractional Differential Equations, Academic Press, San Diego, (1999).

R. Rach, A bibliography of the theory and applications of the Adomian decomposition method, 1961-2011, Kybernetes 41, No.7/8 (2012)1087-1148.

R. Rach, J. S. Duan and A. M. Wazwaz, On the solution of non-isothermal

reaction-diffusion model equations in a spherical catalyst by the modified Adomian method, Chemical Engineering Communications, 202, No. 8(2015)1081-1088, <https://doi.org/10.1080/00986445.2014.900054>.

R. Rach, A. M. Wazwaz and J. S. Duan, The Volterra integral form of the

Lane–Emden equation: New derivations and solution by the Adomian decomposition method, J. Appl. Math. Comput.47, No.1 (2015)365-379.

R. Rach, J. S. Duan and A. M. Wazwaz, Simulation of large deflections of a flexible cantilever beam fabricated from functionally graded materials by the Adomian

decomposition method, Int. J. Dyn. Syst. Differ. Equ. 10, No. 4(2020)287-298.

R. Rach, A. M. Wazwaz and J. S. Duan, A reliable modification of the Adomian decomposition method for higher-order nonlinear differential equations,

Kybernetes , 42,No.2(2013)282–308.

Raut, Shankar R., Bhausahab R. Sontakke, and Vidya N. Bhadgaonkar, Analytical solution of linear fractional partial differential equation of Order  $0 < \alpha \leq 1$  by improved Adomian decomposition method, J Adv. Math. Comput. Sci. 37, No. 5 (2022)32-43.

A. M. Wazwaz, R. Rach and J.S. Duan, Adomian decomposition method for

solving the Volterra integral form of the Lane–Emden equations with initial values

and boundary conditions, Appl. Math. Comput, 219, No. 10(2013)5004-5019.

H. Yopez-Martinez. J. M.Reyes and I. O. Sosa., Analytical solutions to the fractional Fisher equation by applying the fractional sub-equation method, British J. Math. Comp. Sci., 4, No.11 (2014).

X. Zhang and J. Liu, An analytic study on time-fractional Fisher's equation by using HPM, Walailak J. Sci. Tech., 11, No. 11(2014), 975-985.



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