IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⪤ Impact Factor 7.105 ⪤ Vol. 9, Issue 7, July 2022

DOI: 10.17148/IARJSET.2022.9734

Applications of "KUSHARE Transform" in the System of Differential Equations

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Abstract: In this paper we use "KUSHARE Transform" for solving the system of ordinary differential equations of first order and first degree.

Keywords: Kushare transform, System of differential equations, Integral transforms, Initial conditions.

I. INTRODUCTION

Recently, Integral transforms are one of the most useful and simple mathematical technique for obtaining the solutions of advance problems occurred in many fields like science, Engineering, technology, commerce and economics. is to provide exact solution of problem without lengthy calculations is the important feature of integral transforms.

Due to this important feature of the integral transforms many researchers are attracted to this field and are engaged in introducing various integral transforms. Recently, Kushare and Patil [1] introduced new integral transform called as Kushare transform for solving differential equations in time domain. Further, Savita Khakale and Dinkar Patil [2] introduced Soham transform. As researchers are interested in introducing the new integral transforms at the same time they are also interested in applying the transforms to various fields, various equations in different domain. In January 2022, Sanap and Patil [3] used Kushare transform for obtaining the solution of the problems on Newton's law of Cooling.

In April 2022 D. P. Patil, et al [4] solved the problems on growth and decay by using Kushare transform. D.P. Patil [5] also used Sawi transform in Bessel functions. Further, Patil [6] evaluate improper integrals by using Sawi transform of error functions. Laplace transforms and Shehu transforms are used in chemical sciences by Patil [7]. Dinkar Patil [8] solved wave equation by using Sawi transform and its convolution theorem. Using Mahgoub transform, parabolic boundary value problems are solved by D .P. Patil [9].

D .P. Patil used double Laplace and double Sumudu transforms to obtain the solution of wave equation [10]. Dr. Patil [11] also obtained dualities between double integral transforms. Sachin Kushare and Patil [12] compared the Laplace, Elzaki and Mahgoub transforms and used it to solve the system of first order and first differential equations . D. P. Patil [13] solved boundary value problems of the system of ordinary differential equations by using Aboodh and Mahgoub transforms. Double Mahgoub transformed is used by Patil [14] to solve parabolic boundary value problems.

Laplac, Sumudu , Aboodh , Elazki and Mahagoub transform and used it for solving boundary value problems by Patil et al [15]. D. P. Patil et al [16] solved Volterra Integral equations of first kind by using Emad-Sara transform. Futher Patil with Tile and Shinde [17] used Anuj transform and solved Volterra integral equations for first kind. Rathi sisters and D. P. Patil [18] solved system of differential equations by using Soham transform. Vispute, Jadhav and Patil [19] used Emad Sara transform for solving telegraph equation.

Kandalkar, Zankar and Patil [20] evaluate the improper integrals by using general integral transform of error function. Dinkar Patil, Prerana Thakare and Prajakta Patil[21] obtained the solution of parabolic boundary value problems by using double general integral transform. Dinkar Patil used Emad- Falih transform for solving problems based on Newton's law of cooling [22]. D. P. Patil et al [23] used Soham transform to obtain the solutionof Newton's law of cooling. Dinkar Patil et al [24] used HY integral transform for handling growth and Decay problems, D. P. Patil et al used HY transform for Newton's law of cooling [25]. D. P. Patil et al [26] used Emad-Falih transform for general solution of telegraph equation. Dinkar Patil et al [28] introduced double kushare transform. Recently, D. P. Patil et al [29] solved population growth and decay problems by using Emad Sara transform. Alenzi transform is used in population growth and decay problems by Patil et al [30]. Dinkar Patil et al [31] used Soham transform for solving problems in chemical sciences. These problems are also solved by using Kushare transform[33]. Rahane, Derle and patil [32] introduced generalized Double rangaig integral transform. D. P. Patil and Nikhil Raundal[27] used double general integral transform for solving boundary value problems in partial differential equations[33]. Gavit, Gharate and Patil used Emad Sara transform to solve the system of differential equations [34]. Convolution theorem for Kushare transform is proved by Patil et al and applied it in convolution type Volterra integral equations of first kind[35].

In this paper, we use Kushare transform to solve system of differential equations. This paper is organised as follows, Second section is for preliminaries.. Third section is reserved for applications and conclusion is drawn in last fourth section.

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II. PRELIMINARIES :

In this section we state some basic requirements .Now we state definitions.

1. KUSHARE transform: Kushare transform denoted by the operator S(V) denoted by the integral equation $K[f(t)] = S(v) = v\int_0^\infty f(t)e^{-tv^\alpha}\,dt\,, t \geq 0, \tau_1 \leq v \leq \tau_2$

Where α is non real number. The variable v in this vital change is utilized to figure the variable t the contention of the capacity v.

2. KUSHARE TRANSFORM OF THE SOME FUNCTIONS

SR	FORMULA	INVERSION FORLMULA
1	$K(t) = \frac{1}{V^{\alpha-1}}$	$1 = K^{-1}\left(\frac{1}{V^{\alpha-1}}\right)$
2.	$K(t^n) = \left(\frac{\Gamma(n+1)}{v^{\alpha(n+1)-1}}\right)$	$t^n = k^{-1}\left(\frac{\Gamma(n+1)}{v^{\alpha(n+1)-1}}\right)$
3	$k(e^{at}) = \frac{v}{v^\alpha - a}$	$e^{at} = k^{-1}\left(\frac{v}{v^\alpha - a}\right)$

3. KUSHARE TRANSFORM OF DERIVATIVE

Let S(V) be the Kushare transform of the function f(t) , then

$$K[f'(t)] = v^\alpha S(V) - vf(0)$$

III. APPLICATION OF KUSHARE TRANSFORM IN SYSTEM OF DIFFENTIAL EQUATION

In this section we apply Kushare transform to obtain the solution of system of differential equations with initial conditions.

Example: (1) consider the system of equation

$\frac{dy}{dt} + 2y = x$ ………….. (1)

$\frac{dx}{dt} - 2x = y$ ………… (2)

With initial condition $y(0) = 1$ and $x(0) = 0$

Solution:

Applying the Kushare transform to both Sides of equation (1)

$$v^\alpha S_2(V) - v\,y(0) + 2S_2(V) = S_1(V)$$

$$\therefore (v^\alpha + 2)S_2(V) - S_1(V) = v \quad (3)$$

Applying Kushare transform of derivative on (2)

$$v^\alpha S_1(V) - v\,x(0) - 2S_1(v) = S_2(V)$$

$$\therefore (v^\alpha - 2)\,S_1(V) - S_2(V) = 0 \quad (4)$$

Solving equations (3) and (4) we get,

$$S_1(V) = \frac{v}{v^{2\alpha}-5} \quad \text{and } S_2(V) = \frac{(v^\alpha-2)v}{v^{2\alpha}-5}$$

By using partial fraction we get,

$$S_1(V) = \frac{1}{2\sqrt{5}}\left[\frac{-\mathrm{v}}{\mathrm{v}^\alpha + \sqrt{5}} + \frac{\mathrm{v}}{\mathrm{v}^\alpha - \sqrt{5}}\right]$$

The inverse KUSHARE transform of this equation gives

$$x(t) = \frac{1}{2\sqrt{5}}\left[-e^{-\sqrt{5}\,t} + e^{\sqrt{5}\,t}\right]$$

DOI: 10.17148/IARJSET.2022.9734

Simillarly

$$S_2(V) = \frac{1}{2\sqrt{5}}\left[\left(\sqrt{5}+2\right)\frac{v}{\mathrm{v}^{\alpha}+\sqrt{5}} + \left(\sqrt{5}-2\right)\frac{v}{\mathrm{v}^{\alpha}-\sqrt{5}}\right]$$

Applying inverse Kushare transform

$$y(t) = \frac{\sqrt{5}+2}{2\sqrt{5}}\, e^{-\sqrt{5}t} + \frac{\sqrt{5}-2}{2\sqrt{5}}\, e^{\sqrt{5}t}$$

Therefore required solution of the given system of equations is

$$x(t) = \frac{1}{2\sqrt{5}}\left[-e^{-\sqrt{5}\,t} + e^{\sqrt{5}\,t}\right],\ y(t) = \frac{\sqrt{5}+2}{2\sqrt{5}}\, e^{-\sqrt{5}t} + \frac{\sqrt{5}-2}{2\sqrt{5}}\, e^{\sqrt{5}t}$$

CONCLUSION

In the present paper, a new integral transform namely KUSHARE transform was applied to solve system of ordinary differential equations in first order and first degree with initial conditions has been demonstrated.

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